The AIRCRAFT YEAR BOOK

For 1943

AIRCRAFT YEAR BOOK FOR 1943

AMERICAN BATTLE PLANES FLY HIGH

A Boeing Flying Fortress high above the clouds, and overhead a team of Lockheed Lightning interceptors.

The AIRCRAFT YEAR BOOK

(Registered U. S. Patent Office)

For 1943

TWENTY-FIFTH ANNUAL EDITION

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Editor

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U. S. Navy photo

LEST WE FORGET!

Havoc at the Naval Air Station during the Jap sneak raid on Pearl Harbor on the morning of December 7, 1941.

CHAPTER I

THE WAR IN THE AIR

The United Nations Take the War to the Enemy—Air Supremacy on Nine Fronts—General MacArthur Explains Importance of Air Power—Japanese Are Stopped in All Areas—British R.A.F. and American Army Air Forces Pound Axis Europe in Day and Night Bombing Raids—Allied Air Power Dominant in North Africa and Mediterranean Campaigns.

THE United States has been at war 16 months as this is written early in April, 1943. It has not been a long war as wars go, yet it has been long enough for American air power to go into action and make itself felt over all continents and all seas. American flyers in American planes, flying wing to wing with the heroic air forces of the United Nations, have been taking the war to the enemy wherever they can find him. They have been blasting him out of the skies over land and sea, driving him back repeatedly from a score or more of brilliant advances on the surface where he had come perilously near winning his objectives. We are beginning only now to concentrate enough air power in all the far corners of the earth—where the need for greater strength becomes more imperative day by day—but what we have sent out has been brilliantly successful in the ghastly business of hitting the enemy where it hurts him most.

Conditions have become much more favorable to us compared to a year ago when our Army and Navy leaders were charged with the fateful responsibility of getting air power, and plenty of it, into action everywhere. Theirs was the most gigantic task in all aviation history. It was apparent then that American air strength must be built up for action on all fronts. Planes, flyers, maintenance crews and a continuous flow of air force supplies in ever-increasing volume had to be provided. We were on the defensive. The enemy was rampant and still on the march of easy conquest, largely because he was able to put more aviation at work where and when he wanted it, in Europe, in North Africa, in the Southwest Pacific and in the Far East. Leaders of the United Nations realized that we could lose the war, or at least it could be drawn out for too many years, if we did not soon attain supremacy in the air.

We now have that supremacy on all nine fronts and on the seven seas, and we are on the offensive. United Nations air forces, including the British, Australian, New Zealand, Canadian and Nether-

U. S. Army photo

FIVE FOR U. S. ARMY AIR FORCES

This remarkable picture was taken over Lae, New Guinea. Our pilots got five Jap planes without loss. A Douglas bomber is flying about 100 feet high strafing the enemy. A Jap bomber has crashed in the field. The wreck of a Jap Zero is at lower right. Another Zero has been brought down in field at upper right. Two other Zero wrecks are hidden by vegetation.

lands, but preponderantly American in both personnel and equipment, have stopped our enemies in the vital areas north of Australia. Their planes have been shot down in such numbers, and the quality of their aerial combat has so fallen off, as to warrant the conclusion that the Japs have lost most of their best pilots. Their air forces, as a matter of record, have made a progressively poor showing in that theater of operations as our air power has been gaining strength. It definitely made possible our successes in New Guinea, as Gen. Douglas MacArthur stated so enthusiastically after his great victory of Papua.

"The outstanding military lesson of this campaign," Gen. MacArthur wrote: "was the continuous, calculated application of air power inherent in the potentialities of every component of the air forces employed in the most intimate tactical and logistical union with ground troops.

"The effect of this modern instrumentality was sharply accentuated by the geographical limitations of this theater. For months on end, air transport with constant fighter coverage moved complete infantry regiments and artillery battalions across the almost impene-

trable mountains and jungles of Papua and the reaches of the sea, transported field hospitals and other base installations to the front, supplied the troops and evacuated casualties.

"For hundreds of miles bombers provided all-around reconnaissance, protected the coast from hostile naval intervention and blasted the way for the infantry as it drove forward.

"A new form of campaign was tested which points the way to the ultimate defeat of the enemy in the Pacific.

"The offensive and defensive power of the air and the adaptability, range and capacity of its transport in an effective combination with ground forces represent tactical and strategical elements of a broadened conception of warfare that will permit the application of offensive power in swift, massive strokes rather than the dilatory and costly island-to-island advance that some have assumed to be necessary in a theater where the enemy's far-flung strongholds are dispersed throughout a vast expanse of archipelagos.

"Air forces and ground forces were welded together in Papua, and when in sufficient strength with proper naval support, their indissoluble union points the way to victory through new and broadened strategic and tactical conceptions."

Months before Papua, however, our air forces had shown the Jap what to expect from Americans. They had blasted him out of

U. S. Navy photo

THE JAP ATTACK ON DUTCH HARBOR

Navy photo taken of the attacks on Alaska June 3 and 4, 1942. Note Jap dive bomber over radio tower at right of smoke pillar.

U. S. Navy photo

SEEKING JAP PLANES OR SHIPS

A Navy Consolidated Catalina over the Aleutian wilderness.

both air and water in the Coral Sea in May, 1942, and twice near Midway in June, when along with many costly lessons, he received two shocking surprises; one when the Glenn L. Martin B-26 bombers came over his invasion fleet and dropped torpedoes which sank two of his best carriers, besides other ships; and second, when the new Grumman Avenger torpedo bombers knocked whole squadrons of Jap fighter planes out of the sky before sinking their full share of surface craft.

The Japs tried to invade Alaska in the summer of 1942. They brought heavily laden troop transports toward Dutch Harbor. They did not know of our two secret air bases in that area, until our planes were bombing and machine-gunning their surface ships. All they could do was to retaliate by bombing Dutch Harbor, where they did very little damage. Then they occupied some little islands in the Aleutians as a face-saving measure for the benefit of the people back home. Their most important installation was at Kiska, where they tried to establish a submarine base, an extremely unprofitable venture. Our squadrons bombed and machine-gunned Kiska and the other invaded spots so persistently that the Japs could do nothing except keep on pouring in men and ships, and losing both until in March, 1943, Kiska was bombed six times in a single day. For that and other reasons

the Japs knew that we definitely held air supremacy in all that area.

The campaign of the Solomon Islands starting in August, 1942, was a remarkable demonstration of land, sea and air power coordinated to a degree of high efficiency. We took Henderson air field on Guadalcanal on August 16, and from then on used it as a base of operations for helping the ground troops clear that island of Jap forces, knocked down their planes, bombed their surface ships and submarines bringing in supplies and reinforcements, and with MacArthur's air forces adding to the weight of the almost continuous onslaught, bombed their bases and concentration centers for hundreds of miles to the north and west. Not once since May, 1942, have the Japs succeeded in a mission of magnitude in the central, north and southwest Pacific. Their rising sun has been setting there. The Battle of the Bismarck Sea early in March, 1943, marked a climax when United Nations air forces located and engaged a Japanese convoy of 10 warships and 12 transports heavily covered by planes. Our planes sank the entire convoy of 22 ships and 95 escort planes, leaving alive out of about 15,000 troops, besides the crews of the ships, only five survivors to live and tell the story from the viewpoint of men who had been on the receiving end of superior air power.

Lack of air strength was an important factor in Allied loss of the Philippines, Malay, Burma and the Netherlands East Indies. As the

U. S. Navy photo

AT HENDERSON FIELD, GUADALCANAL

A new wind sock is put up to guide our pilots during a day when both the weather and the Japs were placid.

U. S. Army photo

OVER GUADALCANAL

A Boeing Flying Fortress over the shoreline on Guadalcanal leaves a Jap transport in flames. (Note burning ship below the tail of the bomber.)

war dragged on month by month, it became increasingly obvious that only a great deal of air power could recover those lost lands for the Allies. After the fall of Burma, the British R.A.F. and our Army Air Forces were strengthened materially in India, with some additional help for China. The Japanese made no progress after Allied bombing squadrons commenced raiding them at key points in Burma and Indo-China. In March, 1943, Secretary of the Navy Frank Knox stated that Japan had lost 14 per cent of her merchant fleet, largely through our airplane and submarine operations. More aviation is needed, however—much more. It is not enough to have air supremacy over the Japanese in all those far-flung outposts they have conquered. There must be a very great supremacy in all areas in order to make reconquest reasonably quick and without too much cost in ships and men. Enough air power in the Far East will help the Allies regain Burma this year.

Enough air power in China will help push the Japs back into the sea. There has been effective work by our air forces in China during recent months, but it is relatively little when compared to what we have in store for the Japs. Their armies of occupation will not be the only ones to suffer. All Japan will suffer. Japan had a good idea of other disastrous things to come when on April 18, 1942, Gen. James H. Doolittle led his squadron of North American B-25 bombers in the wholly destructive raid on Tokio and other places where the Nippon evil spawns.

In all the other theaters of the global war the air forces of the

United Nations have been doing equally well. On the eastern front in Europe, the only front on which American air forces are not in action at this writing, the Russians repeatedly have gained control of the air until it is no longer a matter of especial mention in the Moscow communiques. So much for the great and powerful German air force, which in fact was really great and the most powerful force of its kind in the world until our own Army and Navy air forces in recent months developed a combined strength now believed to surpass it. Ours, unavoidably, is fanned out all over the world, and even in Russia, a substantial part of our air force equipment is being used by the Soviet squadrons, while American men and machines are in a struggle to the death with the Germans on all other fronts in that hemisphere.

American air forces operating out of England have been helping the R.A.F. in round the clock raids on Germany and German controlled areas in North Europe. There were many heavy raids over Axis Europe in 1942. The R.A.F. made the heaviest, hitting Cologne with hundreds of planes, and wrecking its industries, most of them past rehabilitation.

U. S. Army photo

RAID ON RABAUL

Bombers of the U. S. Army Air Forces surprise a heavy concentration of Jap vessels at Rabaul, New Britain. Photo taken as the attack began.

THE GRUMMAN AVENGER

Navy torpedo bomber which proved so effective in all engagements with the Japanese Navy.

Since January, 1943, the Allies have increased their heavy raids. The R.A.F. with their night bombers have gone far into Germany, while American Boeing Fortress and Consolidated Liberator squadrons have practised their exclusive daylight precision bombing on key centers in Germany and the German-held lands on the continent, with assurance that they, too, soon will have enough air power in that area to take them anywhere in Europe on the most frightful missions of destruction. Around the clock bombing has been the German fare thus far this year. Experts, who have estimated that an average of 4,000 tons of bombs a month were dropped on Axis Europe in 1942, believe that 10,000 tons were dropped in February, 1943. Wilhelmshaven, Nuremberg, Berlin, Essen, Hamm and Cologne, which has been hit four times again this year, have been the main targets; while Lorient, Brest and St. Nazaire, German bases in France, have been bombed repeatedly, along with several other centers of German war industry, railway junctions, supply bases and mobilization points. Essen, home of the huge Krupp munitions and railway plants was raided on two nights in March, 1943, by 400 heavy bombers which dropped 1,000 tons of high explosives. Despite the terrific damage, the Krupp works was not entirely destroyed, al-

though production was surely disrupted and retarded for weeks to come. Essen will continue to be bombed until it is put out of the war.

The raids on German cities have caused enough destruction to warrant still greater attacks, if possible. It is estimated officially that 2,000 German industrial plants have been wrecked and more than a million war workers rendered homeless. Still, there are 31 key industrial cities in Germany, eight in the West, 15 in central Germany and eight in the East. Not only must all these be bombed to destruction, but the new plants which the Germans have located elsewhere must be found and given the same treatment. It is a difficult task and one requiring mammoth supplies running into hundreds of thousands of separate items, besides a steady flow of flying men, ground crews and new flying machines in that one theater of war alone.

More American bombing operations are essential, not only to augment the punishment which the brave and capable, but overworked R.A.F. gives Germany, but because the high precision bombing technique, developed by the Americans and built into their equipment, is necessary to hit principal targets squarely and destroy them completely as part of the softening process preliminary to invasion. Late in March, 1943, an Associated Press dispatch quoted Major Gen. Ira C. Eaker, commanding our Eighth Army Air Force in England, as saying: "American bombers can go to any target in Germany and beat off fighters on their way there and back." He

THE MARTIN B-26 MARAUDER

The Army Air Forces twin-engine medium bombers were in action on many fronts. At the Battle of Midway they shocked the Japs by launching torpedoes with devastating results, including loss of two carriers.

NORTH AMERICAN B-25 MITCHELL

These Army medium bombers were used in the Doolittle raid on Japan. They were powered by Wright Cyclone engines.

added that American air forces, up to March 25, 1943, had carried out 51 bombing raids against German establishments in North Europe, and had destroyed 356 Axis planes, with a loss of 90 American machines.

How quickly the requisite American air strength can be secured in England is a problem for the Allied Command charged with the entire war strategy on all fronts. Our operations in the Mediterranean area must be considered, because we have our own armies there in one of the most important campaigns of the war, requiring all that can be supplied in air power.

Air power has played a most important role in North Africa from the beginning. The odds swung back and forth between the British and the Axis until Allied air power helped stop the German Marshal Rommel and his jubilant troops almost at the gates of Alexandria. American equipment had arrived in quantity, and with it both flying personnel and maintenance crews numerically sufficient to keep the planes in flying condition. They helped the R.A.F. soften Rommel's supply lines and bases; and when Gen. Montgomery sent his British Eighth Army forward to drive the Axis out of Egypt, Libya, and ultimately out of Africa, it was the Allied air squadrons which kept, not only ahead of the British ground forces, but up on top of Rommel's Africa Corps, and even ahead of him as he scurried back in one of the fastest and longest retreats in history.

Now the Allied armies have cornered the Axis in Tunisia, and no engagement has been started without plenty of air bombardment and ground attack. That also applies to the ceaseless operations against Axis bases and supply lines throughout the Mediterranean area and in South Europe. The demand is for constantly increasing air strength in men, machines and the hundreds of thousands of essential items of supply.

When finished, the Mediterranean campaign may well have been only the beginning of a long and costly South Europe invasion, in which case the demands on our air forces will be without precedent.

Meanwhile, anti-submarine patrol, reconnaissance, convoy escort

U. S. Army photo

GENERAL ANDREWS DECORATES CAPTAIN OGLESBY

Lt. Gen. Frank M. Andrews rewards Capt. Sam R. Oglesby for his three-runs, all hits, raid on Benghazi, destroying enemy supplies and transport facilities although his own plane was badly damaged by intense anti-aircraft fire.

U. S. Army photo

CONSOLIDATED LIBERATORS BOMB TRIPOLI

Strategic docks and supply bases were fired on first run over the target area.

and a fast-growing Army and Navy air transport service, which probably is superior to that of the enemy, link together in one world-wide network, between the home front and the nine principal combat zones of our air force operations, one vast system helping to maintain the present Allied supremacy in the air.

CHAPTER II

THE AMERICAN CONTRIBUTION

Combat Victories Prove Excellence of Army and Navy Training Methods—Air Tactics Well-Conceived—The Safety Record—Rickenbacker Lauds American Bombing Technique—Fighter Planes Prove Worth in Combat—Inventions and Other Developments—Aircraft Manufacturers More Than Double Production.

ONLY the maximum of effort here in the United States could have provided the air power required to help take the United Nations off the defensive and place them well on the road to victory. That the maximum effort has been put forth in this country during the 16 months since Pearl Harbor, is evidenced by the record of accomplishment in every activity having to do with building up the world's largest air forces and getting them into day and night contact with the enemy.

A box score of five Jap planes for every machine that we lost was the record for several months during 1942, while in North Europe our developing operations against the vaunted German air force with its highly acclaimed equipment grew to be approximately the same. The R.A.F., for that matter, had proved time and again that the Luftwaffe could be shot out of action. Thus it was no surprise when Secretary of War Henry L. Stimson announced that during the last 11 months of 1942 American planes shot down 987 enemy machines plus 362 probables as compared to our loss of 309. Since then the enemy losses have become proportionately greater with each passing month. The air forces of the Army and the Navy, which also includes the Marine Corps and Coast Guard, have taken the offensive in the air and are demonstrating their superiority over the enemy on all fronts. Here let us take stock of the various factors which have contributed to those happy and extremely promising conditions which must have such decisive influence on the outcome of the war.

There was nothing niggardly in the planning of the Services when they set up the 1942 program for air strength in this global war. The Army Air Forces, according to present plans, will comprise one fourth of the entire Army, regardless of the size that the Army may become in the future. The Navy air forces acquired nearly 5,000 planes during the 12 months ending June 30, 1942, and

ON DUTY WITH THE R.A.F.
Bell Airacobra seeking the enemy.

its pilot-training program had been expanded for adequate personnel in all operations, with sufficient replacements for any contingency. More than a thousand Navy pilot students were put in training every month. All told, the air forces, including flight crews and surface personnel, were being built up to a total of approximately two and a half million men. As explained in detail in Chapter V, the American system of training was unexcelled anywhere. It produced superior airmen and service experts.

The excellent training was emphasized further by the safety figures in non-combat flying. Assistant Secretary of War for Air Robert A. Lovett threw considerable light on the fine record in training operations when in November, 1942, in reply to questions, he wrote the Aviation Sub-Committee of the House Military Affairs Committee, in part as follows:

"The training program of the Army Air Forces and, indeed, all its activities, have been greatly expanded in the last year. In the first seven months of 1942 (the latest completely tabulated figures available) 45 per cent more hours were flown than the whole 10 year period from 1930 to 1940. In spite of this extraordinary expansion, the rate of accidents per 1,000 hours flown was lower in the 1942 period than the 10 year peace time average. Accident rates fluctuate from month to month and from year to year. Hence an

average is used to obtain a reliable comparison. The figures for the first seven months of 1942 show that the accident rate during that period was 15 per cent lower than the rate for the 10 year period from 1930 to 1940. These figures are striking, and especially so when it is realized that our training schools have been working under great pressure, and their facilities are being expanded and taxed to the utmost. Under pressure of war the training period has been compressed in time. Furthermore, the great increase of new pilots has inevitably led to a reduction in the average level of pilot experience. Nevertheless, the frequency rate of accidents in the United States is still actually lower per hours flown than the average of the peacetime years mentioned above."

By August of 1942, our Army and Navy planes had been in combat with the Japs hundreds of times, with more than 2,000 fighter planes involved on both sides. Large numbers of the American Army and Navy pilots had come into actual combat fresh from training. The results were magnificent. While the Jap proved to be a good flyer, adept at acrobatic stunts whenever he flew the light, unarmored and lightly firepowered Zero, which made the ship easily maneuverable, still he was no match for our pilots. The Japs, like the Germans, do their best work flying in swarms, preferably against lone Allied aircraft which they may chance to ambush from a cloud bank. That is probably because the Japs are German-trained. The Germans used the same method in the last war, and this was one of their faults that contributed to Allied superiority in 1918. When they and their Jap friends lose this war in the air, as they are now beginning to do, superior training on the part of the Allied air forces will be one of the reasons.

Aside from size and training, our air forces have been schooled

U. S. Army photo

CURTISS P-40 IN ALASKA

Taking off on a long flight.

BELL AIRACOBRA ASSEMBLY

Rolling off constant motion production lines complete except for attachment of the wings.

in the most efficient tactics. Captain Eddie Rickenbacker, returning from England after an investigation for the Secretary of War, reported:

"In England I had full opportunity to visit the various bombardment and fighter units of the American air forces, as well as to confer with the members of the high command of both British and American air forces. My consensus is that American conceptions of Army aircraft and their tactical employment are proving sound in combat and that the British look upon the practical application of our air war theories with increasing approval. There is a great deal of misinterpretation of day bombing and night bombing. Strictly speaking, it is not a matter of day bombing or night bombing, but day and night bombing, with day bombing mainly being devoted to specific objectives, and night bombing aimed mainly on larger areas such as enemy industrial centers. Both types of bombing are important and necessary. While heavy English bombers can operate in the daytime, they are night bombers mainly. American heavy bombers on the other hand, can operate in the night time as well as in daylight. They have proven, repeatedly, in actual combat that their speeds, altitude and terrific defensive fire power make them dangerous game for enemy fighters. Since American bombers can operate in both daylight and dark, with equal disregard for enemy fighters, and since they can engage in both precision and area bombing, it seems to me

that there can be no question whatever that the Army Air Forces bombardment theory is well sustained in the crucible of practice."

After a year of actual experience under all conditions in North Europe, in the Southwest Pacific and in the Far East, the accuracy of American bombing is a constant source of amazement to the enemy, who can not understand how machines flying 20,000 feet or more above the surface can drop at least one bomb out of every four squarely on a building or anything that has been picked for a target. The fact is that our air forces, in cooperation with the manufacturers, have developed their technique around a special bombsight in conjunction with which the design of the plane itself is an important factor.

The heavy firepower of our fighters and their efficiency despite their heavy loads of ammunition and armorplate has been a major contribution to success, and there are machines now in production far more deadly in their speed, range and firepower—three characteristics which promise to keep our fighter squadrons far in advance of the enemy's equipment, regardless of what he may develop. These new fighters will contribute to even greater success against the Axis in the coming months.

While our four-engine long-range bombers have amazed both the German and the Jap because their armorplate and high defensive

CURTISS-WRIGHT FINAL ASSEMBLY

Warhawks, Kittyhawks and Commandos receiving hundreds of subassemblies in one of the Curtiss-Wright Airplane Division plants.

REPUBLIC THUNDERBOLT PRODUCTION

Final assembly of Army P-47 fighters at the plant of Republic Aviation Corp.

firepower make them under most conditions capable of self protection, they are only the forerunners of more powerful bombers with even greater defensive armament and much heavier bomb capacity which the Germans and the Japs will see over their heads in the near future. At the same time, a variety of special purpose bombs of which the details are as yet secret, already are shattering enemy morale on several fronts and occasionally in his front yard.

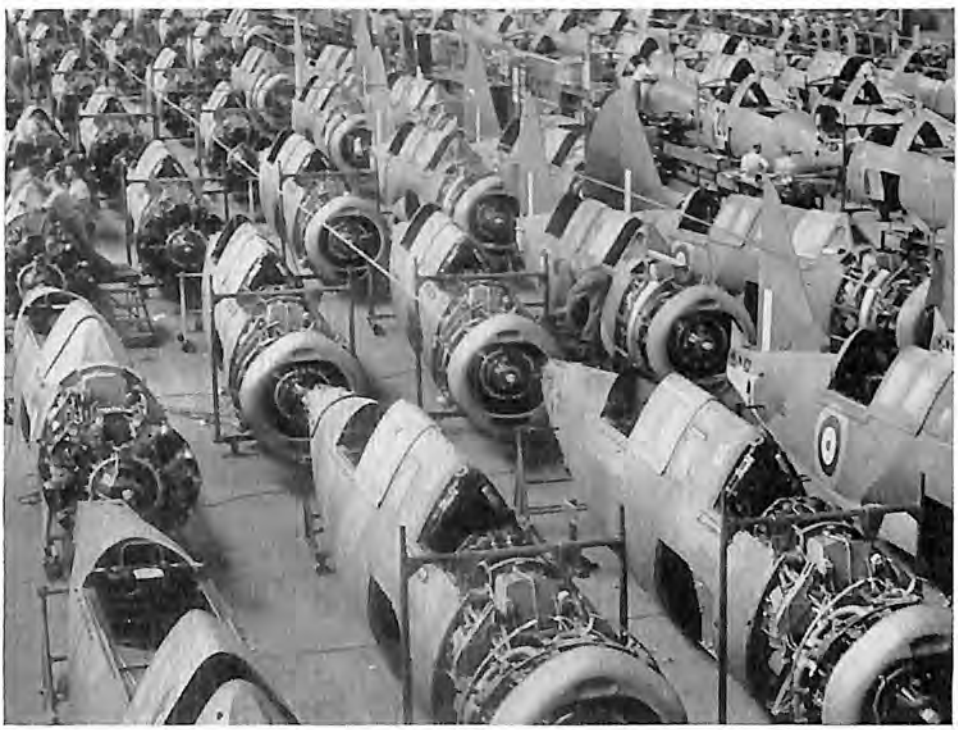
One of the big surprises for the enemy in recent months has been the flexible steel runways which, laid down on any cleared land, provide smooth landings and take-offs for heavy planes. Only a country with the production capacity of the United States would be able to provide these steel runways in sufficient quantities. In January, 1943, we produced thirty-seven million square feet, according to War Department records. The steel runways were surprises for the enemy in 1942. He is due for a much greater shock in the same field of activity within the next few months. Contrary to the tradition that new wartime inventions cannot be used in the course of the war, there are scores of new inventions even now in the combat areas, and very often they could—if military restrictions did not prevent—provide the reason for the mysterious and apparent ease with which a battle has been won.

Probably no greater contribution to the success of air operations has been made than the early development of our Army Air Forces Engineers. They have laid down air fields in the combat zones under almost impossible conditions. Special equipment has been flown to the fronts, the air fields have been ready for operations—to the consternation of the enemy and the utter satisfaction of Allied com-

manders, who can depend on the air power being where they want it, and on time.

The efficiency with which our air forces mechanic personnel has been trained and made available throughout the various Allied fields of operations is another contribution to success. These technicians have been trained in the Army and Navy schools, in private schools and in the plants of the aircraft manufacturing industry. Besides the men in the Services, the larger companies also keep their own corps of specialists in various war zones to service and repair their equipment, particularly if it is being used in large numbers.

Nowhere in the world has there been developed such a system of military air transports as that of our Army and Navy air forces, with some services being operated by the air lines under contract with the Government. It is most effective in maintaining efficient operations by the speedy transportation of personnel, emergency supplies and spare parts to any point in the world where our air forces are located—in a matter of hours compared to days and weeks required by the fastest surface transport on land or sea. Gen. Henry H. Arnold, commanding the Army Air Forces, has covered all fronts on various trips and invariably has been away from his headquarters



BREWSTER DIVE BOMBERS

Navy Blasters and Buccaneers and R.A.F. Bermudas on production lines in one of the Brewster plants.

MARTIN BOMBER ASSEMBLY

U. S. Army Air Forces B-26 Marauder twin-engine bombers nearing completion at the plant of The Glenn L. Martin Company near Baltimore.

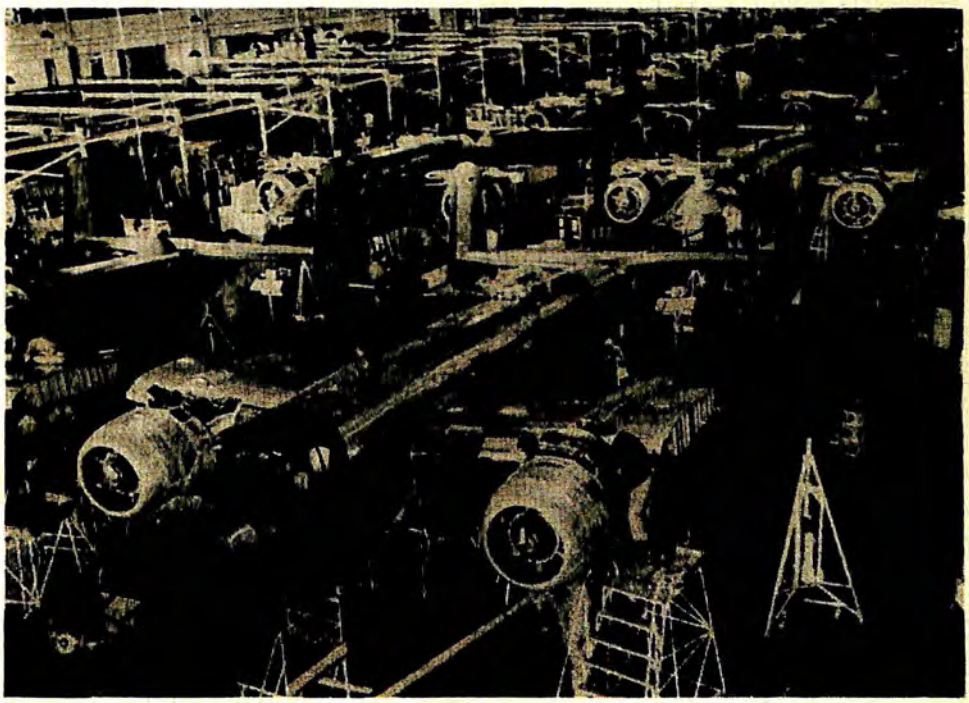
in Washington only a few days. During a press interview on December 8, 1942, he described some phases of the start of the campaign in North Africa, as follows:

"The North African operations involved coordinated air operations originating 3,000 miles apart, from the United States on the one hand and England on the other—operations carried on over a greater distance than any of the kind in the annals of warfare. Some of these air missions were assigned to the British Royal Air Force. Others were assigned to the Army Air Forces. Air units from the United States and from England, moved by ship and air, were welded in the heat of battle into a composite whole as the result of the magnificent advance coordination and tactical timing. So bombers and fighters of all types, arriving from far distant widely separated points, joined under fire in combat operations which depended for success upon perfect timing. One of the most remarkable examples of careful planning and tedious training was the arrival in the battle of parachute troops flown non-stop from bases approximately 1,500 miles away in the United Kingdom. No parachute attack in history had been made over more than a fraction of this great distance. The dropping of troops had to be timed to the minute with the attacks made by bombers and fighters. Some of these planes, incidentally, had arrived but a short time before from America. The paratroopers began bailing out while combat planes were completing the job of

clearing the skies and neutralizing ground opposition in the target areas.

"Such precision on the battlefield is not always expected of even veteran troops. Yet for many of these men this was their first action. The precision with which the paratroops were delivered at an exact spot on a battlefield many hundreds of miles away at the exact time necessary for success is a credit to one of our newest Air Force organizations, the Troop Carrier Command and to the parachute battalions. You will hear more and more of these organizations as we get deeper into this war."

Obviously nothing worthwhile could have been accomplished in the air during our first year of war without sufficient flying equipment to do the job. There can never be too much of anything in war. The more a field commander has to work with, the more he can accomplish. It is especially true of aircraft equipment. Fortunately for our war effort, and in all probability most fortunate for the cause of civilization in our time, the American aircraft manufacturers continued, as they had throughout the years of peace, to provide the Army and Navy air forces with the required number of airplanes, engines, propellers, instruments and thousands of parts used in warplanes. Their output continues to be an industrial miracle, and is



NORTH AMERICAN BOMBER ASSEMBLY

Final assembly of Army B-25 Mitchell medium bombers at North American Aviation's Inglewood, Calif., plant.

CONSOLIDATED LIBERATORS

Army B-24 four-engine bombers moving along the assembly line in a 24 hours a day production program.

so recognized by the military leaders. While asserting that they need even faster deliveries, they are quick to add that the principal companies in the industry, the manufacturers who have designed the world's best combat planes, are producing the maximum number permitted by the Government which controls the production program and the allocations of critical materials, which must be rationed among all war industries—for ships and smaller boats, tanks, guns and other kinds of equipment as well as warplanes.

At the time of Pearl Harbor, the companies were operating about 41,000,000 square feet of productive factory space. They had about 257,000 shop employees working on planes, engines and propellers. There were only 2,500 women employed in this work at the time. Vultee Aircraft had been one of the pioneers, and had found women to be satisfactory in most of the assembly work.

Production in 1941 had been little short of phenomenal, with a total of about 20,000 planes, nearly half of them trainers. Many experts did not believe that the industry could produce more than that number in 1942, not until upward of 50 new plants had been built and tooled and set working at capacity production. There were too many problems, too many obstacles to increased production. But the industry did increase its output past all expectations.

Regardless of the difficulties, the manufacturers more than doubled production in 1942, and at the same time the output of larger planes, such as two- and four-engine bombers, increased proportionately.

President Roosevelt in his message to Congress on January 7, 1943, gave production as 48,000 planes in 1942. That was more warplanes than the United States had produced in all the 23 years since the last war. It meant that a plane had been completed every 11 minutes day and night throughout the year. The value of this production in terms of money was over five billion dollars, a very large part of which went into wages in the plants of the industry and more than 2,000 factories of subcontractors, accessories suppliers, purveyors of tools and raw and fabricated materials in every State. It represented a 135 per cent increase in plane output, 240 per cent increase in engine horsepower production and 136 per cent increase in propellers.

The problems, of course, have been legion. Housing conditions, the difficulty of transporting employees, the rubber shortage and all the other shortages common to other industries have fallen heavily

BOEING FLYING FORTRESS FUSELAGE
Moving on monorail crane on its way to final assembly.

WRIGHT ENGINE "ICE BOX" TEST

One of the engineers of Wright Aeronautical Corporation recording technical observations before starting test on a Cyclone engine under conditions simulating the weather on several fronts in the global war.

upon the aircraft plants in most localities, largely because their expansion in the recent past has been most rapid of all, and they long since have absorbed most of the available labor.

The problems peculiar to the manufacture of aircraft are the most difficult to solve and at the same time maintain quantity production. Air warfare demands the best flying machines, and rapidly changing tactics, with a shifting scene of operations, lead the air forces to demand changes in the equipment. Change orders often run into the hundreds on a single model. Until the war demanded rapid deliveries, the production lines were stopped and no planes came out of the plant until the change orders were completed. Since Pearl Harbor, the manufacturers have had to try to keep on turning out planes while tooling up for what often amounts to a new machine, though it may keep the same name.

Loss of personnel because of the draft has been a major problem. One plane factory alone has lost 9,000 employees to Selective Service. Others have had to be trained to take their places. Again, the short-

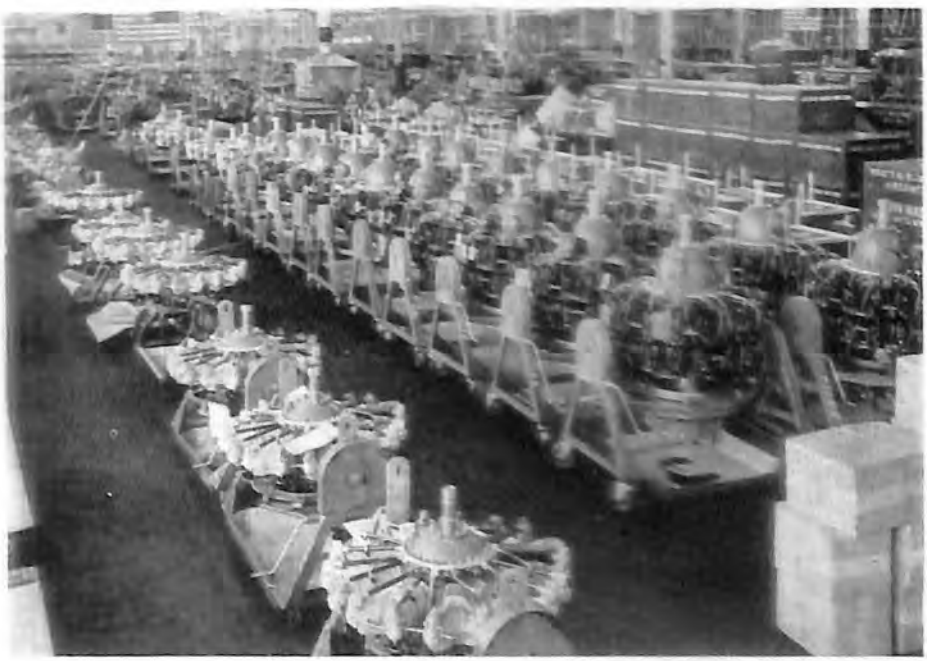
age of materials at irregular intervals in first one plant then another has kept production below capacity for months at a time. Since Pearl Harbor several major companies have released large groups of employees until materials could be procured, only to find them in other war industries and unavailable when the aircraft work was to be resumed.

Productive employees had increased from 300,000 to over 600,000, and 150,000 of them were women. In November, 1942, production had risen to 4,812 planes, or an annual rate of 57,000. Manhours for that month had jumped to one hundred eighteen million as compared to forty-seven million in November, 1941.

In January, 1943, shop employees had jumped to 660,000 of whom 170,000 were women—28 per cent of the total. Seventy-five per cent of all persons hired in that month were women. During the last 12 months new plants had been placed in production; and factory space had increased to eighty million square feet, nearly doubled since Pearl Harbor.

The automobile companies have played an important part in supplying auxiliary equipment and parts for aircraft, including engines. Their outstanding contribution thus far has been in engines and parts; and they are now getting into production on some types of aircraft.

Undersecretary of War Robert P. Patterson gave the total air-



WASPS, TWIN WASPS AND DOUBLE WASPS

Pratt & Whitney engines on the assembly floor; Double Wasps at the right, Wasps in single line at left and Twin Wasps at rear of the line.

craft produced in February, 1943, as 5,500, one plane every seven minutes; and 65 per cent of this total were combat planes. Four-engine bombers showed a steady increase, several hundred being produced in that short month.

Besides the annual rate of 66,000 warplanes produced in February, there was assurance that it would climb higher month by month, with possibly a total production of 90,000 warplanes in 1943—value, twelve billion dollars. As part of this growing air power there also were delivered in February 70,000 aircraft bombs of 1,000 pounds or more, 7,000 20 m.m. aircraft cannon and 27,000 .50 cal. aircraft machine guns. Undersecretary of the Navy James V. Forrestal reported that forty million 20 m.m. anti-aircraft shells, 1,000 every minute, were loaded for the Navy in February.

This vast production of equipment has been accompanied by important improvements in engines and propellers, besides better planes, new tires, new spark plugs to withstand the terrific heat of the new engines and new aircraft gasoline to provide more power—all with improved design and construction methods tending to increase our contribution to the war effort.

U. S. Army photo

ARMY AIR CHIEF RECEIVES MEDAL

Assistant Secretary of War for Air Robert A. Lovett, decorates Gen. Henry H. Arnold for his historic record flight from Australia in October, 1942.

CHAPTER III

THE U. S. ARMY AIR FORCES

Over Six Continents and Seven Seas—U. S. A. A. F. Grows to 44 Times Its Peace Strength of 1940—General Arnold Describes Achievements During Fifteen Months of War—Improved Equipment—Successful Campaigns Against the Japs—Heroic Air Battles Become Daily Routine—Precision Bombing Introduced in European Theater—We Gain Air Superiority Over the Japs—Our Fighters Beat the Germans—Allied Air Power Helps Drive the Axis Out of Egypt and Libya—Operations of the Air Transport Command.

THE first 15 months of American participation in the war were marked by phenomenal growth of the U. S. Army Air Forces and its effectiveness as it carried the war to the enemy over the six continents and seven seas, relentlessly pushing him back on all fronts. Gen. Henry H. Arnold, chief of the A.A.F., in reporting achievements stated that the Army's air service totaled more than a million officers and men, and was due to reach more than two million by the end of 1943. Meanwhile, the Army Air Forces had come a long way on the road to victory. With other United Nations forces they had gained supremacy in the air. This was far different from the beginning when they often had to fight Japanese squadrons of planes that outnumbered them as much as 15 to one.

From the first day, however, Army Air Forces pilots began taking their toll of Japanese planes. During the sneak attack on Pearl Harbor, Lieuts. Welch and Taylor shot down five Jap planes between them. In the Philippines direct hits were made on three Japanese transports near Luzon within a few hours after the war started, and Capt. Colin Kelly died after his immortal attack on the first Jap battleship to come under an American bombsight. Lieut. Col. "Buzz" Wagner began his amazing string of Jap victories when five Jap fighters hopped on him, and he shot down two, drove off the others, then dove on an enemy airdrome shooting up 12 planes on the ground. Not long after, Capt. Wheless demonstrated the toughness of our Boeing Fortress heavy bomber when he dropped his bombs on six enemy transports while being attacked by 18 Jap fighters, and then escaped after a running fight with them for 75 miles, during which

U. S. Army photo

PURPLE HEART CEREMONY IN HAWAII

Wounded receive the decoration at Hickam Field.

four of the Jap planes were shot down and at least three others damaged.

In February, 1942, operations moved to the Netherlands East Indies, and during that month, Army Air Forces heavy bombers, with a few Douglas Dauntless A-24 dive bombers and Curtiss P-40 fighters were active over Java and the neighboring seas, joining in the terrific battle of Macassar Strait, where they fought for a week, and dealt the enemy severe blows. On the last day before their evacuation from Java, Army Air Forces bombers flew on 10 missions, sank five Japanese ships and damaged four others. This bomber group operating from Australia became the nucleus of the Fifth Air Force under Lieut. Gen. George H. Brett, who had been deputy commander of Allied Air Forces, Southwest Pacific, under Gen. Wavell. Within a few days, raids by our heavy bombers based in Australia began on the Japanese invasion bases at Salamaua and Lae, New Guinea, and the important base of Rabaul, New Britain. Two squadrons of Boeing Flying Fortresses [B-17 C's and D's] were used for bombing and one for the ever essential reconnaissance. The line was definitely drawn in the Pacific theater beyond which we would not retreat at any cost. Australia and New Guinea were to become a base for a vigorous counter-offensive against Nippon. MacArthur's "I will return," and "From now on we go north," set the key-note, followed by Brett's statement a few days later, "We've taken the offensive against the Japanese in the air and we'll continue to increase it. Our only limitation is equipment. Our plans are clear-cut."

That this was not the only plan for a counter-offensive against the

Japs in which air power would have a substantial part is indicated by other developments at this time. On February 17 Major Gen. Lewis H. Brereton, commander of the U. S. Air Forces in the Philippines arranged with Gen. Brett that he should take one of the remaining Flying Fortresses and a few officers and men to India as the nucleus of a striking air force to hit the Japanese whenever they might be within bombing distance, and to develop India as a base for pounding Japan herself from forward airdromes in China, smashing her concentrated industries, and hacking to pieces her supply lines in the South China Sea. A few weeks later they arrived in New Delhi and set up headquarters of what was to become the Tenth Air Force.

Although not in any sense officially connected with the Army Air Forces, it is in these early stages of the Indo-Burma-China theater of the Pacific war that mention should be made of that remarkable outfit of Major Gen. Claire Chennault's, the American Volunteer Group, better known to the world at large as the Flying Tigers and as Mme. Chiang kai-Shek's "angels with wings" in China itself. Flying original Curtiss P-40's, always short of equipment and ammunition, outnumbered sometimes 20 to 1 in the air and constantly hiding from Jap pilots while on the ground, the A.V.G.'s ran up a score that will be tough to beat. Besides shooting down 284 Jap planes in seven months, with as many again as "probables" and more than 100 on the

NORTH AMERICAN P-51 MUSTANG

Fast and deadly U. S. Army Air Forces and R.A.F. fighter powered by an Allison engine.

CURTISS COMMANDO AND WARHAWK

The Army C-46 twin-engine transport and Warhawk pursuit plane, latest of the P-40 series.

ground, they turned in a remarkable cooperation job with ground forces over and over again, strafing enemy troops and ground objectives. All this with a loss of 10 pilots and one crew chief killed in action, and nine flyers killed in accidents. Courage, skill, intensive drill in Chennault's tactics and close teamwork were the keynotes to their success.

Army Air Forces units began operations in the Indian theater on April 2 when Gen. Brereton led a successful raid of Fortresses on the Andaman Islands in the Bay of Bengal, for which achievement he later was awarded the Distinguished Flying Cross. During the weeks that followed numerous raids were made by his bomber forces on Rangoon and air fields in upper Burma, and on Jap shipping in the Bay of Bengal. Gen. Brereton's chief of staff was Col. Earl S. Naiden, who was one of the last to leave Java, carrying Gen. Wavell and his air marshall to India in his own plane. After the Japanese conquest of Burma had cut the Burma Road, Col. Naiden organized the India-China Ferry service to fly in urgently needed supplies to Yunnan province over the 16,000 foot "hump", the toughest air route in the world. The actual pioneering of the route itself was left to the capable hands of Col. (now Brig. Gen.) Caleb Haynes, who in 1939 flew a huge B-15 to Chile with medical supplies after an earthquake, surveyed world routes, and pioneered an airway across Africa for the Ferrying Command, and who flew bombers like pursuit planes. About this time Chiang kai-Shek is reported to have said, "Give me 100 Douglas DC-3 transports and the Japs can have the Burma Road."

In the meantime things were happening down under. One of the most spectacular attacks of the war was made on April 13 and 14 under the command of Brig. Gen. Ralph Royce, who led a bomber attack from Australia to the Philippines in specially equipped North

American B-25 Mitchell bombers, destroying ships, hangars, airplanes and other installations. "It was quite a picnic!" declared Gen. Royce on his return.

A few days later, April 18, the Japanese radio, while actually in the midst of broadcasting comforting assurances to the Japanese people that they were entirely safe from aerial attack, suddenly began to issue frantic and contradictory bulletins about an unbelievable air raid then sweeping over Tokio, Nogoya, Kenagwa, Kobe, Yokohama and Yokesuike. A few weeks later Major Gen. James H. Doolittle, went to the White House to receive the Congressional Medal of Honor for organizing and executing the remarkable flight. "The success of the raid exceeded our most optimistic expectations . . . It appeared to us that practically every bomb reached the target for which it was intended . . . About 25 or 30 miles out to sea the rear gunners reported seeing columns of smoke rising thousands of feet in the air." The planes used were North American B-25 Mitchell bombers flown at tree-top level. The 79 volunteers, along with "Jimmy" Doolittle, were all nominated for the Distinguished Service Cross.

PRESIDENT ROOSEVELT DECORATES DOOLITTLE

The Congressional Medal of Honor is presented to Gen. Doolittle on the day he returned home following his Tokio raid. Present were Gen. Henry H. Arnold, Mrs. Doolittle and Gen. George Marshall, Chief of Staff.

THE BOEING B-17F FORTRESS

Eighth of the Flying Fortress line with heavier defense fire power and many other improvements.

During May 4-9 occurred the great battle of the Coral Sea, in which the Japs lost nearly two dozen ships. In this engagement Army Air Forces long-range Fortresses helped the Navy by striking some particularly heavy blows. Another step in Japan's inching-forward movement to cut our supply lines to Australia was blocked.

Then came Midway. Army and Navy aerial reconnaissance kept a constant check on Jap movements, and there was every indication that the enemy had something special under way. Admiral King and Gen. Marshall were fully aware that a huge force was being assembled; Jap ships being withdrawn from the Bay of Bengal, the East Indies and the islands around Australia, leaving the Jap subs to carry on. Midway appearing the most likely spot for attack, our preparations were made accordingly. On June 3 the first blow was struck—but not at Midway. Dutch Harbor was attacked, but we were ready there too. From a secret Army base which the Japs had not discovered, some Fortresses took off and with the Navy Catalinas were searching for the Jap before his first plane appeared. Anti-aircraft batteries at Dutch Harbor opened fire five minutes before the first bomb was dropped. Brig. Gen. Laurence S. Kuter, deputy chief of the Air Staff, flew to Alaska and brought back a first-hand account. "Our bombers in Alaska are carrying the fight to the enemy. American airmen are also devising special means to put the Japs (in the outer Aleutians) within range of fighter planes operating from our Aleutian bases (Note: Aviation engineers were rushing to completion an air base on the Andreanof Islands, bringing Kiska, Aggu and Agattu within range of our Bell Airacobras and Lockheed Lightnings). Never have I seen such a belligerent, bristling and scrappy outfit as we have up there." One of the fighter units had its planes decorated with the sign of the "Flying Tiger", commanded by Capt. John S. Chennault, son of Gen. Chennault, whose Flying Tigers of

China had made themselves well-known to the enemy. As Gen. Kuter put it: "The Japanese are now between two Flying Tigers, and both of them clawing."

The other half of the two-pronged attack started the same day (June 3, P.W.T.). Japanese planes launched a heavy assault on Midway Island. Navy patrol planes had reported a strong enemy surface fleet approaching the island, and a flight of nine Fortresses (B-17E's, with stinger tail guns) took off at noon under the command of Lieut. Col. Walter Sweeney, Jr. They flew about three and a half hours and found the Jap ships, some 600 miles out—battleships, cruisers, transports, cargo vessels, and other auxiliaries. Hits were scored and on the way back huge clouds of smoke were seen. The next day more Fortresses arrived, and a second Jap task force coming from another direction was attacked, with several hits. On the morning and afternoon of June 5 more attacks were carried out on the retreating enemy fleet. Besides Boeing Fortresses, four Martin Marauders (B-26's), fitted as land-based torpedo bombers were in the fight; and they sank two Jap aircraft carriers, with a loss of only two of our planes. Two Marauder torpedo-bombers also sank an enemy ship in the early Aleutian action. During all this time Navy and Marine fighters, dive bombers and torpedo bombers were playing

U. S. Army photo

MARTIN MARAUDER AFTER MIDWAY

This Army B-26 bomber brought its crew out of the battle, although it had received more than 500 bullet holes from the Japs.

CLOSE-UP OF LOCKHEED LIGHTNING

These Army P-38 interceptors proved more than a match for anything the Germans or Japs could send up against them. The Lightning is powered by two Allison engines.

hob with the Jap fleet, sinking several ships, as explained in Chapter IV. For the Army Air Forces part in the total performance Gen. Arnold (just back from London) sent a cable to Lieut. Gen. Delos Emmons in Hawaii congratulating him on the success achieved, ending with the breezy order, "Keep 'em fleeing!" Japan had shot her bolt in the north and central Pacific, and a most serious threat was obliterated. It was a most crippling blow. Three battleships, four to six cruisers and three transports damaged, and one destroyer sunk. The unkindest cut of all was aircraft carriers: two or three sunk and one or two badly damaged, scores of planes lost and many of the best of Nippon's pilots—payment on the revenge for Pearl Harbor. Saddest note for our Air Forces: Loss of able and popular Major Gen. Clarence L. Tinker, commander of the Seventh Air Force, Hawaii.

The scene changes. That same week Generalissimo Chiang kai-Shek and his wife sat in their shaded garden near Chungking conferring with three Americans. They were Gen. Joseph W. Stilwell, Chief of Staff of China's armies; Gen. Lewis H. Brereton, chief of the United States Army Air Forces based in India, soon to be known as the Tenth Air Force; and Gen. Claire Chennault, air adviser to Chiang kai-Shek and commander of the American Volunteer Group. They were discussing many things. Chief among them was the news of the formation of a China Air Task Force to be headed up by Chen-

nault, under the general command of Stilwell. This was to include a Bomber Command under Col. Caleb Haynes, charged with the job of halting the Jap offensive, raiding his bases and installations, and eventually carrying the war in the air to Japan's industrial cities. Also a Fighter Command under Col. Robert L. Scott, Jr., brilliant and daring lone-wolf fighter lately with the A.V.G.'s and destined to become one of the leading aces of the Army Air Forces for 1942. Nucleus for the Fighter Command was expected to be some of the Flying Tigers who were to be disbanded as a group on July 4. All this was announced in Chungking June 8. Gen. Brereton left India to become commanding general of the Ninth Air Force, Middle East, with headquarters near Cairo.

Long before Pearl Harbor the Army Air Forces had begun moving toward the European theater by stages, occupying first the Newfoundland and Iceland bases. Then with other arms and services they began moving into Northern Ireland and on the bases in England. In

U. S. Army photo

ARMY AIR CHIEF DECORATES GENERAL ECHOLS

Major Gen. Oliver P. Echols, commanding the Air Forces Materiel Command, receives the Distinguished Service Medal from Gen. Henry H. Arnold.

British official photo

AMERICANS IN ICELAND

Army Air Forces Bell Airacobra in the foreground and an R.A.F. Lockheed Hudson taking off.

April, 1942, Gen. Marshall and other high ranking officers flew to London and important plans were made. A few weeks later Gen. Arnold and Admiral John H. Towers, then Chief of the Navy Bureau of Aeronautics, flew across the Atlantic, and more detailed plans were set up for the coming aerial offensive. Before Gen. Arnold returned to Washington early in June he stated: "My visit has, I hope, hastened the time when our air arms shall join in an air offensive against the enemy which he cannot meet, defeat or survive." This was a day or two after the terriffic 1,000 plane raids of the British R.A.F. Bomber Command on Essen and Cologne, and just before the battle of Midway. (About eight months later, February 3, 1943, the R.A.F. carried out its 112th attack on Cologne, "to make sure the blitzed city stays blitzed." The feverish repair work the Germans had accomplished there on some 250 factories damaged in May was largely nullified when a hundred two-ton bloc busters and thousands of incendiaries were dropped in less than 20 minutes.) The Army Air Forces initiated action in Europe with a raid by six Douglas Havoc A-20 light bombers on July 4. Accompanied by an equal number of British-manned Bostons (R.A.F. name for the same plane), they attacked airdromes in the Netherlands with excellent results. A few days later announcement was made that Lieut. Gen. Carl Spaatz had set up his headquarters in England for our Eighth Air Force. His chief of Bomber Command was Major Gen. Ira C. Eaker. Much about their great work was to be heard in the near future.

To three theaters of operations—Southwest Pacific, India-China, and the British Isles—a fourth was added in July. The transfer of Gen. Brereton from India to Egypt to head up the Ninth Air Force heralded a flow of United States air power to the Middle East which was to prove of the utmost importance. Already Major

Gen. Russell Maxwell had built up a huge base at Eritrea near the Red Sea, with facilities for the assembly and maintenance of all types of aircraft and engines scheduled to be sent to the Middle East theater. The Air Transport Command's string of air bases across Africa had been built up in cooperation with the Pan American Airways System. Gen. Brereton on his arrival had stated that the natural conditions in the Middle East were nearly perfect for the American specialty of precision daylight bombing. The stage was set. The R.A.F. had been doing a splendid job with what it had, but more planes were needed, particularly long-range bombers. During the early summer they were being flown across Africa by the British and American air transport services—two-engine Wellingtons, Douglas Bostons and four-engine Halifaxes for the R.A.F., and Fortresses, Liberators and Mitchells for our A.A.F.

Action had begun even before the reinforcements were fully organized. On June 12 a force of Liberators had made a raid on the Rumanian oil fields from which Germany drew much of her petroleum. Damage was believed to be great. Four of the planes landed in Turkey. On June 15, in Liberators, Army airmen made a highly successful attack on an Italian fleet that was enroute to intercept a British convoy. Two battleships were struck by bombs, a heavy cruiser was damaged and later finished off by a British torpedo plane, and the Italian fleet streaked for home. Shortly after this the fireworks really began. Under command of Air Vice-Marshall Arthur (now Sir Arthur) Coningham and Brereton's Bomber Command chief, Brig.

U. S. Army photo

THREE AIR FORCES LEADERS ABROAD

Col. Frank Armstrong, Lt. Gen. Carl Spaatz and Major Gen. Ira C. Eaker in England.

U. S. Army photo

BAD NEWS FOR THE GERMANS

Allied air force bombers destroy one of Rommel's supply columns in the Libyan desert.

Gen. Patrick Timberlake, the newly arrived bombers carried out smashing raids, resulting in heavy damage to Axis docks and shipping at Tobruk, Benghasi, in Libya, Crete and Greece. In cooperation with the R.A.F., incessant short raids were carried out, sometimes to the tune of several hundred sorties in a day, and Marshal Rommel's supply depots, trucks, mobile guns and tanks were blasted all along the line. Planes used were mostly twin-engine Beaufighters and Bostons and converted fighters nicknamed Hurribombers and Kittybombers (Hurricanes and Curtiss P-40E's). Regarding the Bostons, air chief Coningham said, "Rommel does not like them, and we are dosing the Germans heavily with them right around the clock. They do more damage than dive bombers, and Rommel does not get our Bostons, while we get his stukas." This activity was officially stated to have been largely responsible for stopping Rommel's drive nearly at the gates of Alexandria, and set the pace for the air cooperation part of the campaign which was to drive the Axis forces completely out of Egypt and Libya.

In the meantime Gen. Ira Eaker's bomber crews in their Boeing Fortresses were putting in their final weeks of orientation training at British bases. These men were starting their daylight raids on the Continent, though the British were skeptical. At the very time the raids began at least one English critic was insisting that valuable crews must not be allowed "to throw themselves away" in daylight raids in the Fortresses, which he claimed were unsuited for that type of work. Gen. Eaker personally led the first Fortress raid on Rouen August 17, without the loss of a ship or a man. Raid after raid followed. "This marks the real start", said Gen. Spaatz. All our bombers

came back from the early raids. The British were frankly amazed at the bombing accuracy, where "every bomb counted." It was the first precision bombing in Europe. On August 21 the Fortresses met another test. A formation of 11 headed out over the North Sea. Just after their escort of Spitfires turned back, a swarm of Focke-Wulf 190's and Messerschmitt 109's came out of the clouds to attack. They were the Luftwaffe's best. They swung in against the tails of our last five bombers. When the shooting was over, three Nazi machines had been downed and nine damaged or destroyed. One Fortress was severely damaged, but all the American ships returned to base. That this was not just good luck was proved in other engagements during the next few weeks, not always, of course, without losses on our side It all added up to a demonstration that the Fortress and the Liberator, which joined the party a bit later, were not only first-class bombing machines but first-class fighting machines as well.

In the eastern theater American wings over China swept into accelerated action on July 1 when Col. Caleb Haynes' newly established U. S. Army Bomber command of Claire Chennault's China Air Task Force raided Hankow, destroying airplanes on the ground, river shipping and military installations. The next day it struck with force at

U. S. Army photo

GERMAN WRECKS

Allied air forces destroyed these M. E. 110 planes when they bombed an Axis landing field near Sollum in the North Africa campaign.

THE CURTISS P-40F WARHAWK

Latest of a long line of pursuits which have been mentioned in dispatches repeatedly from the war theaters in Africa and Asia.

Nanchang, and on July 4 at Canton, where 15 or more airplanes were believed to have been destroyed on the ground. By the end of the week the score stood at 40 enemy planes destroyed, a gunboat and some transports sunk, oil tanks and warehouses set afire, and Japanese troops bombed—all with a few North American two-engine Mitchells.

On July 4, the American Volunteer Group was officially disbanded, some of the Flying Tigers were sworn into the Army Air Forces as members of Col. Robert Lee Scott's 23rd Pursuit Group. Within a few hours of the transfer the group shot down five Japanese planes over Hengyang. This city was the junction of two important railroads, a trading center, and a key point on a great defense line in South Central China. For some years the Japs had raided Hengyang with such clocklike regularity that the residents spent the day in the countryside, returning home at nightfall. There were no defenses, and the enemy bombed his targets at leisure. Early on July 30, nine enemy bombers came in toward the Hengyang airdrome. This time something happened. When the smoke cleared, what was left of the Japs was in a flying retreat, disorganized and minus four bombers. Col. Scott's lusty 26-day old fighter group, equipped with Curtiss Kittyhawks, had turned the trick. To keep up the ancient and honorable game of face-saving the Nips returned later in the day in overwhelming force—27 of their newest type Zeros escorting some three dozen bombers. Again the American pilots proved that their chief, Claire Chennault (who was to become a Major Gen. in the U. S. Army) had made them the most deadly Jap-killers in the air, with four Zeros shot down to one American plane lost (the pilot escaped). Next day 29 more Zeros came over, nine being shot down, raising the two-day score to 17 to 1—good shooting in any language.

Early in August the Chinese minister of information was able to say: "Before the American Air Forces appeared the Japanese could do great damage to us, even with a small air force . . . Now the situ-

ation is changing. Japan is getting a headache trying to solve the hitherto non-existent problem of protecting her air fields and strongholds, which are widely scattered and great in number." This fresh breeze from the West was proving quite a tonic as reports came in almost daily of the exploits of the newly christened "Sky Dragons". By this time Brig. Gen. Clayton L. Bissell had arrived in New Delhi to take over command of the Tenth Air Force, divided into an India Air Task Force and the China Air Task Force.

One of the first chores carried out by the India Air Task Force was a series of raids on the Jap-held Myitkyina air base in Burma, 80 miles north of a direct line between Calcutta and Kunming. This was Japan's chief hope of severing the aerial Burma Road, ferrying vital supplies from India to China. Flying through blinding monsoon downpours, the American airmen put the base out of action and wrecked nearby rail connections. From this point on, their activities were continued, in cooperation with the R. A. F. in India.

Coinciding with this air activity in the India-China theater, operations from Australia were stepped up in July, 1942. Shortly after Pearl Harbor the Japanese had crept down in characteristic fashion along the South Pacific islands, threatening our vital supply line to Australia. Toward the end of January, 1942, they had established bases in New Guinea and New Britain, and later in the Solomons. They had consolidated their position in the Tulagi area, and prepared an air base, now our Henderson Field, on Guadalcanal. These forward positions depended on the strong bases of Rabaul in New Britain, Lae, and Salamaua in New Guinea, the Buna area of Papua. An additional threat was the newly established outpost of Kokoda on the threshold of the mountain barrier between Buna and

CURTISS KITTYHAWK GUN TEST

With Allison engine roaring, the .50 cal. machine guns of this fighter light up the whole plane during a night practice flight.

British Official photo

DOUGLAS BOSTONS OFF ON A RAID

The R.A.F. used them in low level daylight attacks on designated targets.

Port Moresby. These names were to figure in the daily news for many months to come. By this time the heavy bombardment group with their Boeing Fortresses, had been reinforced with fast hard-hitting medium bombers, Martin Marauders and North American Mitchells, a few Douglas Havoc attack bombers, and Curtiss Kittyhawk and Bell Airacobra fighters and Lockheed Lightnings. The Fortresses, with their longer range, made repeated raids on Rabaul, nerve center of the Jap invasion system, and the Mitchells and Marauders plastered Lae and Buna both day and night.

On August 8, a U.S. Navy communique revealed that "United States naval and other forces" had attacked in strength the Japanese positions in the Solomons, the object being to blast the Japs out of the Tulagi area. Although strategically a defensive move, it meant that at last the Allies were tactically on the offensive. The Marines had made "several landings on islands in the Guadalcanal-Tulagi area" and had established their positions, overcoming vigorous enemy resistance, capturing an important air field and turning the island into a base for an offensive northward. Concerning this action Admiral William V. Pratt, U.S.N. Retired, stated (Newsweek, August 24, "War Tides"): "The prerequisites for the success of this invasion are superiority in air and sea control, both of which the Allies apparently hold. An important factor has been the heavy attacks by Gen. MacArthur's air forces, directed against the Japanese bases at Rabaul, Salamaua and Lae, to prevent enemy reinforcements, particularly planes, from being rushed to the invasion area." [See Navy Chapter IV.]

During the last week of August, a strong air and naval counter-attack attempted to regain the lost bases. Newly arrived Lieut. Gen. George C. Kenney's Fortresses and naval carrier-based dive bombers scored four bomb hits on a large Japanese carrier, severely damaged

a smaller one, and also hit several enemy cruisers and a battleship. In one day's action U.S. pilots of all services had shot down 96 enemy planes, with 8 losses. The Jap ships withdrew from the scene. That same week the enemy attempted a landing in Milne Bay at the eastern end of Papua. There they ran into a force of American and Australian bombers and fighters, and lost three transports, a gunboat and six landing barges. The Japs evidently were trying to build an air port to aid their assault on Port Moresby, some 250 miles away. A couple of days later a rescue force "heavily loaded with reinforcements" consisting of eight Jap destroyers and a cruiser slipped through the fog into the harbor. A strong force of Aussies, well supported by Allied Air power, broke up the attempt, driving off the ships and forcing the enemy to leave "all their heavy supply and equipment, including tanks." And so it went, with our bombers striking relentlessly and without pause at enemy shipping and airdromes over a 3,000-mile front.

During that period the Army Curtiss P-40's (Kittyhawks) proved their superiority over the Jap Zeros. On August 23, the Japs sent 27 bombers, escorted by 20 Zeros, to attack Darwin, coming over at around 27,000 feet. The Kittyhawks, aided by an improved warning

British Official photo

DOUGLAS BOMBERS WITH R.A.F.

Boston III crews waiting for their machines to be loaded before taking off on a daylight raid.

British Official photo

DOUGLAS BOSTONS RAID LE HAVRE

Showing A-20C bombers attacking the E and R boat pens in the Basin de Maree in daylight on October 2, 1942.

system and using new tactics, possibly some of Claire Chennault's ingenious methods, shot down four bombers and nine Zeros without a loss to our side. It was during the month of August, as we shall see presently, that the overall box score of two to one in favor of American planes, the average from February 1 to August 1 (not including the higher average of the A.V.G.'s) began to improve steadily.

While our planes were breaking up the Milne Bay invasion attempt, Jap troops were squirming through the infested jungles. They performed a miracle of tenacity by fighting their way up and over the highest ridges of the Owen Stanley mountains. Within a few days "considerable numbers" had filtered through, bringing light mountain guns through this "impossible" country; and their advance toward the open country and the prize of Port Moresby began. Gen. Sir Thomas Blamey of the Allied land forces voiced his confidence that they would not succeed in their attempt. He was counting heavily on the furious air barrage with which Gen. Kenney's bombers were blasting the Japanese rear bases. Ten times in seven days the planes plastered the enemy beachhead at Buna, and carried out heavy raids against other enemy supply bases at Lae and Salamaua. However, the Japs came on—to within 32 miles of Moresby. There they were stopped, and during the last week of

September, when Fortresses and Airacobras teamed up with Dauntless dive bombers to destroy the strategic Wairopi Bridge north of Kokoda, over which the Japs had been moving supplies across the deep Kumusi River, the beginning of the end in New Guinea was apparent. Airacobras and Kittyhawks shuttled back and forth, shooting up trucks and shacks full of enemy supplies. Flying Fortresses struck the Jap vital blows by ranging up to their big Japanese base at Rabaul, New Britain, hitting five ships as they were starting off with more supplies.

In the meantime the fierce struggle for Henderson Field on Guadalcanal was raging, testimony to the supreme importance of air power in sea as well as land activities. About the middle of September an important "omnibian," or sea-land-air battle took place, with Army bombers once again rendering invaluable aid to the weary hard-fighting U.S. Marines, by smashing up Jap supply bases and constant attempts to bring in reinforcements. Once again the enemy retired, although thousands remained in Guadalcanal jungles and hills, awaiting the inevitable return of a bigger and better Jap invasion attempt.

September also saw a flare-up of activity in the Aleutians. A large convoy of American ships made a landing on the Andreanof Islands, and aided by the atrocious weather which precluded enemy aerial reconnaissance, aviation engineers had an air field ready for fighter planes within 10 days and for heavy bombers four days later. This brought Kiska within 250 miles, easy range for the Bell Aira-

U. S. Army photo

CURTISS KITTYHAWK IN ALASKA

While a sentry stands guard, Air Forces mechanics overhaul the ship.

British Official photo

DOUGLAS BOSTONS RAID LE HAVRE

Showing A-20C bombers attacking the E and R boat pens in the Basin de Maree in daylight on October 2, 1942.

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THE BELL AIRACOBRA
Latest standard production model of the P-39 fighter in action on many fronts early in 1943.

cobras and Lockheed Lightnings. On September 27, Consolidated Liberator heavy bombers and Martin Marauder medium bombers carried out successful raids on the Jap occupied island.

Early in the fourth quarter of 1942, the scene again shifted to England. The three Eagle Squadrons, 71st, 121st and 133rd, had just been taken over by Gen. Spaatz from Air Chief Marshall Douglas, R.A.F. Fighter Command, and had become the Army Air Force Fourth Fighter Group. On October 2, Douglas Havocs swept across the channel and raided the docks of Le Havre. Five of the Nazi Focke-Wulf 190's were shot down by Allied escort planes, four being accounted for by pilots of the newly organized Fourth, using the new British Spitfire IX.

The same day a double Fortress raid was carried out, with the Nazi airframe factory at Leaulte as one target and the airfield at St. Omer the other. Goering's prized Yellow Nose squadron of FW-190 fighters was sent into the fray with orders to stop the Fortresses at any cost. Flying in close formation, the heavy cross fire of the .50-cal. machine guns accounted for 13 of the Nazi fighters. All the Fortresses returned. Just as the unexpected fire from the "stinger" tail guns caught the Jap pilots completely off base in the Pacific theater, so the "dustpan" belly turret seems to have been a surprise to the Luftwaffe, as scores of German fighters were knocked off trying to shoot down the Fortresses from below.

The first really big raid came on October 9 when 115 Fortresses and Liberators set out across the Channel, escorted by 500 fighters manned by American, British and other Allied pilots. Some of the Americans were flying Lockheed Lightnings, a ship soon to come

into its own in a big way with the opening of the African campaign. Now the main target was Lille, near the Belgian border, with diversion raids over a wide area. From high altitudes a steady stream of bombs was loosed on the Lille railroad yards and the Fives-Lille steel and engineering works, with a production capacity of 150 locomotives annually. This was hitting where it hurt. On the way home, swarms of Me-109F's and FW-190's attempted to break up the formations and shoot down stragglers. The Allied fighters got five of the Nazi ships, while the heavy bombers accounted for 16 certain, with scores of "probables" and damaged planes. Two Fortresses and two Liberators failed to return, a singularly low percentage for heavily contested daylight raids. It should be noted that a "certain" means an enemy plane definitely observed to have crashed to earth, landed in the sea or pilot bailed out; a "probable" is one seen to have been hit, in a spin, out of control, or badly on fire, but final crash not definitely observed. This is often difficult in high altitude operations.

Lieut. Col. Carl Norcross, Air Intelligence officer of Gen. Eaker's Eighth Air Force Bomber Command, when he returned to Washington in January, reported that during 23 consecutive missions flown by the United States bomber crews over enemy-occupied Europe, they shot down 104 German aircraft in aerial combat, probably destroyed 108 and damaged 117. Our losses during these actions were 18 airplanes. Counting certains and probables this indicated a box-score of 12 to one, or if only "certains" are counted, to be strictly on the conservative side (which is the standard War Department procedure), the score was six to one. This was an extremely high

U. S. Army photo

BOEING FORTRESSES IN ENGLAND

Ground crew at work on the "Yankee Doodle" after two raids over the Continent.

CONSOLIDATED B-24 LIBERATOR BOMBER

tribute to the quality of American heavy bombers and also to our methods of training combat crews, as this record was obtained during the first weeks of actual combat experience against the pick of the German fighter pilots, veterans of hundreds of hours of air combat.

A fundamental principle of the Army Air Forces is that bombardment is the keystone of air power. Gen. Eaker stated in a press conference that air power should be recognized as one of the most powerful means the Allies have of winning the war: "By destroying the enemy's aircraft factories, his air force can be gradually wiped out; by bombing his munitions plants and communications, his armies can be slowed up and brought to a halt; and by destroying his shipyards you make it impossible for him to build submarines." Gen. Eaker went on to warn that every new offensive weapon brings an almost immediate reaction in the field of defense. Every week of delay in pressing home our smashing air offensive on the German industrial and communications system allowed them that much more opportunity to develop more effective defensive measures against our fast, high flying, well defended heavy bombers. Delay could prove costly in terms of precious lives and valuable material.

The Germans admittedly had a tough air defense problem on their hands. The American .50-cal. high velocity machine gun equalled the 20-mm. cannon of the German fighters. Besides this the American gunners had a far more stable platform from which to fire, a computing gunsight for accuracy and power-operated turrets for good measure. The concentrated fire produced by tight formation flying was deadly. Until new and more powerful fighters could be thrown into action, considerably stepped up in firepower and armor, the solution had to be tactical—some new method of using the present planes to more nearly even up the score as between bombers and fighters.

That the Nazis were making some progress along this line was

indicated by the results of two raids in late December, 1942, and early January, 1943, in which six and seven heavy bombers respectively were shot down—a higher proportion than the earlier raids. Two German fighters attacked a single bomber simultaneously and head on, firing into the front of the bomber and sweeping over it. This exposed the bellies of the fighter planes, but our crews reported that their bullets seemed to bounce off, the German machines apparently being heavily armored at that point, like the belly of the Russian IL-2 Stormovik assault plane. These tactics took advantage of the fact that most of the guns had been placed to command the approaches from the rear, sides and bottom (hitherto the customary attack angles), with fewer guns in the nose, and those operated by hand. The tactics also gained from the ballistics angle, increasing the velocity of bullets fired at an approaching target, rather than a receding target, as when firing from the rear. The head-on approach also presented the smallest possible target to the guns of the bombers. But already answers to those new tactics were in the making.

In the North Africa and Middle East theaters during the last quarter of 1942, outstanding examples of air cooperation with ground forces ("coordinated" air power) as well as excellent use of long range bombing raids ("pure" air power). The German Marshal Rommel's supply line had been battered badly by heavy bomber raids on shipping and ports, with systematic shooting and light bombardment by attack bombers and fighter-bombers. After many weeks of careful preparation, Gen. Montgomery struck on the night of October 23. First the bombers, then the artillery—probably the big-

U. S. Army photo

BELL AIRACOBRA IN AFRICA

Waiting to be pulled out of the mud of an advanced base field.

U. S. Army photo

GERMANS DOWN IN NORTH AFRICA

One of the three raiding Junkers 88s which were brought down by Lockheed Lightnings.

gest barrage ever let loose in the desert—and then the infantry. Reversing previous tactics, no tanks—yet. First the infantry went in to overwhelm the enemy gun positions and to clear away the mines. As they went forward, the artillery and the bombers kept pounding away in front of them. On the night of November 2, the British Eighth Army, having gained control of the air, struck its decisive blow against the Axis forces at El Alamein. The tanks rolled forward to carry out a single mission at any cost, "Find the Axis armor and fight it!" Sticking together, like the close formations of Fortresses over Europe against the Nazi fighters, they did just that—they found and smashed the Axis armor beyond all chance of recovery.

In addition to this, however, Gen. Brereton's Ninth Air Force and Air Vice-Marshal Coningham's Royal Air Force Middle East units pulled off the greatest offensive air victory of the war to date, the battle of Britain being the greatest defensive air victory. The air-ground cooperation in the drive against Rommel was now superb, as compared to an admitted weakness in the earlier African drives. The Axis supply lines were kept under steady bombardment before and during the drive itself. The Allied air forces virtually blasted the enemy out of the air, and also clinched the victory with an aerial chase of the retreating enemy that broke all desert records.

At the front a terrific air bomb barrage softened resistance to the advancing British and Australian infantrymen. The new American tanks and powerful mobile guns, and the new British six-pounder anti-tank guns mounted on fast American lorries proved to be a devastating combination. When the Axis line was breached, armored columns and low-flying attack bombers teamed together in a sweep that split the Italian forces in two. Here was an improved version of Hitler's plane-tank team of the early blitzkrieg days, with the shoe

on the Allied foot. Other Allied bombers pounded constantly at the German troops who deserted their Italian allies and fled along the coastal road. Warhawks, Spitfires and Bostons, North American Mitchells and newly arrived Martin Baltimores kept hammering away at Axis air fields in advance of the fleeing Rommel until his air opposition collapsed.

The rapid movement forward of Allied air fields just behind or even ahead of advancing ground forces was another important factor in the sweeping victory. Still another was the extraordinary efficiency of the ground crews. Six days after the breakthrough at El Alamein, ground crews around Tobruk, 450 miles west, already were supplying British and American air forces with practically complete service. The seventh day, Allied fighter planes were attacking El Agheila, 750 miles from El Alamein. It must not be forgotten that although the airplane is the most mobile of weapons, air power as a whole is not. Like Atlas of old it must touch the ground repeatedly to renew its strength. Airplanes without bases are helpless.

The American air attack in Africa became two-pronged with the arrival of Gen. Doolittle and his Twelfth Air Force in Northwest Africa in support of the great drive to clear the Axis entirely out of the African continent. On December 8, Gen. Arnold in a press conference gave a progress report of the Army Air Forces first year of combat which culminated in the North Africa offensive. He stated: "We have built up the closest sort of cooperation between

U. S. Army photo

A DOUGLAS TRANSPORT IN THE DESERT

An Army C-53 unloading emergency rations for fighting troops during a battle in North Africa.

U. S. Army photo

MAJOR GENERAL JAMES H. DOOLITTLE

The hero of the first Tokio raid photographed during operations in the North African campaign.

our armed services, air, ground and sea, and between ourselves and our Allies. I do not think that in the whole history of warfare you can find any finer example of coordination than that between the British Royal Air Force, Navy, and Army, and our Army, Air Forces and Navy in the North Africa campaign. For the first time we have a completely balanced air team in action. And, for the first time, we are up against a real first-class air power. We have had P-40's up against the Germans and Italians in the Egyptian theater, and we have had bombers and fighters up against the Germans in France and the Netherlands. We have met the Jap Zeros—singly and in swarms—but in Africa we are up against the whole cross-section of the German aerial might; and I can tell you we are looking forward to the results with great interest, for we believe that out of this will come the all-out air battles that must come to clear the Germans from the sky. If they meet us plane for plane, the mass of the Ger-

man aerial armada must meet the R.A.F. and our Air Forces under Spaatz and Doolittle. Once they are committed, we hope that it will be a fight leading to the extermination of the aerial hosts of Goering.

"In the African theater the Lockheed P-38 two-engine fighter Lightning now has its chance to prove its worth in large-scale combat. On November 22-23, Lightnings, operating over the Gabes-Sfax area of Tunisia, destroyed 12 Italian troop carrier planes and three others, in the air and on the ground. They also destroyed 11 tanks and some enemy motor vehicles. On the 25th, Lightnings flew reconnaissance missions over Gabes and strafing and bombing missions along the coast roads of Southern Tunis, destroying tanks, armored trucks, motorcycles and other equipment. By the end of the month Lightnings were winning victories over Germany's fastest high-altitude fighters, Focke-Wulf 190's and Messerschmitt 109G's, diverted into this battle by the Germans to meet the Allied assault. Today the Lightnings are fighting and fighting hard with the German 109's

U. S. Army photo

AFTER AN ALLIED BOMBING

Result of a daylight air raid on an Axis ammunition train on the railway near Daba in the North Africa campaign.

U. S. Army photo

DOUGLAS ARMY TRANSPORT IN ALASKA

A C-53 unloading supplies on Umnak Island after a flight from Fort Richardson.

and 190's, and results show the score to be about even to date. That is all that we can ask or expect in a campaign such as this when aerial supremacy of the Mediterranean and possibly all Europe is at stake."

In the Pacific area the China Air Task Force came of age during October, 1942, in the sense that at last occasionally they were able to attack Jap positions hundreds of miles apart, including long-range raids with four-engine bombers, and attack heavily defended targets by daylight with medium bombers and fighter escort. On October 21, a flight of Liberator four-engine bombers attacked Linsi, deep in North China and at the heart of China's richest coal mines—mines which since early 1942 had been supplying Japan's war industries with more than two-thirds of the coke they consumed. The flight of Liberators left behind them blazing ruins of the power plant and mine installations, crippling the pumping machinery and possibly putting the mines out of operation for months. This flight of several hundred miles showed what could be done with more planes available.

A few days later fighter-escorted Mitchell bombers struck the Kowloon dock across the bay from Hong Kong, blowing up long stretches of docks and hitting ships and other targets. The next day a return engagement destroyed the North Point power plant which supplied all Hong Kong with electricity. Gen. Chennault, who already had established himself as one of the world's leading fighter tacticians, as evidenced by the amazing 20-to-1 record of the AVG's, emerged as an outstanding bomber strategist as well. When Gen. Haynes went back to India to head up the India Air Task Force under Gen. Bissell, commander of the Tenth Air Force, Col. "Butch" Morgan of Pennsylvania took over the Bomber Command under Gen. Chennault. Up to the end of 1942 over 50 raids had been carried out in that area, with the phenomenally low loss of only a couple of bombers.

During this period, Col. Scott's Fighter Group was having a field day. Aided by China's uncanny warning and intelligence system, scores of Jap raids were intercepted including several violent attempts to dislodge the Group from its base at Hengyang. The box score to the end of the year showed better than 12-to-1 in our favor. Caleb Haynes also was able to step up bomber operations by the India Air Task Force. In cooperation with the R.A.F.'s Blenheims and long-range Wellingtons, this group, flying Mitchells and Liberators was pounding the enemy at Burma and points east. One of the most impressive raids was the 2,000 mile flight on December 9, of 11 Liberators from an airdrome in northeast India to Bangkok, the Japanese occupied capital of Thailand. A similar raid of a "considerable force" of four-engine bombers was made on December 27, heavy damage being inflicted at the Naval dock area, a large arsenal, and on one of the most important enemy air fields in the occupied countries. Not a plane was lost on either raid, thus maintaining the excellent record of the Liberators.

Early in December Gen. Bissell cabled that the China Air Task Force had attacked Canton with 10 Mitchells, 23 Kittyhawks escorting. One 8,000- and one 6,000-ton ship was sunk in channel, 100 loaded lighters were sunk or turned over, docks were set afire, two airdromes strafed, 20 enemy aircraft shot down and an unknown number destroyed on airdromes, all with no American losses.

WHY AIRPLANES ARE EXPENSIVE MACHINES

High performance and the maximum of safety factors in American aircraft require thousands of manhours of labor. Photo shows a crew at work on the two longitudinal beams that form the fuselage of a Bell Airacobra. The light dots are rivets.

U. S. Army photo

REPUBLIC P-47 THUNDERBOLTS

U. S. Army Air Forces high-flying fighters. The Thunderbolt is powered by a Pratt & Whitney Double Wasp 2,000 h.p. engine.

During the last quarter of 1942 the fighting in the Solomons and New Guinea moved at a faster pace. America's long-range heavy bombers played an ever more important part, and proved by all odds the prize weapon of attack in a war characterized by immense distances. The four-engine Fortresses and Liberators and two-engine Mitchells and Marauders carried the battle to the Japanese in two ways. Together with fast low flying Havocs and Australian-built Bristol Beaufighters, and Kittyhawks, Airacobras and Lightning fighters they were proving to be the spearhead for Gen. MacArthur's land offensive to drive the enemy completely out of Papua-New Guinea. In addition, they systematically bombed every base and boat they could find supplying help to the Japs in the Solomon Islands.

Two of America's top airmen were in charge of these operations. Lieut. Gen. George C. Kenney was Gen. MacArthur's air chief, and both men agree that wars are won by attack. Gen. Kenney learned the lesson well in the first World War—fly high and far, to seek out the enemy's sources of power and to strike hard and often at those centers. Major Gen. Millard F. Harmon was air chief and right-hand man to Admiral William F. Halsey, chief in the South Pacific. Admiral Halsey's recommendation to the War Department that Harmon be made a Lieutenant General was accepted early in February. Those commanders proved again and again that the speed,

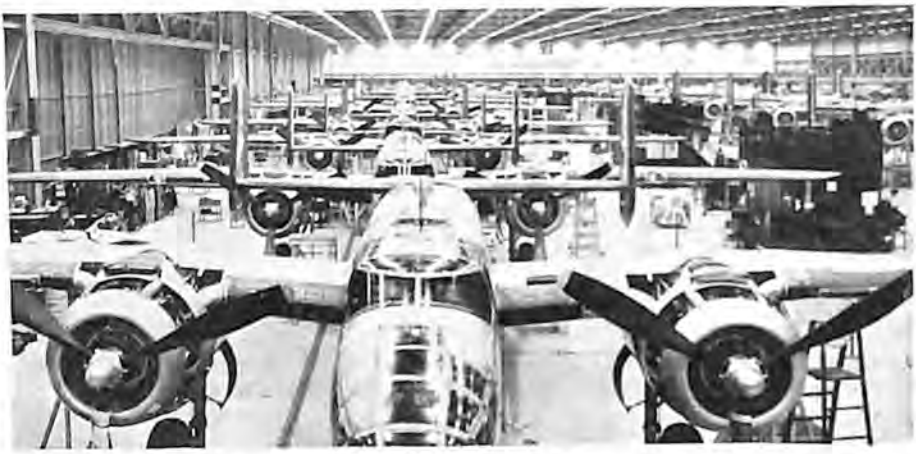
bomb load, firepower, and above all, the radius of action of 1,000 miles or more combine to put American land-based heavy bombers in a class of their own.

Typical of these offensive actions were the smashing raids on Rabaul, New Britain—key base for both the New Guinea and Solomons actions. On October 9, a flock of Catalina flying boats under MacArthur's command flew over the port, with its excellent harbor, and showered down incendiaries that set fires visible for miles. Then squadrons of Fortresses came roaring over and dropped some 60 tons of bombs, turning stores, barracks, machine shops and docks into a mass of flame and smoke. For good measure the attack was repeated the following night. No bombers were lost on either raid. It was now apparent to all, and definitely testified to by Gen. MacArthur a few months later, that land-based air power was the biggest factor, "the pattern of victory," in the Pacific war.

By the middle of November, 1942, the final assault for the Buna-Gona area was ready to be launched. Air power had smashed the Jap supply lines so badly that they had been rolled back through the mountains and jungles to their beachheads. Ground troops had been brought in by air from Australia, with all their supplies, equipment and ammunition, including 105 mm. guns, flown in parts and reassembled. And now, ready for the final push, a strong force of

BOEING TEST FOR HIGH ALTITUDES

Science turns on the refrigerator to study simulated conditions of temperature at substratosphere altitudes of 30,000 feet and over—altitudes at which the Boeing B-17 Flying Fortresses are highly successful in bombing operations. The Cold Room, shown here at the Boeing Aircraft Company, is operated by a complete refrigeration plant which produces accurate temperatures at any given altitude. A reproduction of the tail stinger turret of a Boeing Flying Fortress helps in obtaining data.



NORTH AMERICAN B-25 MITCHELL BOMBERS

Final assembly at the Kansas City plant of North American Aviation.

American troops was flown up from Port Moresby, and landed at a secret field near Buna in one of the largest air-borne troop movements of the war. Medium bombers and fighters bombed and strafed the Japs without letup in preparation for the attack on the beachhead.

At the same time a great naval victory in the Solomons made another tremendous dent in the Jap navy, American losses being comparatively light. One of the contributing factors, as reported at the time, was the land-based American air force which constantly sought out and bombed the enemy warships. Most of these planes were torpedo and dive bombers from Henderson Field, but some of the most telling blows were delivered by Gen. Kenney's heavy bombers based at Port Moresby. During all this time Jap air strength was being whittled down, the ratio of losses running 8-to-1, 10-to-1 and for one period 15-to-1, according to Gen. Harmon's reports. Navy Grumman Wildcats, flown by U.S. Marine fighter pilots, had a big share of intercepting Zeros and Jap bombers. The backbone of their fighter tactics was the two-plane section, into which went the collective experience of Claire Chennault and his Flying Tigers in Burma and China and countless air battles in the Southwest Pacific. The usual method was to attack head-on, opening up fire at 400 yards, double the range of the Jap guns, then a steep dive and back to base—more often than not leaving one or more enemy planes spinning to earth or practically blown up in the sky. Army flyers employed similar tactics with their Bell Airacobras—some being the four-cannon version, especially useful for ground strafing. Curtiss Kittyhawks also were used.

Another large scale attempt at reinforcement of the Buna-Gona area was made on December 13, spotted by aerial reconnaissance. For-

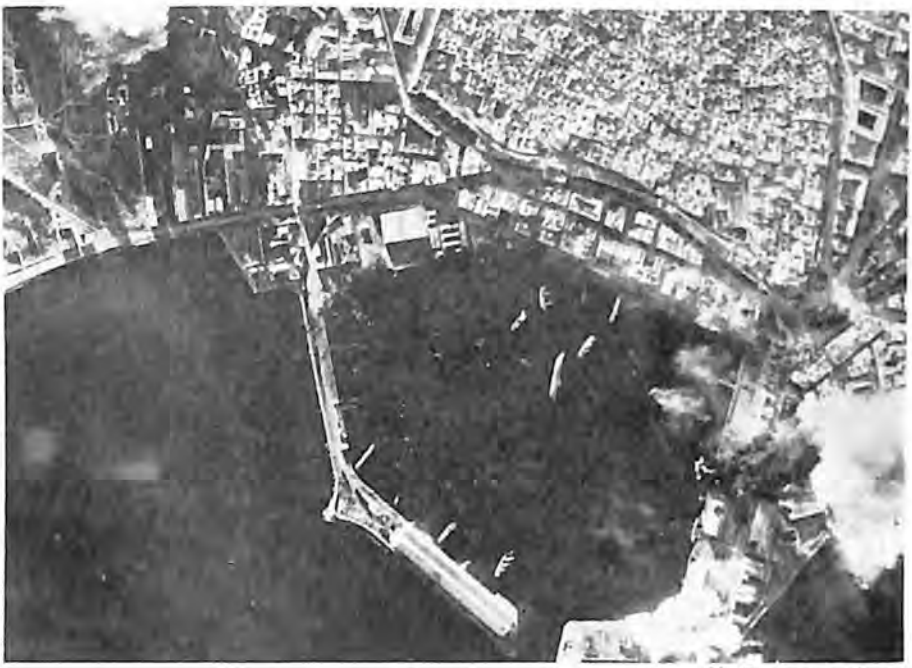
tresses and Liberators broke it up and chased it away. The next day part of the same convoy tried to land troops at another point, and bombers and fighters smashed up this attempt in an all-day fight. In this engagement a new gadget was introduced—a fragmentation parachute bomb invented by Gen. Kenney more than a dozen years before the war. By slowing up the fall of the bomb it enabled the plane to come in low over the target, insuring greater accuracy, higher fragmentation and a quick get-away before the explosion. Gen. Arnold in his Randolph Field address described these parachute bombs as particularly deadly.

Important events connected with the air war in the European theater during the first three months of 1943 included (1) the appointment in early February of Lt. Gen. Frank M. Andrews to the overall command of Army air and ground forces in the European theater. One of America's leading air officers and a specialist in heavy bombardment, his first statement was significant. "We intend to go all-out in intensifying our air warfare." (2) Between January 27 and March 18 five large scale daylight raids by American heavy bombers on Wilhelmshaven (twice), Emden, Hamm and Bremen bombed with excellent results, relatively light losses and success in shooting down a substantial proportion of opposing enemy fighters. Most of the raids were unescorted. (3) Major Gen. Ira C. Eaker of the Bomber Command was put in charge of the Eighth Air Force, and stated his intention of stepping up raids on Germany as rapidly as more equipment became available and that before long our present A.A.F. "token force" would be of a size "very nearly approaching that of the R.A.F. Bomber command."

In North Africa the Allied air forces gradually won supremacy

LOCKHEED C-60 LODESTAR

One of the fleet in Army Air Forces transport service.



U. S. Army photo

AT WORK IN NORTH AFRICA

Our Army Air Forces bomb vital points in Sousse, Tunisia, in the North Africa campaign.

during early 1943, and the arrival in Tripoli about the end of January of the powerful Western Desert air forces (R.A.F. under Coningham and the A.A.F. under Brereton) assured its continuance. From November 10, 1942, to March 10, 1943, the Allies destroyed 790 Axis planes, losing 330. For the first two months the American score in North Africa was about even, but during the period from January 15 to March 15 it was better than two to one. In February Air Chief Marshall Sir Arthur Tedder became overall air commander under Gen. Eisenhower, and Lt. Gen. Carl Spaatz became operational chief of the combined R.A.F.-A.A.F. Northwest Africa Air Force. Air Marshall Coningham, after his magnificent job of air-ground support in the drive which ousted Rommel from Egypt and Libya, had a similar job in the new command. Major Gen. James H. Doolittle had charge of bomber operations.

The urgency of increased aerial aid to China became evident during the first three months of 1943. This was emphasized further by Col. Robert Scott's statement in January that 500 planes would destroy the Jap air strength in China; Madame Chiang kai-Shek's eloquent plea; the President's request to Gen. Arnold after Casablanca to confer with the Generalissimo and Generals Stillwell and Chennault on his visit to Chungking "to see what could be done to give

China more air help"; and finally on March 11 the establishment of the Fourteenth U. S. Air Force headed by Brig. Gen. Claire Chennault under the command of Lt. Gen. Stillwell (replacing the China Air Task Force, which was under the military command of Brig. Gen. Clayton L. Bissell of the Tenth Air Force, with headquarters in New Delhi, India). This indicated that Chennault, who had accomplished wonders with his limited equipment, would be given much more equipment for the campaign in China.

The first quarter of 1943 brought important events in the air war picture in the South Pacific. The middle of January saw the final mopping up in eastern New Guinea and the clearing of the last of the Japs from Guadalcanal. This was followed closely by Gen. MacArthur's significant statement regarding the tremendous power of the air in effective combination with ground forces, indicating an offense against the enemy in "swift massive strokes" rather than an island to island advance. The second outstanding event was the air victory of the Bismarck Sea, when early on March 12 a relief convoy of 12 merchantmen, seven destroyers and three light cruisers, carrying 15,000 Jap troops, was destroyed, and 95 enemy planes. Our losses were three fighter planes, one bomber—twelve airmen. This brilliant victory for land-based planes over sea power by Lt. Gen. George C. Kenney, commander of the Allied air forces in the Southwest Pacific, was the result of air reconnaissance, concentration of every available

U. S. Navy photo

MOST FAMOUS AIRPORT IN 1942

At Henderson Field, Guadalcanal, where a steel flight strip facilitated take-offs and landings of big planes like this Boeing Flying Fortress.

BEECHCRAFT OVER ALASKA
An Army F-2 on a photographic mission.

plane, and the use of modern tactics. Gen. Kenney's arrival in Washington a few days later, with MacArthur's chief of staff, Gen. Sutherland, was interpreted as a plea for more planes to match the growing concentration of enemy air strength in the bases ringing northern Australia.

The supply problem created by the necessity of maintaining American Air Forces offensive operations in many far-flung areas was terrific. The A. A. F. was fighting on more fronts than any other organized military force in the world. Faulty logistics (logistics being the science and art of military supply) has lost more wars than incorrect strategy or tactics. Without the amazing expansion of worldwide air routes before and after Pearl Harbor, America might have lost this war. In recognition of the great part played by air transport the 1942 Collier Trophy, awarded each year for the greatest achievement in aviation in America, was given jointly to the Army Air Forces and the air lines of the United States for pioneering worldwide air transportation vital to immediate defense and ultimate victory.

Scores of combat planes, camouflaged in accordance with their

destination, took off from fields near factories where they were built or from modification centers where vital last minute adaptations were completed, on their way to theaters of operation. Four main airways were developed by the A. T. C. and the air lines—across the north Atlantic, non-stop or in several stages; from the southeastern section of the country, miles across the South Atlantic, to overseas fronts in pre-determined stages; from Southern California westward to Hawaii on the way to our island bases in the South Pacific or Australia; from northwestern United States to the extreme northwest of the continent.

From all these points, not only combat planes, but hundreds of transport and cargo planes took off, taking key personnel, urgently needed supplies and equipment, and the ever welcome mail to a dozen fronts. These operations were carried out by the air lines flying the familiar DC-3's and Lodestars and Stratoliners, in contract work for the Air Transport Command; or by the A. T. C. itself, with C-47's and 53's (Skytrains and Skytroopers), C-54 Skymasters, C-46 Commandos and C-87 Liberator Expresses. It meant that the Army Air Forces, in terms of distance, operated the greatest air line the world had ever known—an air line to everywhere. Major Gen. Harold Lee George, commanding general of the Air Transport Command, headed this rapidly expanding service.

After Pearl Harbor, the War Department set up a Contract Cargo Division charged with arranging a war freight service on the commercial air lines. On July 1, 1942, the ferrying and cargo activities were combined, known as the Air Transport Command. Brig. Gen. C. R. Smith, former president of American Air Lines, was Chief of Staff for the A.T.C. Other prominent air line executives also came into the picture, notably Col. Harold R. Harris, formerly of Pan

THE CURTISS CARAVAN

Army C-76 transport, with a wing span of 108 feet and powered by two 1,200 h.p. engines, is built of plywood.

FAIRCHILD C-61 LIGHT TRANSPORT

Light cargo and personnel transport supplied to U. S. Army Air Forces and the R.A.F

American-Grace Airways, Col. "Larry" Fritz, formerly of T.W.A., and Col. Ray W. Ireland, formerly of United Air Lines.

The July reorganization set up the air evacuation group to transport sick and wounded soldiers by air from combat zones. Its airplanes, capable of carrying as many as 40 patients, were equipped for medical treatment in flight. They served the double purpose of flying medical supplies up to the front and bringing casualties out. Long before this group was organized officially, some of the most astounding, as well as heroic, deeds of the war were accomplished in evacuations from the Philippines, Java and Burma.

Globe circling series of bases were established, and a special network of communications set up to provide daily information about the weather and other matters without which regular flying operations could not be maintained. All types of equipment had to be brought in by ship and plane. With native labor and the most primitive tools, landing fields were built or enlarged and runways extended to meet the requirements of four-engine bombers.

In the spring of 1942 the Ferrying Command was notified that several thousand pounds of essential military supplies were needed as soon as possible at a base in eastern Australia. Exactly 62 hours after these supplies became available on the Pacific coast, they were delivered in Australia. A few months later, at a crucial point in the aerial pummeling which led to the expulsion of Rommel from Libya, vital supplies were needed. An SOS by teletype resulted in their arrival in Florida within a couple of days. Two days later they were in Egypt, and Gen. Brereton's Ninth Air Force was able to continue hammering away.

A badly needed military hospital burned to the ground in a remote section of Alaska. A wire came through, and 36 hours later a 24-bed emergency hospital was set up and in operation with materials and supplies ferried in by the Air Transport Command.

The operations of A.T.C. within two years did more for international flying than could have been accomplished in 10 or 15 years of normal peacetime development. Transoceanic flights in land planes which formerly would have made front page news now became routine. World air transport was no longer a dream but a reality. The sheer necessities of global warfare catapulted the United States into global air transport. Huge investments in air fields, radio stations and weather-reporting facilities were made in foreign lands, many of which were to be on the great routes of future air travel.

Closely related to the Air Transport Command was the Troop Carrier Command, headed up by Brig. Gen. Fred S. Borum. This was officially activated on June 20, 1942, and announced about four weeks later, but, as a matter of fact, was functioning informally from the earliest days of our participation in the war. Wounded troops, ground crews and civilians were evacuated from the Philippines and Java, and were brought to Australia. Later on their activities in New Guinea and the Solomons played a vital part in American victories there. Both Gen. MacArthur and Gen. Vandergrift paid the highest possible tribute to the heroic efforts of this group for flying in reinforcements, food, medical supplies, weapons and ammunition under flying conditions which were just about the world's worst. Secretary Stimson cited the entire South Pacific group early in February, 1943. Gen. Arnold referred to the vital part the Troop Carrier Command played in the North African operations. There were T.C.C. units operating all over the world, wherever U. S. military forces were engaged. The Air Transport Command operated as a great world air line to get planes, men and supplies to the combat theaters, and the Troop Carrier Command flew them to the actual fighting fronts once they got to the combat zones.

CESSNA ARMY PERSONNEL TRANSPORT

The C-78, constructed largely of plywood and fabric around a welded steel fuselage.

THE DOUGLAS SKYMASTER

The U. S. Army Air Forces C-54 four-engine combat transport.

Charged with the vital responsibility of providing supply and maintenance facilities to the tactical squadrons of the Army Air Forces in every part of the world, the Air Service Command had one of the most difficult and exacting assignments of the entire war effort. Commanded by Major Gen. Walter H. Frank, who established the maintenance operations for Army Air Forces in England before his new assignment, the Air Service Command grew in the space of less than a year and a half to be the largest command in the Army Air Forces. In addition to being a military organization of primary importance, and one which in many ways was the pacesetter for the air war, it was an enormous business enterprise, with more than a quarter of a million personnel, untold millions of dollars worth of equipment and world-wide activities unprecedented in the history of human enterprise.

Another indication that air power begins on the ground is found in the important role of the aviation engineers. In each campaign the strategic value of air fields was demonstrated. In the Japanese penetrations of the Philippines, Malaya and the Dutch East Indies, air fields were the first objects of attack, and later, the stepping stones by which the Jap's aviation was able to give effective support to the advance of his land and sea forces. The German Luftwaffe failed in its attempt to destroy the British R.A.F. largely because the Royal Engineers had provided England with a wealth of camouflaged, easily repaired and widely dispersed landing fields which offered a hopelessly decentralized target and enabled the R.A.F. to keep its planes in the air almost continuously. On the other hand the R.A.F. was helpless when it lacked air fields in Greece and Crete.

Brig. Gen. Stuart C. Godfrey was chief of the Aviation Engineers, Army Air Forces. They were trained and equipped to construct with all possible speed advanced military air fields, or to improve existing ones. They were skilled in camouflage, the effective

dispersal of aircraft, the construction of defensive works, and in the instant repair of fields damaged by bombing. One of their most useful items was the portable landing mat, consisting of prefabricated steel grids or networks, constructed in sections. Wherever suitable terrain could be located, these sections were stretched out quickly and locked together, saving weeks of ordinary construction work in making a smooth flying field. The portable landing equipment was demonstrated effectively in the North African campaign, in the southwest Pacific, in the Aleutians and other combat zones occupied by American troops.

Largely through the efforts of Col. Stedman S. Hanks, in charge of the "Flight Strip" division, $10,000,000 was authorized for such strips in the 1942-43 program. During the summer of 1942 the first "flight strip" was dedicated at an important point near the Atlantic seaboard. Later, a considerable number were laid down near the West Coast, along the Alcan highway, and adjacent to transcontinental highways in the United States. The "flight strip" principle also was used in several overseas theaters of operations, and they were of great value as auxiliary landing fields and dispersion points for military aircraft.

To handle procurement problems arising from the war production of military planes and keep ahead of the enemy in performance, the Materiel Division reorganized in the spring of 1942, as the Materiel Command, with Major Gen. Oliver P. Echols in charge. Brig. Gen. Bennett E. Meyers was chief of staff. During 1942, Wright Field's Engineering division, under the supervision of Brig. Gen. F. O. Carroll, increased its active projects considerably. These included a large

THE LOCKHEED CONSTELLATION

Designed and built for T. W. A. service, this four-engine, long-range and fast airliner went into U. S. Army Air Forces transport service. It is powered by Wright Cyclones.

number of new airplane models and aircraft engines; new projects regarding firepower; developments in high altitude flying affecting personnel and materiel; experiments toward increased safety and comfort in long-range bombers; development of communications facilities, including radio and radar; and wind-tunnel and other research regarding trends of aeronautical design in connection with high speeds approaching that of sound.

U. S. Navy photo

McCAIN AND VANDEGRIFT

Rear Admiral John S. McCain (left) as commander of Naval air forces in the South Pacific, talking with Major General Alexander A. Vandegrift, commanding U. S. Marines at Guadalcanal, just before Admiral McCain became Chief of the Bureau of Aeronautics.

CHAPTER IV

U. S. NAVAL AVIATION AT WAR

Magnificent Achievement of Coordinated Sea-Air Power During First Year of War—Marshall and Gilbert Raids—Japs Surprised by Efficiency of U. S. Naval Aviation—Results of Years of Planning by Bureau of Aeronautics and Aircraft Industry—Battle of the Coral Sea—The Battle of Midway—Naval Aviators in the Philippines—The Japs Are Stopped in the Aleutians—Wake Island Operations—The Solomon Islands Campaign—Battle of Santa Cruz—Heroes and Awards—U. S. Coast Guard.

"THIRTY-TWO years after the first naval officer learned to fly, Naval Aviation has proven its vital place in maintaining sea power"—thus a veteran Naval airman and historian of U. S. Navy Aviation succinctly stated the case for coordinated sea-air power early in 1943. Naval Aviation spread its wings further and further over the world's battle areas during the year-and-a-half following the debacle at Pearl Harbor, where 80 of the Navy's pitiably few warplanes were smashed in the Jap's treacherous sneak punch. Reeling under the initial blow, but basically far more ready for global warfare than generally realized, the Navy's air force came surging back to strike a retaliatory blow at the enemy within eight weeks. The raids on the Marshall and Gilbert Islands on February 1, 1942, had a far-reaching significance which only became apparent many months later. Those raids, while damaging, were not catastrophic to the Jap. But, as succeeding months saw Naval Aviation rain blow after blow on the enemy, there emerged the realization that the Marshall and Gilbert episode had proved that the Navy was ready, as a result of years of planning, to strike back at any foe, that it was not, as apparently believed by the Japs and many others, a decadent force which had been blown into oblivion at Pearl Harbor.

The Marshall and Gilbert raids were the opening guns in a salvo preliminary to the historic actions at Bougainville, Wake and Marcus, Salamaua and Lae, Tulagi, the Coral Sea, Midway, the Aleutians, the Solomons, Santa Cruz and North Africa. By the first anniversary of Pearl Harbor, Navy air power had destroyed at least 1,570 enemy warplanes, and had lost only 306 planes in combat. In addition, enemy warships and auxiliary vessels, including transports loaded

U. S. Navy photo

THE "WASP" ON WAY TO MALTA

Watching from the bridge of the carrier as she ferries a load of planes to the relief of the garrison at Malta.

with thousands of soldiers and worth many hundreds of millions of dollars, had been sunk or severely damaged. There was none to deny that the Navy's air arm was as deadly and efficient as any in the world, that the Navy's 30-year concept of air-sea power was sound. Admiral Ernest J. King, Commander-in-Chief of the United States Fleet and Chief of Naval Operations, with justifiable satisfaction, stated:

"I have come to the conclusion that a great many people in this country . . . are under the impression that the tremendous importance of Naval Aviation as a part of our military organization was discovered on December 7, 1941 . . . The facts of the matter are that the United States Navy pioneered in the development of aircraft as a military weapon . . . we have spared no effort to develop it and fit it into our organization. We have watched it grow and we have grown with it. We took advantage of each and every advance in aviation . . . We built and tested carriers. We experimented with and developed various types of planes, and we worked out techniques for their tactical development. In short, aviation soon became an integral part of the profession of every Naval officer, regardless of whether or not he himself was an aviator."

So the O'Hares, Thaches, John Smiths, Gays, Widhelms, Powers,

Parunaks, Masons, and the heroic deeds they performed, were no accidents. Neither were the planes they flew which, miraculously it seemed, kept flying with empennages or fuselages or wings shot away, with the wind whistling through surfaces laced with Jap bullet holes. Thirty-two years of planning and practice provided the background for what appeared to be an almost unbelievable comeback, but what actually was a rugged and well-conditioned fighter, dazed by a low punch, struggling from the canvas and shaking away the cobwebs before tearing in after a sadly-misled opponent.

Far removed from the fighting fronts, from the trackless wastes of ocean guarded by Navy airmen, was the dynamo that has kept the machinery of Naval Aviation grinding inexorably—the Bureau of Aeronautics. In Washington, in the labyrinth of the Navy Department building, the Bureau of Aeronautics carried on the years of work which had given the United States the finest Navy fighting planes, the best-trained Navy airmen in the world. Directed by Rear Admiral John Sidney McCain, who took up the post when Vice Admiral John H. Towers was named Commander of Air in the Pacific, BuAero's hundreds of officers labored on means of producing finer airmen (see

U. S. Navy photo

THE END OF THE "WASP"

Enemy submarines torpedo the carrier while on escort duty near the Solomon Islands.

CHANCE VOUGHT F4U-1 CORSAIR

This Navy shipboard fighter was powered by a Pratt & Whitney 2,000 h.p. Double Wasp engine and a Hamilton Standard Hydromatic propeller.

Chapter on Training and Education) and faster, harder-hitting, longer-range warplanes. When the Navy's plane strength in 1942 was ordered increased from 15,000 to 27,500, these experienced officers ordered the planes. Thousands of craft of proven efficiency were rushed to completion to meet the needs of the hour; thousands of others of new and improved design were hurried into production. These new sky sluggers, capable of dealing lethal blows of a magnitude inconceivable to the enemy, were kept carefully guarded secrets. One soon placed its ineradicable mark on the Jap—the Grumman Avenger torpedo bomber, acknowledgedly among the finest in the world, which made its bow at Midway. Another, the Vought Corsair fighter, was ready to slash at the Jap early in 1943. Still others, performance abilities of which were to be revealed to the enemy only after he paid dearly in men and materiel, rolled steadily from assembly lines to the Navy squadrons.

Possibly the greatest disillusionment to the enemy as it met and reeled under the sledgehammer blows of the Naval air force was the lethal fire power and amazing durability of American planes. The Navy and the aircraft industry had designed and built into fighters, dive bombers, torpedo bombers, patrol bombers and scouts a hitting power and an armor-plate protection which the Jap sacrificed for a slight edge in speed and maneuverability. But these Japanese advantages failed to prevail over aircraft and aviators that wouldn't quit, men and planes that eagerly kept boring in through shot and shell to reach and blast their objectives.

As a result, the Navy's air force in the first year of war so reduced the Jap's air and sea power as to induce a caution surprising in the

fanatical enemy. It was estimated that Naval Aviation in that year knocked out nearly one-third of the Jap's air power. Six Jap carriers were sunk, one probably sunk, and seven damaged. Returning Naval flyers reported that some of the seven damaged carriers were left in such condition as to make it impossible to believe that they could have been salvaged. In any event, approximately half of the carrier force with which the Jap started the war was put completely out of action. In addition, scores of battleships, cruisers, and destroyers were sent to the bottom, as related here in later paragraphs.

The American aircraft carriers and her squadrons of fighting planes they bore to the war theaters emerged from the first year of conflict as probably the most destructive instrument of the combat. True, four of our carriers were lost, but the price they made the enemy pay was conclusive evidence that the aircraft carrier was not scheduled for limbo, as some critics claimed, for many years to come. The carrier's ability to increase the range of an air striking force by thousands of miles was an irrefutable argument in her favor. Her extreme ruggedness was another. In no instance was the Jap able to sink an American carrier. The four lost, all badly damaged, were sunk by American torpedoes and shells to prevent their falling into Jap hands or to prevent flames from attracting Jap forces to the scene of action. This durability, coupled with knowledge that advances in carrier construction would make our new carriers virtually fireproof, convinced Navy chieftains that the carrier was one of their prime offensive weapons. A known dozen U. S. carriers, some converted from cruisers and merchant ships, were launched by early 1943.

The Patrol Squadrons, using Consolidated Catalinas and Coro-

U. S. Navy photo

GRUMMAN TORPEDO BOMBERS

They are being lined up on a carrier deck.

U. S. Navy photo

THUMBS UP!

Lt. Comdr. John S. Thach, who led a Grumman Wildcat squadron off the "Lexington" in the Battle of the Coral Sea. His squadron also accounted for at least 25 Jap planes at the Battle of Midway.

nados and Martin Mariners, swept thousands of miles of ocean on patrol flights, keeping watch for the enemy, in whatever form he appeared. The Coastal Patrol covered the unending columns of convoys carrying men and arms and supplies to the battlefronts and to the United Nations. The pilots and crews of the big flying boats of the Patrol Squadrons and Wings, in addition to their assigned function, took on many additional, hazardous assignments. They saved scores of survivors of torpedoings and forced landings at sea. It was a Catalina that found Capt. Eddie Rickenbacker, and his party, followed by the most widely publicized rescue of the war. It was a Navy scout plane, a Vought Kingfisher, which effected the rescue, landing in a rough sea and taxiing 40 miles to a port after squeezing one of Rickenbacker's companions into the crowded plane and lashing Rickenbacker and another companion to the wings.

It was Patwing 10 which fought one of the most valiant withdrawing actions in military history. Comprising the only Naval air unit in the Philippines when the Japs overwhelmed the islands, the men of Patwing 10 fought Jap combat aircraft, for which their patrol planes were no match, all the way back to Australia, arriving there with only a tattered remnant of their personnel and planes, but with a glory-rimmed record of destruction of the enemy.

It was Patwing 4 which withstood the initial surge of the enemy into the Aleutians in June, 1942, at the same time that Naval Aviation was helping mightily to smash the Jap invasion fleet at Midway. Also equipped with Catalinas, which were not designed for fighting, they searched out the oncoming force, attacked it, slowed it down, and stopped it. They defended Dutch Harbor against air raids; they bombed the Jap ship concentration at Kiska incessantly through three days of increasing anti-aircraft hell, diving their huge craft down on the harbor, making pull-outs which required the combined strength of two men on the controls.

Performing remarkably efficient service in anti-submarine and convoy escort duty along with the patrol bombers was the lighter-than-air establishment of the Navy. Flying non-rigid blimps in dawn-to-dusk patrols, these crews compiled a splendid record of protecting the convoys against submarines. Only one merchant ship was lost to subs by the blimps, and that one early in the campaign. Also participating in the Coastal Patrol were the Navy's scout planes, the Kingfisher and the Curtiss Seagull. These were the types used, too, for scouting work from battleships and cruisers.

U. S. Navy photo

O'HARE GOT FIVE OVER CORAL SEA

In one fight in the Battle of the Coral Sea, Lt. Comdr. Edward H. O'Hare with his Grumman Wildcat fighter brought down five Jap planes.

CURTISS SB2C-1 HELLDIVER

One of the U. S. Navy's latest dive bombers, the SB2C-1 is for aircraft carrier use.

The Naval Air Transport Service, established to speed men and critical supply items to world outposts, had logged millions of miles by early 1943. Utilizing the talents of peacetime air line leaders and operating personnel, NATS personnel, with no fanfare, braved the perils of tropic jungles and Arctic icecap to deliver what was needed, where it was needed, when it was needed. In a Boeing clipper, NATS flew President Roosevelt and his party safely to the historic Casablanca conference with Winston Churchill. NATS used many other transport planes made by Beech, Curtiss, Douglas, Lockheed, Fairchild and Vought-Sikorsky.

The men of all these services displayed a quiet determination, a flaming courage from the outset that soon must have told the enemy that overwhelming defeat was to be his share. The Jap pilot, after Pearl Harbor, behaved like a man set apart from his fellow, a superbeing destined to reshape world destiny. That happy state of mind for the Jap did not last long. The slant-eyed little yellow man received his first taste of disillusion on the morning of February 1, 1942.

A task force under Admiral William Halsey, later Commander of all forces in the Southwest Pacific, steamed quietly toward the Jap-held Marshall and Gilbert Islands. Carriers spearheaded the force. While surface forces shelled enemy installations, the air groups of the carriers took off and bombed, torpedoed and strafed enemy vessels and shore installations. The air group of the "Yorktown," the carrier destined to scourge the Jap relentlessly before being lost at

Midway, sent Douglas Devastator torpedo bombers and Douglas Dauntless dive-bombers against the islands of Jaluit, Makin and Mili, where they inflicted great damage. The air group from another carrier, however, had even better luck. Launching eight attacks against Taroa, Kwajalein, Wotje and Roi, they blew up storehouses, hangars and ammunition dumps, and destroyed many Jap planes on the ground. From the Marshall and Gilbert raids emerged many of the Navy's first World War II air heroes, one of whom was Lieut. C. E. (I Fly for Vengeance) Dickinson, Jr., who was to carry on his destruction of the enemy in many later battles. Fighter squadrons of Grumman Wildcats played general havoc with the enemy, shooting down Zeros and strafing ground objectives with vigor. In all, 35 Jap planes were destroyed, 13 auxiliary and patrol vessels were sunk, a cruiser was left in a sinking condition, as was a seaplane tender—all this in addition to destruction of hangars, storehouses, barracks, an ammunition dump, a fuel tank and a radio station. Our Naval losses were seven planes. The Golden Wings of the Navy had struck their first blow. This engagement, incidentally, marked the first offensive use of carriers by the Navy.

The Jap was not to be left waiting long to feel the second demonstration of Navy offensive air power. Just 20 days later, the carrier "Lexington" was steaming westward in a task force when it was spotted by two Jap patrol planes near the island of Bougainville. The Japs sent out 18 twin-engine land bombers to sink the "Lex." Under Lt. Comdr. John S. Thach, another in the long line of Naval air heroes to emerge from the first year of war, a squadron of Grumman Wildcats went aloft to intercept the Japs and save their carrier. Five

MARTIN PBM-3 CARGO PLANE

One of the Mariner type long-range flying boats converted for Navy transport.

GRUMMAN WILDCAT
Standard fighter of the U. S. Navy and Marine Corps.

of the first wave of nine bombers were shot down. As the second wave of nine approached, only two Wildcats were in a position to intercept. The guns of one of these planes jammed, and within a few seconds, America had one of its greatest heroes. Lieut. Edward H. O'Hare, pilot of the lone remaining Wildcat, attacked the nine bombers. Burdened with the realization that the fate of a priceless carrier, with all her men and planes, depended on him, he flashed into position on the tail of the enemy plane on the end of one prong of the tight V-formation in which the Japs were boring in on the "Lex." Quickly, he picked off the last two bombers on the prong. Conserving his invaluable ammunition, he swung away momentarily in an evasive tactic and darted back in, bringing down three more bombers with sparkling marksmanship, and severely damaging another. Only four bombers were able to drop their bombs, and these fell wide of the mark. That day the Japs lost 19 bombers, the Navy lost two Wildcats and one pilot. O'Hare was awarded the Congressional Medal of Honor and promoted to Lieutenant Commander.

Four days later, Wake Island was bombed, and on March 4, Marcus was hit. Substantial damage was inflicted on buildings, hangars, gasoline dumps, magazines in both instances. Our losses were two planes.

Seeking out the enemy and hitting him wherever they found him, thus fulfilling the promise of President Roosevelt, the Navy struck again less than a week after its Marcus assault. A large concentration of Jap warships, transports and cargo vessels was reported berthed in the harbors of the Salamaua-Lae section of New Guinea. Squadrons from the "Lexington" and "Yorktown" were sent out to attack. Their exploit must be considered one of the outstanding achievements of the war. To reach the enemy, they had to fly over

15,000-foot high mountain ranges covered by unexplored jungles. Available maps showed little detail of the country. Still, every plane but one returned safely. Wave after wave of Douglas Dauntlesses and Devastators roared down on the enemy, dive-bombers attacking first to engage the Jap anti-aircraft and allow the torpedo bombers to slash in nearly on the surface of the water to release their deadly "fish." Fighters strafed the harbor and aided in diverting the enemy from attack on the Devastators. Two heavy cruisers and one light cruiser were sunk, as was a destroyer. Five transport or cargo ships were sunk. A minesweeper and a gunboat probably were sunk, two destroyers possibly were sunk, other ships were damaged.

By this time, Jap losses were infuriating the enemy, and probably causing him to wonder regarding his invincibility. But the real devastation was only beginning. On May 4, in a forepiece to the historic Battle of the Coral Sea, three attacks were made on Tulagi by planes from the "Yorktown."

Again, Devastators, Dauntlesses and Wildcats participated. In the first attack seven Devastators sank two destroyers and so damaged a light cruiser that she beached herself. They returned to the carrier to refuel and rearm, which, incidentally, was done so quickly that the pilots did not have time even for a cup of coffee, before they flashed

U. S. Navy photo

HEROES OF CORAL SEA BATTLE

Lt. Comdr. J. H. Flatley, USN, Commanding Officer—VS-2, Lieut. S. W. Vejtesa, USN, and Lieut. John A. Leppla, USNR, compare notes on the two day battle. Lieut. Vejtesa singly downed three of seven attacking Jap Zeros, and Lieut. Leppla accounted for seven Zeros.

U. S. Navy photo

GRIN OF VICTORY

John Liska demonstrates how he downed three Jap Zeros during the Battle of the Coral Sea.

back to the attack. That day the Japs lost a light cruiser, two destroyers, a cargo ship, four gunboats and five seaplanes. In addition, a destroyer, a seaplane tender and a cargo ship were damaged and numerous harbor craft sunk. Two Wildcats and a Devastator were lost, but all personnel was saved.

The Coral Sea epic wrote a new page in the history of sea warfare. Here for the first time a great naval battle was waged entirely by the aircraft of two great surface forces. On May 7 a United States task force, headed by the carriers "Lexington" and "Yorktown," intercepted a Japanese fleet which was moving on New Guinea. A fierce, two-day air action followed, at the conclusion of which a battered and beaten enemy was forced to abandon its mission.

In this battle, for the first time, carriers from both forces were involved. At the very outset, the Jap carrier "Shoho" was made the subject of one of the most devastating assaults in naval annals. Scouting Dauntlesses scored two bomb hits, followed by five direct 1,000-pound bomb hits by dive-bombing Dauntlesses. The "Shoho" was a mass of flames. Immediately, nine torpedoes were put into her at short range. All this damage was wrought by "Lexington" squadrons. Now the "Yorktown's" flyers lunged to the kill. Their Dauntlesses put 14 bombs on the carrier; more torpedo hits were scored. Within three minutes the "Shoho" plowed bow-first beneath the waves.

U. S. Navy photo

TAUGHT JAPS A BITTER LESSON

Lt. Comdr. Joe Taylor, demonstrated our Navy air power in the Battle of the Coral Sea.

U. S. Navy photo

THE JAPS FELT HIS STING

Lt. Comdr. W. O. Burch, Jr., one of the heroes of the Battle of the Coral Sea.

The last flyer to dive on the "Shoho" saw that she was doomed, so he laid his bomb on a nearby cruiser, which promptly sank. During the day seven Zeros were shot down and two damaged by Wildcats.

Next morning, an enemy force of two carriers, accompanied by cruisers and destroyers, was spotted. The weary but triumphant "Lexington" and "Yorktown" squadrons roared off to a new attack. Two 1,000-pound bomb and five torpedo hits were scored on the carrier "Shokaku," which was left a mass of flames in a sinking condition.

The "Yorktown's" dive bombers swooped on another Jap carrier, the "Ryukaku," made six direct hits, pulled out and shot down 11 attacking Zeros, damaging nine more. Coordinating their attack with the dive bombers, torpedo bombers scored three hits flush into the "Ryukaku." Darting away from the fiercely-flaming carrier, our torpedo bombers shot down three Zeros for good measure. The Navy was handing the enemy burning proof that in every category its aviation excelled theirs—that even heavy dive- and torpedo-bombers, not designed to meet fighter planes, could more than hold their own with the Jap's highly-vaunted fighter, the Zero.

Meanwhile, a heavy force of Jap planes attacked the "Lexington."

Thirty-six of these planes were shot down, but the gallant "Lex" was struck by two torpedoes and five bombs. Fire, which was the nemesis of every U.S. carrier lost, got out of control. Personnel was disembarked to awaiting destroyers, without loss, and the "Lexington," which had paid for herself 10 times over, was sunk by an American torpedo.

All told, the enemy lost one, and probably three carriers, a light cruiser and 91 planes. The "Lexington" and 27 planes comprised the Navy losses.

Even as the Battle of the Coral Sea reached its crescendo, another Navy carrier was aiding the United Nations cause on the other side of the world. Badly-beleaguered Malta, British Mediterranean island stronghold, showed signs of cracking under merciless German and Italian aerial assault, due to lack of sufficient intercepting fighters. To get the vitally-needed fighters to Malta, our carrier "Wasp" took aboard a load of British Spitfire fighters, and in company with a British carrier and other escorting vessels, slipped into the Mediterranean. Early on the morning of May 8, the Spitfires swept into the sky from the flight deck of the "Wasp" and sped to the rescue of Malta. The "Wasp" returned to her station without incident.

One month later the wounded, aroused Oriental enemy massed his strength to attempt to crush the hated opposition. The greatest sea battle in history resulted, the Battle of Midway. In this combat, on which the outcome of the war undoubtedly hinged, aircraft of the

U. S. Navy photo

END OF THE "LEXINGTON"

The "Abandon ship!" order has just been given. The destroyer at right is taking off sick and wounded. Other men are going over the side. Not a man was lost in abandoning the doomed carrier.

U. S. Navy photo

A GRUMMAN DROPS ITS TORPEDO

One of the Navy's TBF-1 Avengers in action during a battle with the Jap Navy in the Pacific area.

Army, Navy and Marine Corps turned back the enemy. The oncoming Jap force was first spotted by a Navy Consolidated Catalina. Preliminary thrusts at the enemy were made by the Army and by a flight of Catalinas, which made a night torpedo attack, scoring two direct hits on transports during an up-moon approach. The defenders of Midway, meanwhile, got set for the expected blow. It came early on the morning of June 4. Waves of Jap bombers attacked the island. Marine Corps pilots in Grumman Wildcats and Brewster Buffaloes took off to intercept. Word soon came that Grumman torpedo bombers, aptly named Avengers, which had been launched from the island, had dropped their torpedoes at carriers. Then came news that a Marine Corps dive-bomber group had secured two hits on a carrier and one on a battleship with their Vought Vindicators. In the four days of action at Midway, the Marine Corps airmen and the anti-aircraft gunners of Midway destroyed 56 and damaged 14 attacking Jap planes. Thirty-eight of our planes based at Midway were lost, along with a large number of intrepid Marine Corps pilots who gave their lives to save the Hawaiian Islands and possibly some of continental United States.

While these land-based defenders were fighting so gallantly, the Navy's carriers at sea were making history. At noon on June 4, Dauntlesses from the "Hornet" made contact with a tremendous enemy force comprising four carriers, two battleships, four cruisers

and six destroyers. One group of Dauntlesses attacked the carrier "Kaga," another the carrier "Akagi." At least eight hits were scored on the "Kaga," smoke from resulting flames making an accurate count impossible. Three hits were made on the second carrier, which burst into flames. Three carriers in all were left in flames on that attack. The opposing fighter and anti-aircraft fire was fierce, however, and 18 of our dive-bombers failed to return, although six pilots and five rear gunners were rescued later.

During this action, also, nine torpedo bombers were lost with their crews, after they pressed home their attack on a carrier in the face of withering anti-aircraft fire, and attacks by 25 Zero fighters.

That same afternoon, the depleted Dauntless squadron from the "Hornet," reinforced by seven dive-bombers from the "Yorktown," screamed down on the carrier "Soryu" and a Jap battleship. Six 1,000-pound bombs crashed into the carrier, two into the battleship. The carrier burst aflame from stem to stern. Next day, June 5, the "Hornet's" dive-bombers sank the heavy cruiser "Mogami," while our six accompanying fighters strafed two Jap destroyers.

It was on this day that the original Torpedo Squadron Eight, honored by all the United Nations for its heroism, attacked four enemy carriers and having become separated from its covering fighters, chose to fly to death and glory. Boring straight in, unprotected, every man save Ensign G. H. Gay was lost. Gay reported a direct

U. S. Navy photo

SUICIDE SQUADRON

Ensign G. H. Gay was the sole survivor of torpedo squadron No. 8 lost in the Battle of Midway, after destroying three Jap aircraft carriers.
Standing, left to right: Lieut., J. G. Owens, Jr., Ensign Fayle, John C. Waldron, R. A. Moore, U. M. Moore, W. R. Evans, G. W. Teats, and H. J. Ellison.
Kneeling, left to right: G. M. Campbell, W. W. Ambercrombie, H. R. Kenyon, Jr., G. H. Gay, J. D. Woodson, W. W. Creamer, and R. B. Miles.

U. S. Navy photo

"YORKTOWN" HIT AT MIDWAY

A Jap bomb scores a direct hit on the carrier despite a tornado of anti-aircraft fire.

torpedo hit on a carrier, and expressed the belief that his mates must have scored others before they died.

The same formation of enemy carriers attacked by the "Hornet's" torpedo bombers also was attacked by the planes from the "Yorktown." Ten members of the torpedo squadron were lost, but not until they scored three hits on one carrier and one on another. The dive-bombers laid six big bombs on the "Soryu." The carrier in a few seconds was a roaring inferno. Four dive-bomber pilots saw that the carrier was doomed and shifted their attack to a cruiser and a battleship. The dreadnaught was left smoking; a direct hit was made on the cruiser.

Begrimed, bloody, dog-tired as they were, there was to be no rest for the Navy flyers. Returning to the "Yorktown," they found the carrier about to be attacked by 17 Jap bombers and 18 fighters. Joining with the "Hornet's" fighters, which quickly arose to intercept, they shot down all but seven of the attackers. These seven, however, hit and badly damaged the carrier. All "Yorktown" aircraft were ordered to land on another carrier. An hour and a half later Jap torpedo planes resumed the attack on the "Yorktown." All but one were destroyed, but one torpedo struck the ship. She began to list, and her abandonment was ordered. Next day, however, the stubborn ship was still afloat and a salvage party, led by her commanding officer, boarded her. Work was progressing satisfactorily, when a salvo of torpedoes from a Jap sub struck the ship. Salvage was abandoned and the following sun-up, the "Yorktown" was sunk with battle flags flying. During her life, she had sunk three cruisers, three destroyers, five auxiliaries and had played a leading part in sinking four carriers.

On the morning of June 6, the "Hornet's" squadrons carried on. Three hits were made on a battleship, two on a heavy cruiser and one on a destroyer. That afternoon, as men, ships and planes groaned with the strain of conflict, the "Hornet's" dive bombers drove home the

last attack of the battle. Six hits were made on a light cruiser; one on a destroyer. A 1,000-pound bomb hit smashed the insides out of a heavy cruiser, which was abandoned, the Japs clambering over each other to escape from the ship. During the attack, Lt. Comdr. Thach (later promoted to Commander) led his fighters in dogfights which cost the Jap 25 planes certainly shot down, with 15 more almost sure victims.

The aroused, determined enemy had been repulsed, with tremendous losses. Four carriers were sunk, as were two heavy cruisers and three (possibly four) destroyers; two, probably three battleships, were damaged. So were three heavy cruisers and one light cruiser. It was estimated the Japs lost 5,000 men. The Navy lost the "Yorktown," 150 airplanes, 92 officers and 215 men.

The other prong of this, the most concerted offensive of the war against long-held U. S. territory, was met with less equipment, but certainly with not one whit less fighting spirit. Far to the northward, through the ever-present low-hanging, dense fogs and swirling storms, the enemy moved a strong force toward Alaska. Officers and men of Patrol Wing Four, flying their big scouting seaplanes, stormed out into this, admittedly some of the worst flying weather in the world, and found the Jap. That finished their part of the campaign—or should have. However, as the fortunes of war had it, these sturdy, but not fast or heavily armed or armored Catalinas, were the only Navy planes in the territory. Patwing Four knew it would face an enemy of vastly superior strength, but the odds mattered little to these Vikings and their planes. They accepted the challenge. Through

U. S. Navy photo

FIGHTING FIRE ON THE "YORKTOWN"

An episode in the Battle of Midway.

U. S. Navy photo

GRUMMAN AVENGER AFTER MIDWAY

This Navy torpedo bomber fought until disabled; but brought its pilot back to Midway under its own power.

sleet and ice, they sought the enemy, found him, attacked him. Their radios flashed reports, detailing the enemy's strength, disposition and intention back to headquarters, hour after hour, each hour making more certain that the Navy flyers would have insufficient gas to return to base. Contact was maintained until landings in the ice-strewn sea were forced. That mattered little. The job was being done. The Jap's two raids on Dutch Harbor on June 3 and 5 were repulsed. Meanwhile, reinforcements were rushed from San Diego. More Consolidated Catalinas were in the thick of the fighting four days after they left the California base. By June 12, despite the weather and equipment deficiencies, the Navy was ready to launch counter-blows. For three days and nights, the enemy's major concentration, in Kiska Harbor, was bombed incessantly in the face of ever-increasing anti-aircraft fire. This rain of shrapnel finally became so devastating as to force cessation of the raids, but not before the enemy was convinced that his advance was halted. Illustrative of the superlative effort made by Patwing Four were these facts found in the Wing's war diary: One pilot flew 193¼ hours out of 24. Another flew 178 hours in 18 days. The entire crew of a seaplane tender worked 36 hours without sleep. Aided throughout the Aleutians campaign by Army bombers, Patwing Four carried on by conducting search and escort flights of tens of thousands of miles as troops of the Army were moved into the Andreanof Islands in August. Nearly 30 of the members of Patwing Four were decorated early in 1943 for their largely-unpublicized efforts in rolling back, under the most trying circumstances, a serious threat to the continent.

Within eight short weeks, the ambitious Jap who through his treachery was able to carry much of the battle to America, throughout the first seven months of the war, was thrown on the defensive. The tide began to turn on the morning of August 7, when an American task force launched the historic Solomons attack, which resulted in the capture of Guadalcanal and many surrounding islands—all major keys to the vital supply route to Australia, and also the requisite primary springboard from which a counter-offensive could be launched. Throughout the Solomons Campaign, which was still continuing early in 1943, Naval Aviation played a leading role. This part, a many-sided one, which encompassed scouting, dive-bombing, torpedo bombing, all offensive activities; and fighter interception, which proved so valuable in protecting captured areas; cost the Japs heavily. Translated into money, it must have totaled a billion dollars. Working with the heroic U. S. Marines, who stormed the beachheads on that historic August morning, with the Marines' unconquerable aviators, and with Army forces of all types which moved in subsequently, the Navy airmen never let up on an enemy which admitted the strategic importance of the area by striving, in the face of one disastrous setback after another, to retake the Solomons.

Aircraft squadrons from three carriers covered the August 7 and 8 landings. Despite bad flying weather, fighters, scouts, dive and

U. S. Navy photo

ECHOES OF THE BATTLE OF MIDWAY

Ensign G. H. Gay and Lieut. E. S. McCuskey swapping experiences. Note seven Jap flags on fuselage of Lieut. McCuskey's plane representing victories.

U. S. Navy photo

JAP CRUISER DIES AT MIDWAY

A heavy cruiser of the "Mogami" class sinking after bombing by our carrier-based planes in the Battle of Midway.

torpedo bombers winged over Guadalcanal and surrounding areas, seeking out enemy installations and silencing them, or driving their personnel into jungle interiors for escape. The Commander of the task force in a public commendation declared that American aircraft effectively silenced virtually all sources of opposition to the landings, and thereby made possible their success.

That operation was the first in a continuing series of battles which were not ended early in 1943. The Jap kept coming back, time after time, in vain attempts to retake the Solomons. During the three months following the landings, it was often touch and go. Daily naval shellings and bombings kept the forces holding the vital Henderson airfield on Guadalcanal alternately scrambling for planes to take to the air, or diving for foxholes when all planes were damaged to the point of uselessness, as they often were. Despite these and the vicissitudes imposed by tropical diseases and equipment shortages, the Marine and Naval aviators withstood the enemy onslaughts successfully, shooting down approximately 700 Jap planes by the end of 1942. Carrier-based squadrons operating in the area destroyed approximately 300 warplanes in the same period.

Far more costly to the enemy, however, were the hundreds of attacks on Jap warships and auxiliary vessels which comprised the numerous fleets that were sent down from the enemy bases at Rabaul and Truk to drive out the American forces, all to no avail. By early 1943, the waters surrounding the Solomons were the graveyard for

more than 60 Jap ships, a good share of which were sent to the bottom by Naval air torpedoes and bombs.

Major assaults on the Solomons positions took place on August 24; October 25-26 and November 11-12-13. Naval and Marine Corps Aviation played important parts in all these, played its most important role, perhaps, in the October 25-26 action, which became known as the Battle of the Santa Cruz Islands. In this battle the Japs launched an all-out land, sea and air attack offensive designed to retake Guadalcanal. On the first day, Dauntless dive-bombers attacked a force of enemy cruisers and destroyers. A direct bomb hit stopped one heavy cruiser. Late that afternoon, Dauntlesses again attacked this force, scoring a heavy bomb hit on another cruiser. Back on Guadalcanal, repeated aerial onslaughts by the Japs were beaten off, with losses to the enemy of five bombers and 17 fighters, all of which were shot down by Grumman Wildcats. The same day Navy and Marine Corps dive-bombers found and sank two Jap destroyers. That night, Navy Catalinas attacked an enemy surface force, torpedoing a carrier and bombing a cruiser, without loss to themselves.

U. S. Navy photo

LOADING NAVY BOMBS IN ALASKA

Working in sub-zero weather, a Navy ordnance crew prepares a Consolidated Catalina patrol bomber for operations from an Aleutian air base.

DOUGLAS DIVE BOMBER OF U. S. MARINES

The SBD-3, Navy scout bomber Dauntless, one of the most effective dive bombers in the world and superior to any "stuka" as yet used by the Nazi air forces.

The next day, October 26, the battle reached its peak. Dive and torpedo bombers from Navy carriers severely damaged two Jap carriers, one so badly that retiring flyers declared their conviction that it could not be saved. This carrier was beset by a coordinated force from the carrier "Hornet," which was destined to be lost that day. Seven 1,000-pound bombs were laid on the enemy carrier's flight deck and in a few minutes it was blazing furiously from stem to stern. Lt. Comdr. W. J. Widhelm, who led the attacking dive-bombers until he was shot down within sight of the target, reported that the carrier was larger than the U. S. Navy's largest. Adrift with his rear gunner in their rubber liferaft, Widhelm watched the ship burn. Widhelm was rescued and returned to find that the "Hornet," on which he had been stationed since the day she was commissioned, had been sunk by her own forces after she was so badly damaged by wave after wave of Jap bombers over a 10-hour period, that she was a menace to other Navy forces in the vicinity. The "Hornet" did not succumb until she and the task force of which she was a part had shot down 156 Japanese planes, and when she slipped quietly beneath the waves, battle-flags flying, in the Southwest Pacific dusk, she had in her career exacted a staggering toll from the enemy. At the least, her squadrons had accomplished: One torpedo hit on a carrier, 2,500 pounds of bombs dropped on a battleship, one heavy cruiser destroyed, six 1,000-pound bomb hits on another cruiser, 1,000 pounds of bombs dropped on another cruiser, 1,500 pounds of bombs dropped on destroyers, a destroyer strafed by fighters, probable destruction of a huge carrier, four 10,000-ton transports, capacity 20,000 men, sunk, and scores of

enemy ground installations—gasoline dumps, supplies, radio stations and warehouses—destroyed. All this was in addition to the numberless enemy planes her fighters shot down.

Another U. S. carrier helped avenge the "Hornet's" loss on the day she was sunk. Squadrons from this carrier, using Avengers and Dauntlesses, laid two 500-pound bombs on a Jap carrier and two 1,000-pound bombs on a battleship and scored a torpedo hit on a cruiser. They also strafed a cruiser and shot down 23 Jap planes.

The battle of the Santa Cruz Islands ended in victory for American forces, with the enemy, badly beaten, again forced to retire.

While the Santa Cruz affray was raging, Naval carrier strength once more was making itself felt on the other side of the world, as it had when the "Wasp" had gone to the rescue of Malta. This time, a large number of carriers, moving with the largest armada in world history, helped make possible the daring conquest of North Africa. In a carefully-coordinated and timed attack, Naval aircraft swept on ahead to prepare for the landings by capturing opposing airfields, immobilizing troops, and destroying supplies and other installations. It was Navy dive-bombers that finally silenced the French battleship, "Jean Bart," when the battlewagon was imperilling the troop landings with fire from its big guns. At the height of these salvos, dive-bombers screamed down to drop their bomb loads on the dreadnaught. The "Jean Bart's" guns did not speak again. Offshore, also, Naval aviators were performing vital functions, patrolling against submarines, beating off opposition warships, which launched potentially

U. S. Marine Corps photo

ONE REASON WE TOOK GUADALCANAL

Leader of Fighting Squadron 223, Marine Corps Major John L. Smith, chalked up 20 out of his squadron's 100 victories over the Japs at Guadalcanal. An ace of aces.

U. S. Navy photo

IN THE BATTLE OF SANTA CRUZ

A Jap bomb splashes astern of a U. S. carrier. Note anti-aircraft fire.

catastrophic attacks against U. S. landing boats careening beachward through heavy surf.

The North African expedition provided an answer to the critics of the ability of carrier-based aircraft when opposed by land-based aircraft. Naval planes, operating from carriers during the three days of the fighting, destroyed more than 125 land-based fighters and bombers while losing only about 25 planes themselves.

Our carriers performed still another duty in the North African campaign, in addition to covering the armada with a cloud of protecting fighters during the long Atlantic crossing. This extra duty comprised transport of Army Air Forces fighters, in large numbers, across the ocean. These fighters were flown off while their carriers were still at sea, streaking landward to strike the opening blows of the attack with their Navy teammates.

So, by early 1943, Naval air force had taken meritorious part in virtually every major action of the war. It played a vital, if not outstanding, role in repelling three Japanese invasion efforts—Pearl Harbor, Midway and the Aleutians. It lent mighty aid in the two chief American offensive thrusts at the enemy—the Solomons and North Africa.

Details of the growth of Naval air strength since Pearl Harbor may not be revealed, but during 1942 an increase in plane strength to a

total of 27,500—easily the size of Hitler's Luftwaffe—was ordered accomplished by the end of 1943. Much of this increase was attained during 1942 as the aircraft industry delivered to the Navy ever-increasing numbers of newer, faster, more heavily-armed, and armored, sky sluggers. How the thousands of pilots and crew members to man these planes were acquired and trained is detailed in the Training and Education chapter. Results accomplished by the Naval air force since the Pearl Harbor shambles certainly gave eloquent proof that Naval Aviation was competent and ready for quick expansion at that time.

Further proof of the ruthless efficiency of America's Naval air arm appeared in the growing body of Naval aviators called forward to be decorated for their gallant deeds. By February, 1943, decorations had been awarded to 469 Naval and Marine Corps heroes in official recognition of exceptional achievements and gallantry, the execution of which, to the flyers and crewmen themselves, was simple carrying out of duty. Five were honored with the highest medal within the power of the President to bestow, the Congressional Medal of Honor. Five more received the Distinguished Service Cross. There were awarded 244 Navy Crosses, highest purely Naval decoration. Several flyers received this decoration twice. The Distinguished Flying Cross was awarded 179 times; the Air Medal 31 times, the Silver Star four times, and the Legion of Merit, once.

The names of 18 recipients of awards for exceptional services

U. S. Marine Corps photo

FLYING VETERAN OF GUADALCANAL

Capt. Marion E. Carl, U. S. Marines, one of the flying aces in the Solomons campaign.

U. S. Navy photo

JUST BEFORE ATTACK ON NORTH AFRICA

A few minutes before the zero hour and the "Pilots, man your planes!" order for the first attack on North Africa, these pilots on a carrier had a songfest.

rendered their country were scrived on the Honor Roll in gold. They gave their lives in performance of what they deemed their simple duty. Seventy-two more had been listed as missing.

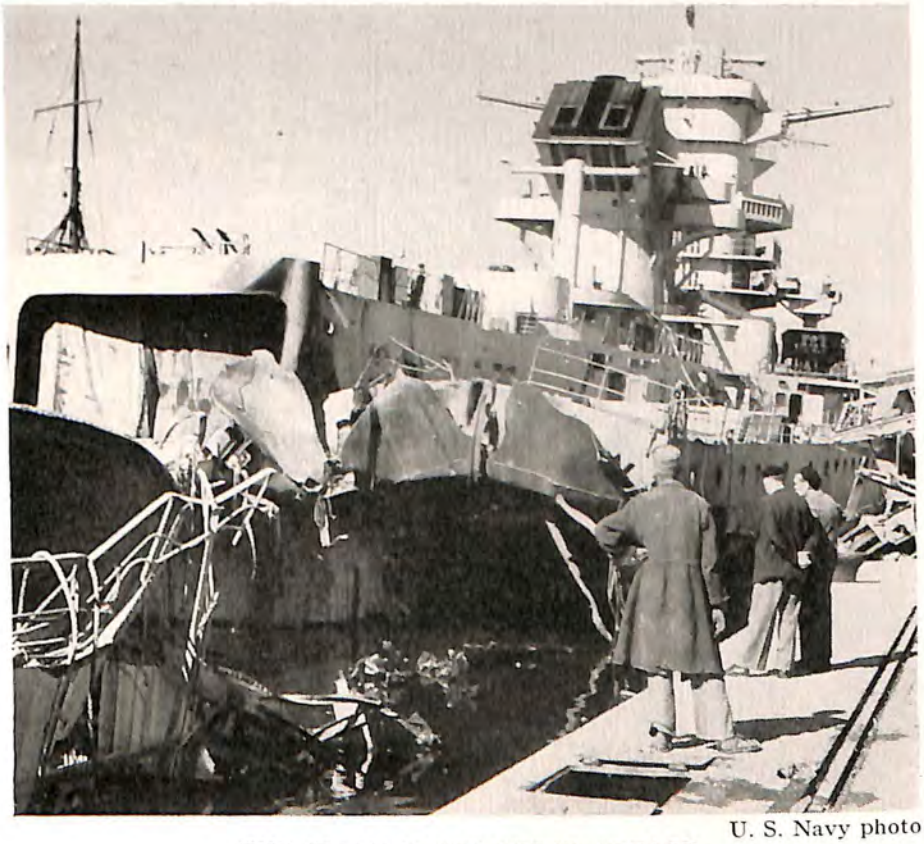
These Naval air heroes are too numerous for richly-deserved description of their individual exploits here. The gallant band who laid down their lives, however, was typified by Lieut. John James Powers, USN, during the Coral Sea Battle. President Roosevelt, in an address on September 7, 1942, described Lieut. Powers' achievements in these words:

"During the first two days, Lieutenant Powers, flying a dive-bomber in the face of blasting enemy anti-aircraft fire, demolished one large enemy gunboat, put another gunboat out of commission, severely damaged an aircraft tender, and scored a direct hit on an aircraft carrier which burst into flames and sank soon after. As the pilots of his squadron left the ready room to man their planes (on the third day of the battle) Lieutenant Powers said to them, 'Remember, the folks back home are counting on us. I am going to get a hit if I have to lay it on their flight deck.' . . . . He was last seen attempting recovery from his dive at the extremely low altitude of 200 feet, amid a terrific barrage of shell and bomb fragments, smoke, flame and debris from the stricken vessel. His own plane was destroyed by the

explosion of his own bomb. But he had made good his promise to 'lay it on the flight deck'."

"There is no question John knew what he was doing," one of Lieutenant Powers' fellow pilots told a war correspondent. "He knew that if you go below about 700 feet in your recovery the blast will get you every time. He just decided not to miss, God bless him." Lieutenant Powers was awarded, posthumously, the Congressional Medal of Honor.

The almost superhuman accomplishments of Marine Corps aviation in hurling back the Jap aerial assailants of Guadalcanal were an epic of the War in themselves. Raided so many times that they could not even keep an accurate count, the Marine Corps flyers, often only a handful, climbed their Grumman Wildcats into the steaming jungle sky again and again to blast the enemy. They made the Jap pay exorbitant cost in planes and personnel compared to damage inflicted on Guadalcanal, heavy though the latter sometimes was. Often Jap losses



U. S. Navy photo

THE "JEAN BART" AFTER ATTACK

During the U. S. attack on Casablanca American gunfire and air bombs had to wreck the French battleship to stop the fire from her big guns. This is what was left of the stern after a 1,000-lb. bomb hit it.

U. S. Navy photo

FIRE FIGHTERS ON A CARRIER

Asbestos-garbed experts on the flight deck ready for quick and effective rescue action in case of a bad landing.

would run as high as 20 to 1. Major John Smith, Capt. Joe Foss and many others became leading war aces. Foss downed 30 Japs, Smith 20, Smith's famous Fighting Squadron 223, more than 100. Nameless because of their number, but heroes of the Guadalcanal campaign as much as the flyers themselves, were the Marine Corps ground crews who somehow kept a few planes always in flyable condition. Woefully short of spare parts during the first two months of their stand, these enlisted mechanics performed feats of wizardry with the scraps they had at hand.

Enlisted personnel as a whole, Navy and Marine, flying and non-flying, were the unsung heroes of the war. To the Navy rear-seat men—the combination radio operators and machine-gunners—and to the ground personnel—machinists, metalsmiths, ordnancemen, plane handlers—the pilots handed the bulk of the laurels for successes achieved. Without the skill and unflagging determination of these men, this account of Naval Aviation's attainments could not have been written. They kept the planes flying. Often, after working round the clock to place planes in condition to fly, these enlisted men climbed into the rear seats and went aloft to fight as machine-gunners.

"Those boys really loved to shoot, and they could shoot," reported Lt. Comdr. Widhelm. "So all we did was set the shots up for them. They did the rest. The rear-seat men in my squadron alone shot down 15 Zeros during our attack on a Jap carrier on the last day of the Santa Cruz Battle. We never would have gotten out of there alive had it not been for them. God bless 'em."

There were no Navy aces, in the World War I sense of the word. This was for two reasons. The breath-taking tempo of World War II air fighting, with its terrifically high speeds, made accurate determination of who-shot-down-who-and-how-many virtually imossible. Usually, the aviators could report no more than: "Harry and I each managed to get bursts into one of them. He caught fire and went spinning downward. Probably lost." The second reason was the reticence of the flyers to claim victories. "Too hard to determine just what happened, everything was going around too fast up there," was the usual report to the squadron intelligence officer back on the carrier. "But we are pretty sure we shot down 11 or 12 of them. Just make the report

U. S. Navy photo

BAGGED FOUR JAP PLANES IN ONE DAY

The eight Jap flags on the fuselage of Machinist Donald E. Runyon's plane represent his victories during the month of August, 1942—four of them in a single day's combat.

GRUMMAN WIDGEON

These utility amphibions were used in coast patrol and other vital operations by U. S. Navy and Coast Guard.

read 'We shot down' not 'I shot down'." The same maintained for ship-sinkings.

As the war went into 1943, aviation comprised more than one-fifth of the Navy and was growing rapidly, destined to be one of the deciding factors in determination of final victory, and of final peace.

On November 1, 1941, the United States Coast Guard was transferred from the Treasury to the Navy Department. This shift and the outbreak of war on December 7, 1941, placed entirely new demands upon Coast Guard Aviation. No longer were the inspection of aids to navigation, the routine police and patrol operations and the flying ambulance and rescue flights the first concern. The Coast Guard as a whole had to shift from its former role of a maritime policeman mainly concerned with the preservation of life and property upon the seas to that of an active participant with the Navy in the struggle against the Axis powers. Its larger cutters helped to escort convoys directly to the shores of allied countries while the smaller ones were busy in coastwise convoy operations and anti-submarine patrol. A number of Naval transports and auxiliaries were completely Coast Guard manned. Landing barges often had a Coast Guardsman at the tiller.

Even the Coast Guard surfman, who formerly patrolled his lonely beat armed with a Very Pistol and a time clock and only concerned with the distress signals at sea, was armed with more formidable weapons and ready for any eventuality—a torpedoed merchantman, a U-boat on the horizon or perhaps an attempted landing from a German submarine.

The Coast Guard Aviation likewise assisted the Navy in every way in the coverage of convoys and anti-submarine patrols. At the same time it preserved its own unity for administrative purposes

under its Commandant, Vice Admiral R. R. Waesche, although its operations were under Navy direction. Coast Guard Air Stations were manned as before by Coast Guard personnel under the direction of Comdr. Frank A. Leamy, Senior Pilot and the Headquarters Chief of Aviation Operations. The closest liaison was maintained with the Navy. A Naval Intelligence officer was attached to each Coast Guard Air Station. The Stations and planes were manned and operated by Coast Guard personnel, while additional planes were procured from the Navy. The most generally used type of plane in that category was the single-engine Vought OS2U-3. It was used by nearly every Coast Guard Air Station as well as many Naval Air Stations. The planes were equipped with depth bombs and other armament to increase their effectiveness against submarines.

In the period between the start of hostilities on December 7, 1941, and June 30, 1942, Coast Guard aviators flew 23,442 hours, during which 17,842,231 square miles were searched and patrolled while 2,245,357 miles were cruised. The normal routine of those patrols was exacting and tiring. In this period there were 6,032 patrol flights during which 63,233 surface vessels and 12,951 planes were identified. That gigantic task was performed with 107 pilots and about 100 planes.

The patrols were never really routine. Sometimes a small boat of survivors were sighted. In the first half year of 1942 there were 310 assistance flights; and 508 survivors of torpedoed vessels were located so that surface vessels could be directed to their rescue.

The Elizabeth City, N. C., Air Station, under the command of Lt. Comdr. R. C. Burke, was one of the centers of rescue operations. Two enlisted men there perfected the "food bomb" which was dropped to survivors of torpedoings much in the same way that, before the war, the Coast Guard would drop a storm warning to those fishermen

BREWSTER F3A FIGHTER

This design of the Vought-Sikorsky F4U Corsair is intended for U. S. Navy carrier operations.

who lacked radio communication ashore. The "food bomb" resembled a depth charge. It had a soft concrete cap which disintegrated on contact with the water. Its contents included seven cans of water, a first aid kit, a pint of whiskey, two rations and several packs of cigarettes with matches. Harold V. Booth and Frederick J. Denio were officially commended for that invention.

There were many instances of Coast Guard bombing attacks against submarines, the exact number of which cannot be disclosed for military reasons. Nor their success!

The Coast Guard Air Patrol on the Great Lakes with its Grumman amphibion V-192 was active in reporting ice conditions on the lakes to assist the ore carriers in the delivery of strategic raw materials.

LOADING COAST GUARD DEPTH BOMB

Protecting convoys from lurking U-boats was one of the Coast Guard's main activities over the North Atlantic.

CHAPTER V

THE CIVIL AIR PATROL

Private Flying Goes to War—Emergency Service Over Land and Sea—The Success of C.A.P. in Anti-Submarine Operations—Rescue Work and Other Relief Operations—Women Pilots Join the Men on Dangerous Missions.

CITED for "meritorious achievement," and "a high degree of courage," two men of the Civil Air Patrol stood before President Roosevelt in the White House on February 10, 1943, and received Army Air Medals, the first of this valiant organization to be so honored, but not the first nor the last C.A.P. members to perform heroic deeds. Behind the simple ceremony was a drama which was only one of the countless exploits of the Civil Air Patrol which daily added to the story of America's conquest of the air. Not until final victory would the full story of C.A.P. be told—a story of private flyers piloting light airplanes in almost impossible weather on missions which would have seemed incredible in peacetime; aided, of course, by ground and operational crews who made the flying possible.

The pilots honored at the White House landed a light amphibion plane on a sea where swells were running eight to ten feet high, and rescued the personnel of another C.A.P. plane which had crashed while on anti-submarine patrol. The citation said the sea was too rough for the rescue plane to take off and so, while one of the C.A.P. men taxied the plane for five hours, the other clung to the wing to overcome a dangerous list until the plane was taken in tow by a Coast Guard boat.

James N. Landis, Director of the Office of Civilian Defense, said all civilian defense volunteers "must share a sense of pride" in the Army awards for civilian action for the first time.

On the same day the awards were made, the head of an important war plant lauded the C.A.P. emergency courier service after a C.A.P. plane flew through stormy weather which in ordinary times would have kept him grounded, and delivered a shipment of vitally necessary war parts from one factory to another. "This emergency service of the Civil Air Patrol," said the plant manager, "answers an urgent need in cementing the link between supplier, producers and the armed services . . . these Civil Air Patrol flyers are rendering a great service to American industry's victory drive."

THE CIVIL AIR PATROL
Operations Office of the Maine C.A.P.

Thus on dangerous inland missions and over perilous coastal waters, C.A.P. contributed private flying's share and more to the destruction of enemy submarines and accepting other dangers and risks on the home front, thereby releasing military flyers and aircraft for combat duty.

Civil Air Patrol was founded by the Office of Civilian Defense on December 1, 1941, to mobilize civilian airmen and their equipment for volunteer wartime duties. With a Wing Command in each of the 48 States, C.A.P. was organized into Squadrons and Flights at more than 1,000 airports throughout the country. Several officers of the Army Air Forces were assigned as national C.A.P. officers. Civil airmen in the United States thus were able to carry on private flying in wartime operations under C.A.P., a program which helped to preserve private flying in wartime United States.

At the time of Pearl Harbor, the United States had 100,000 private pilots and a comparable number of student pilots, with 25,000 privately owned airplanes operating from more than 2,000 fields in all parts of the country. The job of the Civil Air Patrol was to mobilize the personnel, equipment and facilities of civil aviation not at once required for military service. C.A.P. came into being after weeks of planning by a committee of airmen. Thousands of pilots were banded

into units and disciplined to prevent flights by unauthorized persons or violations of wartime restrictions. Otherwise, it would have been necessary to stop private flying entirely. More than 66,000 civilian volunteers had been enrolled early in 1943. A Wing of C.A.P. in each of the States reported directly to C.A.P. National Headquarters in Washington. The larger State Wings were divided into Group Commands with several Squadrons in each group. Each Wing, Group and Squadron had its own commander and staff officers assigned to special duties such as operations, intelligence, communications, transportation and medical. About one third of the members were pilots and a third

CIVIL AIR PATROL AMBULANCE
Operated by the Illinois Wing C.A.P.

THE NEW HAMPSHIRE C.A.P.

Small parachutes are used to drop blankets, food, medicines and equipment in C.A.P. rescue missions.

student pilots. The others had special skills, and included mechanics, radio operators, photographers, nurses, typists and ground crew members. Each unit was self-contained, its personnel, equipment and training able to perform any light plane mission.

Each member was required to cover the ground studies necessary for a private pilot's license. The basic C.A.P. course of 81 hours stressed military and defense subjects such as infantry drill, discipline, first aid, gas protection, military secrecy and signalling. The advanced course of 150 hours included air navigation, meteorology, crash procedure and a number of flying missions simulating the actual wartime assignments of the Patrol. All members were required to complete both the basic and advanced courses if they were to remain in good standing. Thousands left the Patrol for flying duties in the armed forces, the Air Transport Command, the pilot's schools and on the air lines, better prepared by their C.A.P. experience. From its detailed roster, C.A.P. frequently recommended men and women for special war posts.

The program was strictly voluntary. The members paid nothing and received no pay. But serious work was involved. C.A.P. officials emphasized that they were not interested in giving free instruction to persons who merely wanted to know something about aviation. Nor

was the Patrol a place for pilots who desired to fly without engaging in the necessary ground work that was a part of the C.A.P. program.

The personnel was carefully selected. Members had to be American citizens, naturalized for at least 10 years, and come from a friendly country. Naturalized citizens from enemy nations were excluded. All prospective members were fingerprinted for possible checking by the Federal Bureau of Investigation.

Civil Air Patrol Cadets were founded October 1, 1942, and offered a Cadet grade of membership in C.A.P. to a limited number of students in good scholastic standing in the last two years of senior high school. Cadets undertook the same drill and studies as C.A.P. but were not assigned to flying duties. On completion of Cadet courses and graduation from high school, they attained unrestricted membership. Each local Squadron was authorized to form a Squadron of Cadets. Thus a reservoir of prospective C.A.P. members was always on tap.

C.A.P. Cadets were required to be native-born Americans whose parents met the citizenship requirements of C.A.P. The minimum age for membership was 16, with 18 years as the minimum for flying duties. Members wore Army uniforms with special C.A.P. insignia. The insignia was red braid and red shoulder straps. C.A.P. was the only civilian organization permitted to wear the "U. S." on its emblem, which was a red, three-bladed propeller in a white triangle on a blue disc. Officers were appointed as majors, captains, and lieutenants and wore Army rank insignia. C.A.P. flight officers, sergeants and corporals also were appointed.

C.A.P. National Headquarters acted as a central clearing house, dividing the work as evenly as possible among the various Wings. The Commander of each Wing was given assignments, which originated through requests from Army units. He acted, in effect, as Oper-

BEECH AIRCRAFT PRODUCTION
Final assembly on AT-10 advanced pilot trainers.

TAYLORCRAFT ARMY GRASSHOPPER
The L.-2B, Army liaison plane.

ations Officer for the job at hand. It was his duty to see that men and equipment adequate for the assignment were available when needed. The inland missions were more decentralized than the C.A.P. coastal patrol which was under the direction of National Headquarters. When a C.A.P. pilot reported to an Army base for special duty, he was under the direct jurisdiction of the Army Commanding Officer.

Unless on special missions or assignments, most members in local units continued their regular civilian operations and devoted their spare time to patrol. Thousands of members, however, were able to volunteer 30 days or more for continuous active service, and were detached from their Squadrons for assignment to active-duty missions.

Early in 1942 when Axis submarines began to take a heavy toll of United Nations shipping on vital supply routes along the coast, C.A.P. organized a series of coastal patrols at points designated by the Army. This was the most spectacular, and at the same time the most secret of C.A.P. activities. They took their own planes, repair tools, radios and other equipment to fly watch over submarine-infested coastal waters. Submarines spotted by C.A.P. observers were sunk. Others about to attack merchant vessels were forced to crash dive at the approach of C.A.P. planes. Vessels in distress were reported by the Coastal Patrol, and hundreds of survivors of torpedoed ships were rescued when their positions were radioed to shore and rescue vessels.

After C.A.P. had been on this assignment for some weeks it was disclosed that these small planes, covering long reaches of the coastline, were equipped with inexpensive, but deadly effective bomb racks and bombsights invented by Major Lester G. Orcutt, while he was stationed at Morrison Field, Fla. Air Forces Magazine had this to say about "Inexpensive Bombing for Civil Air Patrol":

"The bomb rack was designed, built and installed on a Stinson 105 in 48 hours at the request of Army Air Forces headquarters. It was built to carry 100-pound demolition bombs so C.A.P planes could blast subs they spotted in their daily patrols. Pilots who flew the

planes soon wanted a bombsight so they could aim their bombs. Two days later Major Orcutt turned one out. The materials cost only 20 cents, but the bombsight was effective up to 3,000 feet. So successful were the bombsight and racks that they were produced for light patrol planes in all parts of the country. For certain special purposes they even have been used on occasion in regular military planes.

"Major Orcutt's bomb rack is a metal frame attached to the lower right longeron. The release lever is placed on the floor of the cockpit right in front of the co-pilot's seat. Since the first design, the rack has been improved so it can carry two demolition and two smoke bombs. The bombsight is made of metal and consists chiefly of two adjustable sight rings. It is attached to the outside of the cockpit door of the small plane for which it was designed."

The full story of C.A.P.'s submarine patrol probably awaited the end of the war, but enough was known to prove that this service accomplished a great deal against enemy subs. These coastal patrol planes flew as far as 40 miles offshore in their little single-engine land planes. Crash landings at sea were in store for them if the engine cut out. At least five pilots were lost on patrol missions, but millions of miles were flown in anti-submarine operations. The Army indicated the sites for Coastal patrol bases and turned the entire operation over to the C.A.P. Many of the pilots had never flown over water before, but they knew navigation, radio, crash procedure, instrument flying and basic military operations. The number of submarine sinkings credited to C.A.P. grew larger each month and the number of submarines sent to the bottom by regular military patrols as the result of C.A.P. spotting was even larger.

In addition to coastal patrols, C.A.P. carried on extensive inland missions for the Army, to release military planes and pilots for combat duty. While planes upward of 90 horsepower were required for coastal patrol, the lighter aircraft, of which thousands were available for the service, were used on other assignments. Courier service

PIPER GRASSHOPPER FOR THE ARMY

totaling thousands of miles a day on regular routes and schedules were flown, with officers, dispatches and shipments between Army posts. Other operations included towing aerial gunnery targets, tracking flights for guns and searchlights, aerial reconnaissance and inspection, simulated air support for ground troops in training and searches for lost aircraft.

U. S. Army photo

BOMBARDIER IN TRAINING

Making his way between the two racks of bombs, a student bombardier goes up front to take his position in the nose of the plane.

CHAPTER VI

TRAINING FOR WAR AVIATION

Millions Receive Training in All the Various Branches—Huge Air Forces for Combat Service—Army and Navy Turn Out Legions of Pilots and Other Flight Personnel—Ground Crews Trained for All Fronts—C.A.A. War Training Program—Vocational Training—Work of the Schools.

A HOST of young Americans went to war in the aviation branches of the Services and hundreds of thousands of others entered some form of training within 15 months after Pearl Harbor. The Army and Navy were developing the world's largest air forces. Young men were going abroad and into all war zones as civilian technicians and mechanics. Men and women were being trained to take their places in aviation at home, in the plants, repair depots and operations bases throughout the United States. The flying schools were training pilots and other flight crews by the tens of thousands. Other schools were turning out mechanics by the hundreds of thousands.

The Civil Aeronautics Administration undertook in February, 1942, to foster and encourage an aeronautics training program for youth, as a national asset in war and in peace. This program had two major objectives: 1. The development of a well qualified pool of youth for the air forces; in effect, the creation of a reservoir of youth whose initial training for the air forces would be effected prior to more advanced training in the air branches of the Army, the Navy, or the C.A.A. War Training Service. 2. The preparation of youth for participation in the gigantic development of aviation and the expansion of air commerce in the post-war world. This second objective requires no different or additional activity since the basic, elementary principles of aeronautics are the same for both military and civil aviation.

Air commerce draws its strength from youth. The same preference for youth is expressed by the military air services. Every year over a million youths complete their high school education. Over 600,000 are boys. It is estimated that as many as 40 per cent of these boys will go into the air forces. More and more of our young women are going into commercial aviation and being looked to for auxiliary services of the air forces. After this war the bulk of the personnel for

THE AERONCA PT-23
An Army primary trainer.

our expanding air commerce must come from these high school graduates—both boys and girls.

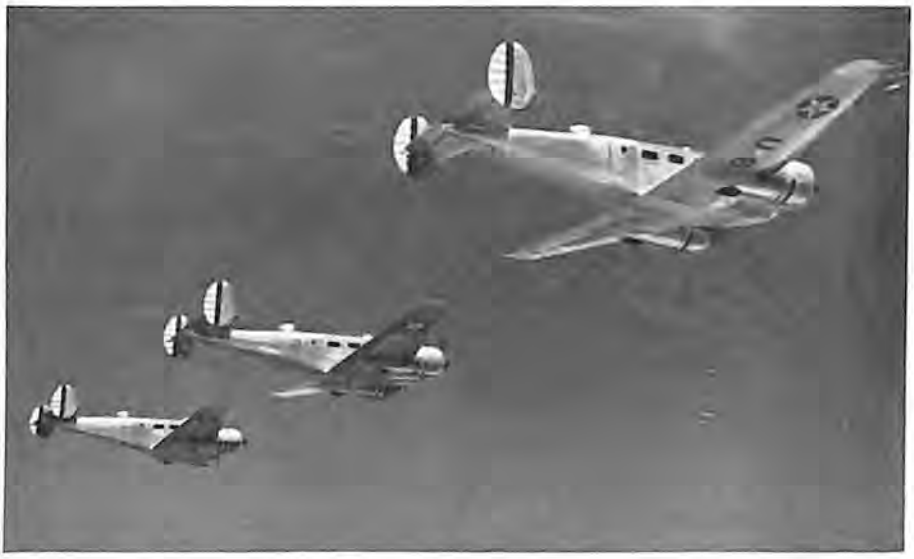
The first measure undertaken by the C.A.A. to prepare graduates for the air forces and for post-war aviation development was to foster and develop a program to introduce pre-flight aeronautics instruction in the public, parochial, and private high schools of the United States. Instruction in the elementary principles of the science of aeronautics such as aerodynamics, airplane structure, meteorology, navigation, airplane engines, and radio communications, were considered to be the minimum training needed for a basic approach to aviation whether for war or post-war participation and understanding. Drawing upon its experience with the Civilian Pilot Training Program, later the C.A.A. War Training Service, the C.A.A. concluded that this was essential training which should be undertaken at the high school level.

The Pre-Flight Aeronautics Program during the following 11 months was able to meet and solve these problems in part as follows: 1. To develop pre-flight aeronautics teaching materials, including both student text materials and teachers manuals, a research program was initiated in March, 1942. Comprehensive materials suitable for the junior and senior level of high school were developed and published. With such study resources, pre-flight aeronautics courses of high scientific standards were started in September, 1942, the beginning of the school year. In addition, research was conducted in the development and preparation of relevant aviation materials in such courses as mathematics, physical science, industrial arts, biology, geography, cartography, etc., and these materials also were completed in time for use in the fall term of 1942. The supplementary materials were useful in pre-flight aeronautics as well as other courses by providing an understanding of the relationship and application of

these subjects to aviation. 2. To help provide qualified teachers for pre-flight aeronautics, the C.A.A. made arrangements to admit teachers of this subject to the C.P.T. ground school classes in the summer of 1942. Over 2,000 were trained. Of these many continued their training and reached the level of proficiency sufficient for them to obtain C.A.A. ground instructor ratings. By cooperating with teacher training institutions, the C.A.A. was instrumental in persuading these institutions to train another 3,000 teachers as a part of their 1942 summer sessions. 3. To give technical advice and guidance to the thousands of school authorities and teachers who needed and asked for help, the C.A.A. provided them with the services of a small staff of consultants. These consultants besides fostering and encouraging the introduction of aeronautics in the high school curriculum were of immeasurable assistance to the school authorities in helping them to plan and organize pre-flight aeronautics courses, and to increase the quality of the instruction given. However, such services were limited by staff and fund considerations. 4. To meet the need for teaching aids and equipment, intensive research also was conducted in this field by the C.A.A. Comprehensive and annotated guides and references to aeronautical teaching resources, both theoretical and applied, were developed and distributed to school authorities. 5. To provide students

TRAINING ARMY AIR FORCES TECHNICIANS

Maintenance crews receiving instruction on a Boeing Flying Fortress.



BEECHCRAFT ARMY NAVIGATION TRAINERS

An all-metal low-wing monoplane carrying a crew of five. It is powered by two Pratt & Whitney 450 h.p. engines.

of pre-flight aeronautics with some goal toward which they might strive in order to obtain a high level of proficiency, the C.A.A. made available to high school students of pre-flight aeronautics the C.A.A. examination service of its General Inspection Division. Through the high schools these students could take the C.A.A. Private Pilot Ground School Examination. Students who passed the examination in one or more fields received the C.A.A. Certificate of Aeronautical Knowledge. Students who passed all four subject fields of the examination were credited with achieving the ground school knowledge required for the C.A.A. Private Pilot Certificate. If such students obtained proper flight instruction they could qualify for their Private Pilot Certificates. Since the vast majority of pre-flight aeronautics classes started during the 1942-43 school year, most students were to take this examination for the first time in May and June, 1943. The examination was given only upon election of the student and permission of the school authorities. Appropriate study guides were made available to the schools interested in increasing by this method the scholastic proficiency of pre-flight aeronautics students.

Response of the schools was encouraging. Close to a quarter of a million boys and girls in their last year of high school were receiving instruction in pre-flight aeronautics early in 1943.

Courses in aircraft occupational skills and related technical information were being given in the vocational schools in every State. In many centers of aircraft construction, the training program during 1942 literally taxed the capacity of the schools. Following are the

more important achievements of the vocational schools in the aircraft field under the war production employees training program: Trained more than one million men and women in aircraft mechanical occupational skills—to do specific jobs—since July 1, 1940; assisted aircraft war contractors in numerous centers by establishing special schools at or near plants as part solution of training problems; retrained tens of thousands of automobile mechanics in "conversion" courses for jobs in the aircraft industry; retrained many thousands of unemployed in the former white collar trades—salesmen and non-mechanical people—for jobs in the aircraft industry; retrained many thousands of civil service "mechanic-learners" for the U. S. Army Air Service Command; trained large numbers of men and women for air transport mechanical occupations; trained operators of heavy excavating machines for service with the Air Service Command; trained thousands of parachute artisans, engine mechanics, aircraft sheet-metal specialists, assemblers, electricians, and other aircraft technicians.

Under the regular vocational training program of the U. S. Office of Education, functioning through State Boards of Vocational Education, instruction in aircraft mechanical skills was provided for more than 76,000 students from July 1, 1939 to December 31, 1942.

In February, 1942, the Office of Education on a request from the Secretary of the Navy, instituted a model airplane building project. The project was organized to meet a need of the Bureau for a large number of model planes built to scale for such purposes as recognition,

BOEING N2S-4 TRAINER
Army PT-17 transferred to Navy.

CURTISS SNC-1 COMBAT TRAINER

Delivered in quantity to the Navy air forces. The SNC-1 is powered by a Wright Whirlwind engine.

range estimation and determination of cones of fire. Specifications for making such model planes were sent by the Office to schools throughout the country. During the last half of the school year, 1941-42, the project involved the construction of 10,000 model aircraft of each of 50 types. The project was extended into the 1942-43 school year in order to complete the 500,000 planes first requested and to make an additional 300,000 models, 10,000 each of 30 new types, or a total of 800,000 models in all. Planes of both the United Nations and the Axis were included in the project. Instruction material consisted primarily of template and assembly sheets and a booklet containing directions for construction of the model planes. More than 6,000 schools cooperated in the project. About 500,000 youths participated under the supervision of 9,000 instructors.

A special program of aviation education in the high schools was instituted on the recommendation of the Office of Education during 1942. Acting on a report of a special committee of the U. S. Office of Education Wartime Commission, the Commissioner of Education secured the cooperation of the Federal Security Administrator and the War, Navy and Commerce Departments in the creation of a national policy committee to develop a plan for wartime readjustment of the organization and curricula of secondary schools. A High School Victory Corps, designed to provide a pattern for this curriculum revision, was organized in the nation's schools. Among the five divisions, the Air Service Division was afforded a position of major prominence. About 40 per cent of boys graduating from high school were needed for the Army or Navy air services, and the purpose of the Division was to accelerate their training for future responsibilities.

"Our flyers are the best in the world. One reason is: We give more hours of actual flying in our training than do others. Our pilots now get over 250 hours in school with another 200 in our operational

training units before reaching the combat theater. In the last war the average was 90 hours before going into combat. Eddie Rickenbacker, our ace of aces in World War I, had but 35. In no other nation does the average young man have the natural ability and temperament so essential to aviation students. The quality of American airplanes, too, has helped. Of all accidents, only 14 per cent are due to engine or structural failure. Every accident is carefully investigated." Gen. Henry H. Arnold, commanding general of the Army Air Forces, made that statement in December, 1942, before the largest number of aviation cadets ever assembled. They numbered tens of thousands, and covered ten acres of ground at the San Antonio, Tex., Aviation Cadet Center.

In March, 1939, the Army Air Forces was training about 500 flying officers a year at two air fields, Kelly and Randolph. Three Air Corps officers in the Training and Operations Division of the office of the Chief of the Air Corps in Washington ran the show. Entire training personnel, officers, enlisted men and students was less than 3,500. With the outbreak of war in Europe, in September, 1939, the training program went up to 7,000 a year, with civilian schools

THE FAIRCHILD PT-19A
Army trainer powered by a Ranger engine.

THE FAIRCHILD AT-14

A fast bomber crew trainer built of plastic plywood by the Duramold process.

coming into the program for elementary training. In the spring of 1941 the rate was boosted to 12,000 a year, with more civilian schools in the picture and new Army air fields mushrooming all through the South and southern California. In June, 1941, the Army Air Forces adopted an expanded program to train 30,000 aviation cadets a year, and provision was made for special gunnery schools, and schools for bombardment and navigation. Aviation cadets began coming into the mill at the 30,000 rate in November, 1941. After Pearl Harbor the sky was the limit. Within a few months aviation cadets were pouring in at the rate of several thousands a month.

On January 23, 1942, a separate command under Major Gen. Barton K. Yount took over the flying training program. A constant effort was made, with some success, to cut down the percentage of washouts. When an aviation cadet was appointed, he went to one of the Aircrew Classification centers, and there received exhaustive physical, mental and psychological tests to determine whether he was to become a pilot or a bombardier-navigator. The course for the latter was combined at the expense of a few extra weeks training, but resulted in a more generally useful combat crew member. The next step was the Pre-Flight Training School for either pilots or bombardier-navigators and a short military orientation course.

The pilot candidates then proceeded to a civilian flying school for a nine weeks course in elementary flying training, which toward the end of 1942 was beginning to include a few hours in the elements of instrument flying. The next stage was nine weeks of basic training, in many cases also given in some of the larger civilian flying schools under Army supervision.

At the advanced flying training stage there came a parting of the ways. Long before this the pilot candidate knew whether he was to become a fighter pilot, in which case he went to one of the advanced single-engine schools, or a bomber pilot slated for a twin-engine school. Either course covered nine weeks. That made up the 27 weeks for the flying training proper, plus the nine weeks for the preliminary stuff—36 weeks in all. It formerly had required a full year.

As more equipment became available it was found possible by the autumn of 1942 to provide a larger amount of specialized and transitional training in the advanced courses, both single and twin-engine. Bombardier-navigator candidates, after passing through their Pre-Flight Training school, went on to highly specialized courses, including theory and practice in reading weather maps; the science and art of navigation by sight, dead-reckoning, radio navigation, celestial navigation and various combinations of these methods. This important crew member was responsible for getting the bomber to the desired objective and back again to its base in any kind of weather. In the case of a medium bomber with a smaller crew or, if the bombardier in a heavy bomber were disabled, the bombardier-navigator had to be able to take charge when approaching the bombardment run.

The air fighting in 1942 placed tremendous emphasis on the need for the best possible training in aerial gunnery. When it came to actually knocking out enemy fighters, the gunner was the man who did it. The excellent box-score on all fronts provided ample testimony to the sound training methods and also the superiority of the .50-cal. high velocity machine gun in American bombers and fighters.

The Navy in 1943 was inducting more pilots in a single week than it had trained in several years only a short time previously. Training had stepped up to meet the demands for flying personnel needed for the 27,500-plane Naval air forces. The desired annual rate of output of 30,000 pilots was scheduled to be reached by the middle of 1943. This was not accomplished by simple multiplication of induction rates. Quality was not sacrificed to attain quantity production of pilots. No compromise with caliber, was the first tenet laid down by Naval flight training chiefs when they were handed their tremendous assignment. That determination only intensified

FLEETWINGS ARMY BASIC TRAINER

The BT-12 in flight, first stainless steel military plane on record.

U. S. Navy photo

NAVY FLYING CADETS

At the Naval Air Station, Corpus Christi, Tex., they are in the air on flight training by seven A. M. daily.

their problem, which they met and solved during the first year after Pearl Harbor. They solved it by streamlining the training and at the same time increasing efficiency of the system. Several innovations were introduced to attain increased efficiency. Research psychologists went to work. Two written tests were devised for prospective Aviation Cadets to assure a minimum of washouts in training. The researchers succeeded beyond their most ambitious hopes. Where washouts in prior years had run as high as 40 per cent, they dropped to 10 per cent. That was the first miracle in the program. Other stimulants to improved training were ingenious aids to instructors and students, such as daily instruction sheets which told the student what he would practice the next day—just that, no more—and patter booklets, based on thousands of interviews with instructors, which gave the instructor exactly the most effective language to use in talking to his students while aloft.

The success of the researchers in devising the written tests which weeded out potentially poor airmen in the pre-selection period led training chiefs to apply a similar system to instructors. An excellent pilot was not necessarily a good instructor. A Flight Standardization Board was set up, composed of seven pilots. The Board traveled from training base to training base, checking the instructor's ability to instruct and his fitness for instructing by administering cleverly conceived tests.

The Navy did not stop there. Questions arose: How to assure Navy pilots the topnotch physical condition necessary to the superior

fighting pilot? The training day, with its many hours in the air and in ground school, was too full to allow for the physical conditioning necessary to keep the student fit for the grind which took so much out of him every 24 hours. So the Pre-Flight School was conceived. At those establishments, operated at four college campuses and a converted resort hotel, the Cadet spent three months before entering primary flight training. The country's outstanding physical educators were commissioned by the hundreds to condition the Cadets. These schools filled the need so satisfactorily that a decision was reached to extend the theory in still another direction. If the student during flight training could be relieved of some of the burden of ground school, with its mathematics, physics and navigation, would not the increased freedom of mind in the air permit him to concentrate on his flight problems to greater advantage? Navy training chiefs believed it would. So 20 Flight Preparatory Schools were opened early in 1943, also at colleges and universities, where the Cadet got three months of academic conditioning as the first step toward winning his "wings of gold."

Now, decided the Navy, there remained one more question to answer. How could valuable, hard-to-get training equipment best be preserved? The answer to that was the Civilian Pilot Training Program. This program, established in 1939 to train hundreds of thousands of civilians to fly, had ample training facilities available. True, the CPT curriculum utilized so-called light planes, much slower and easier to handle than the speedy, tricky, high-performance Navy trainers and combat planes. Eager, however, to undertake any experiment that might result in speedier production of better pilots,

CURTISS TWIN-ENGINE TRAINER

The AT-9 advanced trainer produced by Curtiss-Wright for U. S. Army Air Forces multi-engine pilot training.

THE CESSNA BOBCAT

Army AT-17 two-engine advanced bomber crew trainer.

with a minimum equipment loss, the Navy began giving all its Cadets preliminary training in the light planes. It found, happily, that this training saved a disproportionate amount of time when the Cadets entered the more advanced stages of training. So thousands of CPT courses were acquired under contract. The Navy training program had been completely streamlined.

Naval flight training covered, from start to finish, 16 to 17 months, a lengthy training period in wartime, but one which turned out superior fighting airmen, and the facilities established were so capacious that the requisite number of flyers, however large, could be accommodated.

The Cadet first went to Flight Preparatory School, where for three months he studied classroom subjects designed to enable him to master the navigation and other problems he was to encounter later. On one of 20 college campuses, in uniform, he studied under civilian professors, at the same time living under Naval discipline, learning Navy customs and traditions, preparing to be an officer.

Next, the Cadet got his CPT flight training, completing 30 hours of solo time. He was at a CPT base for two months.

From CPT he entered one of the Pre-Flight Schools, where, along with further classroom work, he became a strong, rugged athlete able to hold his own in endurance with anyone. Sports, scientifically designed to achieve for him this stage of physical condition, were his daily fare. He boxed, wrestled, ran heart-breaking obstacle courses, went on 20 mile marches, swam fully clothed.

When, after three months in Pre-Flight, the Cadet entered Primary Flight Training at one of the 18 stations of the Air Primary Training Command, he was prepared for intensive flight work. In his three months of primary, the student got 72 to 85 hours of flying in Ryan or Boeing trainers.

Then came Intermediate Flight Training, at one of the two huge Air Stations at Pensacola, Fla., or Corpus Christi, Tex. Intermediate also consumed three months and brought the Cadet's hours of flight time to well over 200. After finishing this phase, the Cadet got his wings of gold, and was commissioned an Ensign.

Now, the Cadet neared the end of his training and entered one of the most important stages—Air Operational Training. Entering this phase, the Cadet undertook to become a specialist in a distinct category of aircraft. Contingent on abilities he had demonstrated during his 14 months of training, he went into Fighter, Torpedo, Dive Bombing, Observation, Transport, Bombing, or Patrol Bombing training.

After some work in North American's Texan advanced trainer, he flew, according to his specialty, the Grumman Avenger torpedo bomber; Douglas Dauntless, Brewster Buccaneer, or Curtiss Helldiver dive-bomber; the Grumman Wildcat or Vought Corsair fighter; Consolidated Catalina or Martin Mariner patrol bomber; Vought Kingfisher or Curtiss Seagull observation plane; any of a number of transport types, or one of a number of other types in the above cate-

U. S. Navy photo

FOR NAVY HIGH ALTITUDE FLYING

Here in a test chamber, Navy cadets learn to use high altitude oxygen masks, under simulated conditions. A doctor administers oxygen to a cadet who has passed out at "18,000 feet."

BOEING NAVY TRAINER
The N2S-3 with 220 h.p. Continental engine.

gories. Broadly, he either trained in carrier-based operation or seaplane operation. Training carriers were maintained on the Atlantic and Pacific and on the Great Lakes.

It was in Air Operational that the Cadet learned the actual practices of aerial war in his specialty. The carrier pilot learned to land and take off from carrier decks, a highly specialized art. First he made simulated carrier landings on strips marked off on land, then tackled the real thing, the most difficult landing operation in aviation—bringing his ship down on the restricted flight deck of a moving carrier.

If he was in a seaplane, the Cadet was catapulted into flight in one of the observation plane types which operated from cruisers and battleships at sea, first from catapults on land, then from catapults on the decks of ships rolling in the sea. Along with the patrol bomber pilots, he also learned landings and take-offs on the surface of the sea.

The patrol bomber Cadets learned to operate the huge, multi-engine flying boats and perfected the teamwork so necessary between the large crews of these craft.

The carrier students learned the techniques of dive or torpedo bombing, or fighter plane tactics, as the case might have been. They worked in squadrons of varied size, learned defensive and offensive mass maneuvers, and individual combat tactics. They learned, if they were in bombers, the techniques of high-level, glide and dive bombing.

After two to three months in Air Operational, the Cadet had completed his training, and was sent forth to destroy the enemy. How well he succeeded, as a result of Navy Flight Training, was recounted in Chapter IV.

The Navy also trained lighter-than-air pilots and crewmen at two schools, one at Lakehurst, N. J., the other at Moffett Field, Calif., to operate the non-rigid blimps which were so successful in fending off and destroying Axis submarines seeking to knock out the United Nations by destroying ocean transport of food, supplies and munitions. How well these lighter-than-air schools trained their students was reflected in the fact that of the thousands of vessels convoyed by Navy blimps during the first 15 months of war, only one ship was lost to enemy submarines.

Preparing for every contingency, the Navy, through the U. S. Marine Corps, began training seaplane glider pilots. Six CPT glider schools were used for preliminary training, after which the students went to advanced training. Enlisted men selected from fleet and shore establishments went through glider training to become glider co-pilots, while some Marine Corps pilots, after completing the Intermediate Flight Training stage of regular Naval Flight Training, took advanced glider training and became glider first pilots.

Throughout the Aviation Cadet's training, many studies not mentioned above were emphasized. Gunnery received great emphasis. Navy training chiefs knew that the finest pilot is a liability if he cannot shoot well. Likewise, they knew that the most accomplished radioman or machinist's mate, flying in the rear seat of a dive or torpedo bomber, must be an expert marksman with the high velocity guns installed in Navy planes. Efficiency of the Navy's aerial gunnery training was apparent from battle action reports.

Inestimable credit for the Navy's air victories in the first year of war was handed to the enlisted personnel which repaired and serv-

BOEING AT-15 CREW TRAINER

Built of plywood and fabric over steel tubing it was designed for flight crew training.

THE BEECHCRAFT AT-10

A transitional trainer for multi-engine bomber pilots of the Army Air Forces.

iced the planes in the battle areas. Many of these men trained in the Navy's technical schools doubled as gunners or performed other flight duties.

On these technicians—the thousands trained in 1942 and the 100,000 to be trained in 1943—the Navy and the nation were placing great dependence in the fight for victory, and peace.

A whole new program of training was under way for Coast Guard Aviation. By July, 1943, there were to be 80 more commissioned Coast Guard aviators and 160 more enlisted aviation pilots. These aviation pilots were drawn from the enlisted ranks of the Coast Guard. They were sent to Pensacola, Fla., in groups of 20 in each monthly class. The only requirements for these young men were that they be under 27 years old and had finished high school, had their commanding officer's recommendation and were able to pass the flight physical examination. Young men, having these qualifications, were then selected by Headquarters for the next class at Pensacola. Designation as Coast Guard Aviator was open to all officers of the Coast Guard, Reserve and Regular, who could meet the age and physical requirements for assignment to the Naval Air Station at Pensacola.

The Academy of Aeronautics operated by Charles S. (Casey) Jones at New York Municipal Airport, La Guardia Field, expanded its program, with increased facilities for the all-out victory effort. It had an Army contract to train enlisted men as air mechanics, and most of its facilities were devoted to that enterprise. The Academy hangar at the airport was turned over entirely to that work and the Academy dormitory, used as a barracks, was supplemented by quarters for the trainees in several nearby apartment houses. The Academy received the Efficiency banner of the First District, U.S. Army Air Forces Technical Training Command, for operating the most efficient civilian mechanics school in the district. Under a new set-up, to make

Army air mechanics available more quickly for active service, the program at the Academy was on a seven-day week basis with classes operating in three shifts through a 24-hour day. Through the joint efforts of the U.S. Department of Education, the Board of Regents of the State of New York, the United States Civil Service, and the Army Air Forces, additional men and some women war mechanics were trained. Other groups, including women as well as men, were trained for American Airlines in its enlarged program with the Army Air Forces Air Transport Command. The Academy also continued to offer courses in aircraft design and construction to civilians. The curriculum, almost identical with that of the department of aeronautical engineering in the parent institution, The Casey Jones School of Aeronautics, provided complete theoretical courses and training in engineering laboratory work.

Aero Industries Technical Institute, Los Angeles, Calif., geared its training and instruction program closer to the war effort with construction of additional buildings, installation of new equipment and addition of several new instruction courses. A part of the facilities were contracted to the Army Air Forces Technical Training Command. The Institute broadened its own training program, making it available to men and women without previous aircraft experience. Thousands of students were trained for aircraft employment through Aero Tech's home study modern aircraft construction course, and employees of the industry in 15 United States and Canadian plants also received instruction through this course. To

BEECH BOMBER TRAINING

Army AT-11 Beechcraft bomber trainers take on cargoes of practice bombs at a field in Texas.

AT ACADEMY OF AERONAUTICS

Drafting room at the school at La Guardia Field, New York.

help alleviate the shortage of engine mechanics, the Institute introduced a short, intensive training course of 16 weeks.

Airport Ground Schools, Inc., Hollywood, Calif., doubled facilities and operated wartime accelerated schedules training ground instructors for instruction work at military, naval and private schools.

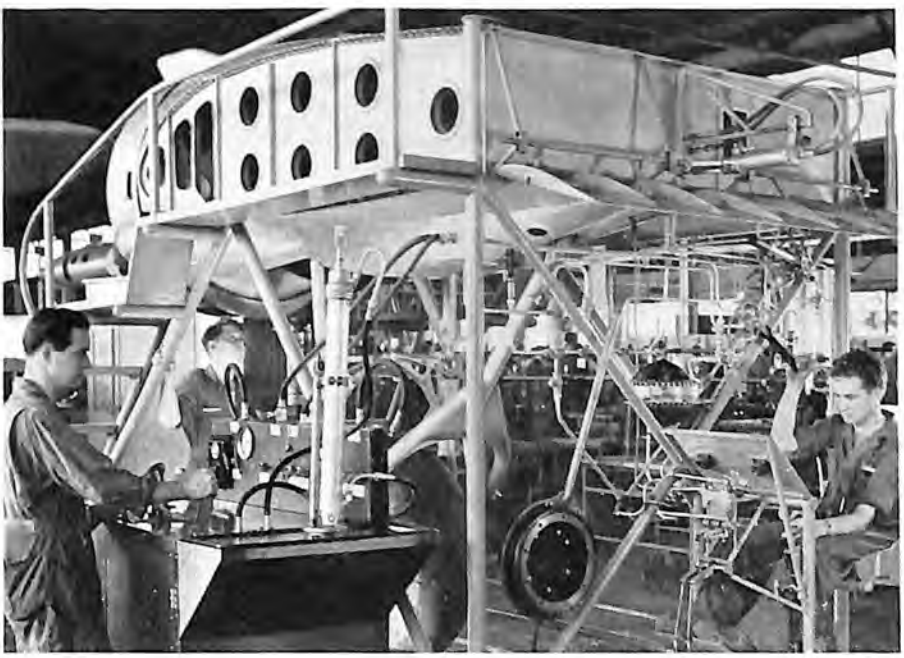
American School of Aircraft Instruments, Glendale, Calif., with expanded facilities gave courses to both men and women in instrument maintenance.

The Aviation Institute of Technology, Long Island City, New York, owned and operated by Frank Ambrose, increased facilities by addition of a six-story barracks, a mess hall and shop space, 57,000 sq. ft. total, to be used exclusively by enlisted men of the Army Air Forces. The Aviation Institute of Technology was awarded the Banner Award for efficiency by the Army Air Forces Technical Training Command. The school was approved by the New York State Board of Education and the C.A.A. for instruction of airplane and engine mechanics, and was training specialists for the Army Air Forces, with approximately 100 instructors.

Cal-Aero Academy, Ontario, Calif., Mira Loma Flight Academy, Oxnard, Calif., and Polaris Flight Academy, Lancaster, Calif., all operated by Major C. C. Moseley, devoted their entire facilities to military pilot training. Since their establishment in July, 1939, the schools' cadets and instructors had flown approximately 25,000,000 miles for each cadet flying fatality. One hundred and ten graduates had been awarded Distinguished Service Crosses, Distinguished Flying Crosses, Silver Star Medals, Purple Hearts, Air Medals and mention in dispatches during the first year of war. Shift of the Polaris plant from British to American training made possible the assignment of Cal-Aero exclusively to primary training for the Air Forces instead of carrying on both primary and basic training at

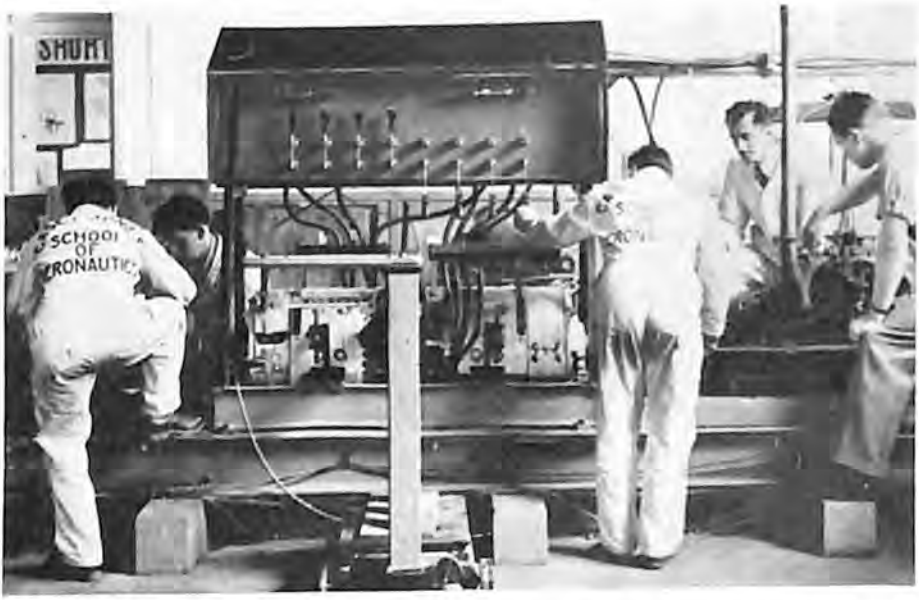
that school. Cal-Aero and Mira Loma handled primary training, sending graduates into Polaris for basic work. Women maintenance mechanics and women flying instructors attended the schools, with additional women scheduled for staff work. An instructors' refresher school for flyers was maintained by the three flying schools while the women mechanics were given training at the Curtiss-Wright Technical Institute also operated by Major Moseley. Curtiss-Wright Technical Institute, Glendale, Calif., had its biggest year since its establishment in 1929. Training of civilians in aviation mechanics and aeronautical engineers continued on a large scale in conjunction with an expansion in training Army Air Forces technicians. Breaking a tradition that had existed since its founding, Curtiss-Wright Tech opened its doors to women. They were trained both for maintenance work on Army training aircraft used in the three sister flying schools and for outside employment, particularly as aeronautical engineers in aircraft factories. Curtiss-Wright Tech opened the first civilian parachute maintenance school in the nation for Army Air Forces personnel. Another development was the training of Latin-American students from 21 nations, invited by the Civil Aeronautics Authority to the United States for this work. A large Chinese civilian enrollment also was trained.

California Flyers School of Aeronautics, Inglewood, Calif., discontinued civilian flight and mechanics training for the duration of



AT CURTISS-WRIGHT TECHNICAL INSTITUTE

Mechanics students working on one of the school's specially constructed training jigs.



AT CASEY JONES SCHOOL OF AERONAUTICS

Aeronautical engineering students at work on a dynamometer.

the war, devoting all facilities to Army Air Forces mechanics training.

Dallas Aviation School, Dallas, Tex., trained commercial students and 250 others in a War Training Service program. It also trained Army cadets at Fort Worth and Brady.

Embry-Riddle School of Aviation, Miami, Fla., continued its expansion program for the training of Army pilots, technicians and civilian aviation workers. In Miami, enlisted men were learning to become engine mechanics, electricians, welders and sheet metal workers. At Carlstrom and Dorr Fields in Arcadia, Fla., and at Embry-Riddle Field, Union City, Tenn., Air Forces cadets were given primary flight training. RAF cadets received flight training in Riddle Field, Arcadia, Fla., under the British curriculum. At Chapman Field in Miami and at the seaplane base on the MacArthur Causeway, private and C.P.T.P. students received flight instruction.

The Casey Jones School of Aeronautics, Newark, N. J., occupied eight buildings in its expanded program as compared with one floor in a small building when it was started 10 years ago. Like the Academy of Aeronautics it operated on a three-shift, seven-day week, 24-hour-a-day schedule to expedite the training of mechanics for the Army Air Forces. While most of the school's facilities were devoted to that effort, the aeronautical engineering department still offered courses to civilians with a curriculum developed over a decade providing a complete, practical course in the engineering field. With the cooperation of the U.S. Department of Education, the Board of

Education of the State of New Jersey, the U.S. Civil Service, and the Army Air Forces, civilian students, both men and women, were trained in a number of specialist courses for service in war industries. Several groups were trained, too, for jobs with American Airlines for its expanded services in conjunction with the Army Air Forces Air Transport Command. A group of 100 picked young men from countries south of the United States attended the school for aeronautical instruction as a part of the Government's good neighbor policy.

Lodwick Aviation Military Academy, Avon Park, Fla., operated for the second year as a primary flight training school for cadets of the Army Air Forces, expanded in size and scope. New barracks buildings were constructed alongside the hotel barracks, and additional class-rooms were added to the former country club converted into ground school quarters. A new steel hangar was erected at the main airport, and additional auxiliary fields were acquired. The school began operations under War Department contract in October, 1941.

New England Aircraft School, Boston, Mass., expanded activities to provide facilities and staff for training members of the Army Air Forces Technical Training detachment. The civilian school at Commonwealth Airport was training, in addition to civilians, Civil Service employees for the Army Air Forces and women as technicians for Northeast Airlines.

Parks Air College, East St. Louis, Ill., was still expanding facilities to take care of the wartime needs for training pilots and mechanics for the Air Forces. By April 1, 1943, approximately 1,600 aviation cadets were to be constantly in training at the five institutions operated under the management of Oliver L. Parks. Besides the home school at East St. Louis, there were the Alabama Institute of Aeronautics at Tuscaloosa; the Missouri Institute of Aeronautics at Sikeston; the Mississippi Institute of Aeronautics at Jackson; and the recently established Cape Institute of Aeronautics at Cape Girardeau, Mo. In addition to flight training for servicemen, CAA war service training was being carried on at Tuscaloosa for a group

LODWICK AVIATION MILITARY ACADEMY

Continental-powered Boeing trainers on the flight line at the school in Avon Park, Fla.

RYAN SCHOOL OF AERONAUTICS
Flight line at the school in Tucson, Ariz.

of approximately 70 students. At Parks Air College a sizable detachment from the Army Air Forces received mechanical training in aircraft, aircraft engines and propellers. Parks Air College also maintained its school for civilians offering four courses, each of which specialized in one of the major fields of aviation. These courses required for completion two or two and one-quarter years. From the attack on Pearl Harbor up to the end of 1942, 162 men were graduated from the civilian school. A check, made in February, 1943, disclosed that each of these 162 men, excepting two who lost their lives in an automobile accident, were engaged actively in work of strategic importance in the war effort. A postwar planning board for the Parks organization had a twofold objective: To bridge, for the more than 1,200 employees, the gap between wartime and postwar activity, and to make use of the technical ability represented in this group in the further development of aviation.

Robertson Aircraft Corporation's mechanics school division had in training hundreds of enlisted men of the Army Air Forces north of Robertson, Mo. At the same time a Naval Aviation Cadet training program was under way in conjunction with Westminster College. Robertson also operated an elementary CPT training program at Fulton, Mo. Facilities were being expanded as the size of classes increased.

Roosevelt Aviation School, Roosevelt Field, Mineola, N. Y., completed 16 years of teaching flying and aeronautical mechanics. The

civil school averaged approximately 400 students, and a corps of some 600 men from the Army Air Forces was in training constantly as aviation mechanics. The school specialized in an airplane and engine mechanics course which prepared for the tests given by the Civil Aeronautics Authority for the aircraft and aircraft engine certificates of competency.

Ryan School of Aeronautics, San Diego, Calif., suspended its Lindbergh Field operations to comply with the military requests to move flight instruction out of the "combat zone." All Ryan training was given at the school's two military training bases near Hemet, Calif., and Tucson, Ariz. As a result, the school ceased commercial training of pilots, aircraft mechanics and engineers for the duration, and concentrated on the training of Army primary pilots. The Ryan School continued to expand its affiliate, the Ryan Aeronautical Institute, which offered specialized home-study instruction in aeronautical drafting and engineering, stress analysis, aircraft power plants and aircraft construction and maintenance.

Safair Flying School, Roosevelt Field, Mineola, N. Y., after 12 years of operations in the New York area, due to the exigencies of the war, was forced to shift operations to the Sunbury Airport, Sunbury, Pa. The school, for the convenience of New York City students, maintained headquarters at 45 Rockefeller Plaza, New York, and in addition to the airport operations, conducted the complete model Sun Valley Camp equipped with barracks to house 300 students as well as ground school and recreational facilities at Sun-

AT STEWART TECHNICAL SCHOOL
In the aircraft engine overhaul department.

bury. Safair prepared students for all pilot courses, including the highest grade of licenses on land or seaplanes. The school contracted with the Government to train students from New York University through the Civil Aeronautics Administration War Training Service, and also cross country trainees and instructors.

Spartan School of Aeronautics, Tulsa, Okla., gave flying training, technical ground training, maintenance and overhaul programs. In addition to its civilian training, the school had two United States Army Air Forces flying training detachments at Tulsa and Muskogee, Okla., operated a British flying training school at Miami, Okla., and had a large Air Forces mechanics training detachment at Tulsa.

Spartan inaugurated a six-day week class schedule to speed up training of pilots, weather forecasters, aircraft instrument technicians, radio technicians, aeronautical engineers, maintenance engineers, mechanics and aircraft assembly workers, expanding all its facilities. Enrollment in civilian classes passed the 600 mark. More than 3,500 hours were flown in May, more than 3,600 in June and almost 4,000 in July.

Stewart Technical School, New York, devoted its mechanic facilities to the training of technicians for the Army Air Forces. Groups of enlisted personnel reported periodically to take the aircraft engine overhaul mechanics course and a detachment of the Army Air Forces Technical Training Command was stationed at the school. The training of civilians in aircraft mechanics was temporarily suspended although the aeronautical drafting, including detail design course was still open to them. The school was chartered by the Regents of the University of the State of New York in 1914.

E. W. Wiggins Airways, Inc., operating flight schools at Concord, N. H., and Columbia, Mo., and a Government-approved mechanic school at Norwood, Mass., trained approximately 750 pilots for Army and Navy at its flight bases during 1942, and about 100 mechanics at the Norwood base.

THE ST. LOUIS PT-23SL

An Army primary trainer built by St. Louis Aircraft Corp., and powered by a 220 h.p. Continental engine.

CHAPTER VII

GOVERNMENTAL ACTIVITIES

Work of the Federal Bureaus—The Civil Aeronautics Administration—Civil Aeronautics Board—Division of Commercial Affairs—Division of International Communications—Federal Communications Commission—Fish and Wildlife Service—Inter-American Defense Board—National Advisory Committee for Aeronautics—The National Inventors Council—Petroleum Administration for War—Reconstruction Finance Corporation—Smithsonian Institution—U. S. Forest Service—U. S. Public Health Service—U. S. Weather Bureau—War Production Board.

DURING the first year of United States participation in World War II the Federal bureaus increased the scope of their work and took on new tasks of solving the problems and administering the many activities connected with the all-out prosecution of the war. Accounts of the work of the individual bureaus follow:

The Civil Aeronautics Administration

Activities of the Civil Aeronautics Administration in 1942, all closely geared to the war effort, were summarized under four main headings—airways, airports, airmen and air safety. The Airways system, built, maintained and operated by the C.A.A., played a key role in wartime aviation. Aircraft movements along C.A.A. routes were almost quadruple those of 1941, totaling about 9,000,000. Of this total, approximately 80 per cent was military traffic by Army, Navy, and Coast Guard planes. C.A.A. control of this traffic was extended from "ramp to ramp" with the taking over of control towers at 70 airports, at the request of the Services. Fifty additional towers were scheduled to be taken over by the summer of 1943.

To provide an adequate complement of traffic control personnel, the C.A.A. conducted an intensive training program. During the last half of 1942 alone, more than 600 men and women began courses designed to qualify them as airport or airway traffic controllers. The opening of nine new airway traffic control centers during the year also created a need for personnel in this field. In the same period, more than 200 controllers already employed were given refresher or advanced

training to fit them for additional responsibilities. Hundreds more of Army and Navy personnel were trained in traffic control. It also was necessary to train replacements and additions to the staff of aircraft communicators. Between July 1, 1942, and May 1, 1943, the training quota for this type of work was 1,200. C.A.A. airways communications facilities also were expanded in the international field of operations. To the transatlantic station near New York were added intercontinental transmitters at New Orleans, San Francisco, and Seattle, serving Army and Navy needs in this global war.

Approximately $200,000,000 was appropriated to the C.A.A. for construction or improvement of airports during the fiscal year ending June 30, 1943. This brought total funds authorized since the beginning of the Defense Landing Areas program in October, 1940, to $339,333,050 for work at 668 sites. At the beginning of 1943, however, the War Production Board, as part of a general policy curtailing construction, revoked priorities and halted work on 41 C.A.A. airport projects, having a total cost of $23,585,056.

Three phases of C.A.A. activity concerned airmen—pilot training, pre-flight aviation education and research on the selection and training of pilots. Originally termed Civilian Pilot Training, the first became the C.A.A. War Training Service during 1942. At the beginning of the year, negotiations were under way to integrate C.A.A. pilot training facilities more closely with the needs of the Army and Navy Air Forces. As far back as September, 1940, students had been pledged to make themselves available when needed by the Services, and before Pearl Harbor some 20,000 trainees had entered the Services, but with the United States actually at war a more direct tie was necessary. In June, therefore, arrangements were put into effect whereby all C.A.A. trainees would be enlisted in the Army or Navy aviation reserve. The Navy contracted to supply the C.A.A. over a period of a year with 20,000 men (since increased to 30,000) to be given elementary (and in half the cases, secondary) training before going to Navy combat flying schools. The Army chose at the outset to utilize C.A.A. facilities for training men disqualified for combat flying to become transport pilots, flight instructors, glider and liaison pilots. A total of 112,000 courses in these fields was scheduled.

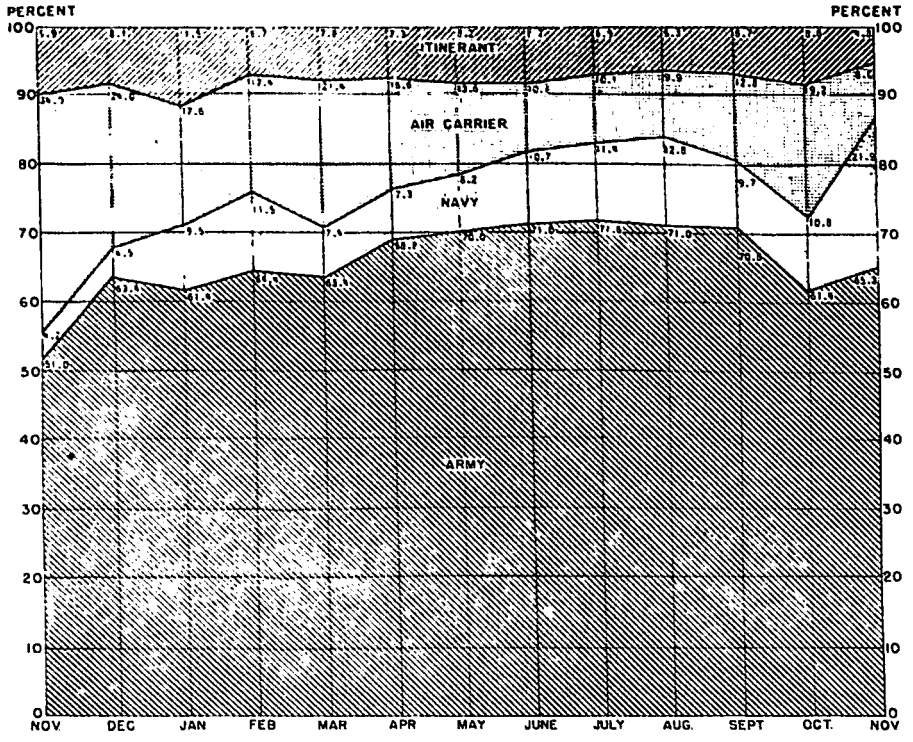
At the beginning of 1943, however, the Army announced that the C.A.A. had in training, or enrolled and waiting training, enough men to meet its needs in these categories for a year. Enrollments under this plan, already suspended because of the President's ban on voluntary enlistments, therefore were halted. At the same time, the War Department said that beginning in April, 1943, it would send a "certain proportion of prospective aviation cadets" to C.A.A. contract schools for "special qualification courses." These would include up to 10 hours flying instruction, as a result of which "men who are found unqualified for additional flying training will be eliminated

as pilot trainees and will be used in other capacities by the Army Air Forces."

The year 1942 also saw extension of air training to the high schools. Some 14,000 high schools introduced pre-flight aeronautics courses under a program initiated by the C.A.A. in cooperation with the U. S. Office of Education. Groundwork was laid by a C.A.A.-sponsored research project which produced a series of textbooks and teachers manuals, and by the throwing open of C.A.A. ground school courses to teachers. An experiment in actual flight training was conducted at 21 high schools, where a total of about 210 students took the regular C.A.A. elementary courses, and averaged the same flight grades as older lads had been scoring.

Civil Aeronautics Board

Activities of the Civil Aeronautics Board changed markedly since the outbreak of the war. Approximately 50 per cent of the work of the Board was connected with that part of the war program in which the country's domestic and international carriers participated. Under a Governmental policy determined May 6, 1942, for maximum utiliza-



PERCENTAGE DISTRIBUTION OF ALL AIRCRAFT OPERATIONS IN THE CONTINENTAL UNITED STATES NOVEMBER 1941 TO NOVEMBER 1942

Prepared by U. S. Civil Aeronautics Administration

AT ACADEMY OF AERONAUTICS

The students at the school at La Guardia Field, New York, get practical experience on an Allison engine.

tion of facilities afforded by the domestic air carriers for the prosecution of the war, the Board prepared a plan for the division of aircraft owned by the domestic air carriers between those to be retained by the carriers for use in scheduled air transportation and those to be sold to the Government for military operation. It also planned the routes and points to be served, and the frequency of service, with the limited number of aircraft retained by the carriers for operations essential to the war program. It collaborated and advised with the military forces in keeping the wartime air service pattern adjusted to the changing needs of wartime commercial air travel; in the formulation of contracts between the military forces and the air carriers for military transport requirements; in obtaining and analyzing traffic and financial reports for those purposes, and for the coordination of the financial results of contract and commercial operations; and in investigating and preparing reports on special confidential matters.

The war had a far reaching effect on the safety work of the Civil Aeronautics Board, with many new problems, including congestion of military and civil air-traffic at airports and on the airways. The induction of much of the skilled personnel of the aviation industry into the armed forces resulted in the necessity for greater diligence in preventing lowering of safety standards to an extent which would increase hazards in air transportation. However, while the experience

of first officers (co-pilots) was more limited than formerly, it was possible to retain as captains men of long experience.

Shortly after the entrance of this country into the war, directives restricting civil flying, other than scheduled air transportation, along the Pacific and Atlantic seaboards, were laid down by the War Department and were later supplemented with an order directing the discontinuance of all such flying on the Pacific coast. Non-air line civil flying along the Atlantic seaboard continued under certain restrictions until sometime in August, when all such flying within certain defined areas was stopped. Even flying schools were directed to remove their flight operations from the established zones. This curtailment of civil aviation was accompanied by a slight reduction in the number of accidents of all types from 5,526 during the fiscal year 1941 to 5,493 during the fiscal year 1942. Of the accidents occurring during 1942, 115 involved air carrier aircraft. Of these, six resulted in fatal injuries, one in serious injury and seven in the complete destruction of the aircraft. Individual reports covering 532 serious accidents were released to the public, and covered all phases of flying activity. All accidents reported were analyzed for statistical surveys and group studies. Of the total number, 3.2 per cent resulted in fatal injuries; an additional 3.7 per cent resulted in serious injuries and 8.7 per cent in the complete destruction of the aircraft involved. During the fiscal year 1942, 28 public hearings were held in connection with aircraft accident investigations; 12 involved air carrier operations and the remaining 16 non-air carrier activities.

Division of Commercial Affairs

The Division of Exports and Defense Aid of the Department of State after June 18, 1942, became the Division of Commercial Affairs, and it continued to administer the registration and licensing provisions of Public Resolution No. 54 approved November 4, 1939. Section 12 of the Act required that all persons engaged in the business of manufacturing, exporting, or importing any of the articles or materials enumerated by Presidential proclamation shall register with the Secretary of State. The President's proclamation of May 1, 1937, was superseded by a more complete listing of arms, ammunition and implements of war in the proclamation of April 9, 1942. The articles listed in this proclamation include aircraft and gliders of all kinds, aircraft engines, propellers, essential parts such as wings, hulls, fuselages, undercarriage units, and tail units, and a number of items of aircraft armament including gun turrets and aircraft armor plate. It was unlawful for any person to export or import any of the articles listed in the President's proclamation without first having submitted to the Secretary of State the name of the purchaser and the terms of sale and having obtained a license therefor. These regulations, however, did not apply to Lend-Lease shipments. Licenses were not issued in

any case in which it had been determined that the proposed shipment would be contrary to the interests of the war effort. During 1942 two special unlimited licenses were issued to the British Ministry of Supply Mission covering certain exigencies in the international munitions traffic. On January 15, 1943, an unlimited license covering shipments to and from Canada was issued to all those importers and exporters registered with the Department of State. Matters pertaining to priorities on aircraft, aircraft parts, and accessories also were handled by the Division.

Division of International Communications

The Division of International Communications of the Department of State was created on August 19, 1938, in order more effectively to meet the steadily increasing problems which confront the United States in the field of international communications. In establishing the Division, the Secretary of State defined its duties as follows:

The functions of the Aviation Section included the negotiation of international agreements on such subjects as air navigation, the operation of air transport services, the reciprocal issuance of airman certificates and the reciprocal recognition of certificates of airworthiness for export, as well as agreements on various phases of international air law. The Aviation Section is in charge of the technical work connected with participation in international aviation conferences and in the activities of international aeronautical organizations such as the International Technical Committee of Aerial Legal Experts (CITEJA) and the Permanent American Aeronautical Commission (CAPA).

Federal Communications Commission

A total of 6,902 authorizations for the use of radio transmitting equipment in the aviation service, including aircraft, aeronautical, aeronautical-fixed, airport control, flying schools, and flight test radio stations were issued by the Federal Communications Commission during the calendar year 1942. Many of the commercial aeronautical facilities were operating in conjunction with the military forces, and the facilities remaining for commercial use were being operated to the limit of their capacity. The resultant burden upon the aviation communications facilities serving military and commercial operations necessitated several changes in the related administrative procedure and regulatory action of the Commission. The changes were made after conferences with the War Department, the Navy Department, the Civil Aeronautics Administration and other war agencies of the Government, as well as with representatives of the aviation industry.

More than 500 licensed aeronautical stations were required to

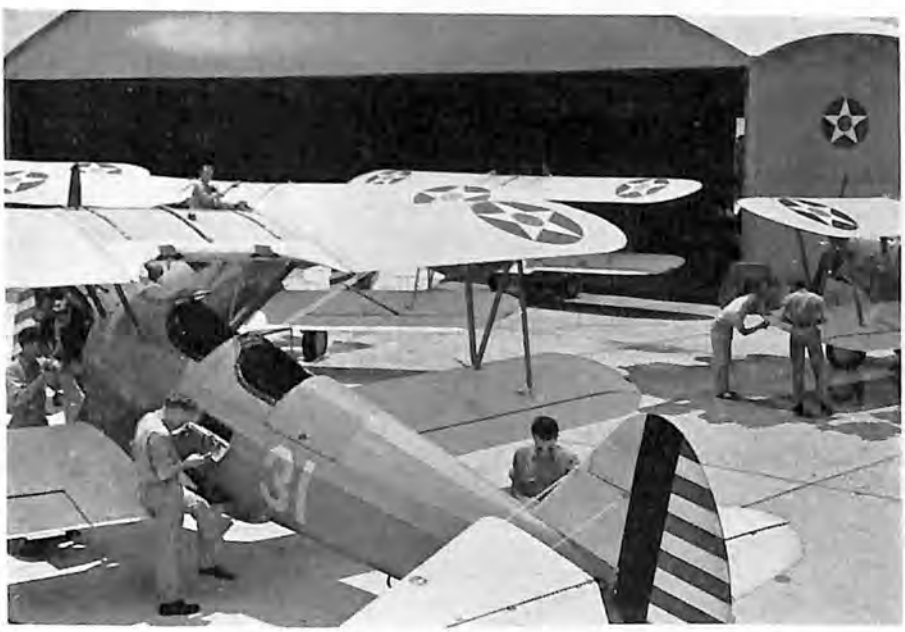
serve radio equipped aircraft. Largely owned and operated by commercial air lines, however, they were primarily engaged in communicating with scheduled commercial aircraft. Various changes in commercial air traffic, such as shortening of routes to save vital materials, temporary closure of radio stations during construction work on airports and landing fields, diversion of commercial operations to military service and similar factors, resulted in the closing of some aeronautical stations, but in most cases it did not signify abandonment.

The number of airport control stations authorized by the Commission in 1942 represented an increase of approximately 23 per cent over 1941. Included were five stations equipped for instrument landings, for safety of landing during adverse weather conditions.

Commercial flying school radio stations usually operated on one of the four ultra-high frequencies allocated by the Commission. Transmission characteristics of the ultra-high frequencies were adapted especially to the type of local communication needed for flight training activities. Communication between the student flyer and the instructor on the ground or in another aircraft, by use of radio telephony, was of great assistance in the training program. In some instances they actually averted serious accidents.

The Fish and Wildlife Service

The Fish and Wildlife Service of the U. S. Department of the Interior continued the maintenance of aerial patrols over Alaskan



AT LODWICK SCHOOL OF AERONAUTICS

Maintenance crews at work on Boeing training planes at the school in Lakeland, Fla.

fish and wildlife resources during 1942 in the discharge of their duties connected with the enforcement of the Alaska Game Law, the Lacey Act and the Migratory Bird regulations. Field men of the Alaska Game Commission—the Service's operating agency in the Territory—found that the airplane was ideally suited for their work of spotting illegal fur trapping activities. They traveled 156,384 miles by plane during the fiscal year 1942. This was five times as much as any other form of transportation used. In addition, employees of the Service's Division of Alaska Fisheries covered about 10,600 miles in the total flying time of 104 hours while engaged in Alaska fishery patrol activities. Of the total, 92 hours of flying was done in southeastern Alaska and 12 hours in central Alaska. Five ships comprised the air fleet of the Alaska Game Commission—three Fairchilds and two Monocoupes. Two Fairchilds and one Monocoupe were equipped with pontoons. They were based at Ketchikan, Anchorage, Dillingham and Fairbanks.

Inter-American Defense Board

The Inter-American Defense Board, an international body resulting from Resolution XXXIX of the Rio de Janeiro Conference of 1942, composed of experienced Army, Navy, and air officers from the twenty-one American Republics, approved three resolutions, initiated in its Plenary Committee for Air Defense, which contributed to the development of aviation and aeronautics in the Western Hemisphere.

The earliest of these resolutions, entitled, "Exchange of Air Information," suggested to the Governments of the American Republics that they maintain a continual interchange of air information and information of common interest in continental defense. A second resolution suggested to the Governments the simplification of the required legal procedure in order that military aircraft of all countries represented on the Board might fly with the greatest freedom through the skies of the Americas. A later resolution to the Governments of the American Republics suggested exchange of official visits by squadrons of the representative military air forces for the purpose of strengthening the bonds of friendship among the air forces of the American Republics.

National Advisory Committee for Aeronautics

After Pearl Harbor, research investigations leading to the development of airplanes and engines capable of operating at higher speeds, higher altitudes, with heavier loads and over longer ranges were conducted by the National Advisory Committee for Aeronautics 24 hours a day in the Committee's numerous wind tunnels and other research facilities. At Langley Field, Va., site of the largest and oldest of the N.A.C.A. research stations; at Moffett Field, Calif., in the N.A.C.A. Ames Aeronautical Laboratory, strategically located near the con-

centrated Pacific Coast aircraft manufacturing centers; and at the Cleveland Municipal Airport where the new N.A.C.A. Aircraft Engine Research Laboratory was approaching full-capacity operation; the research men of the Committee were waging an all-out scientific war against the best aeronautical brains in the Axis nations.

Without disclosing military secrets, the general manner in which the N.A.C.A., through cooperative efforts with the industry and the Services, assisted in shooting down enemy airplanes can be described. In the early stages of the design of a new airplane, for example, small, light-weight scale models of the new aircraft were tested in one of the free-spinning wind tunnels at Langley Field. They determined whether the airplane would recover from a spin satisfactorily, and might result in recommendations from the Committee's staff regarding improvements which might be made to provide better spin-recovery characteristics.

Next came a series of investigations in the free-flight wind tunnel at Langley Field with actual flying models to check the stability, controllability and maneuverability of the new type. This was followed by an investigation of the lift and drag and of the pitching and rolling forces, and then by a study of the flutter characteristics and suscepti-

AT CURTISS-WRIGHT TECHNICAL INSTITUTE

Part of the student body at the Glendale, Calif., school listens to an address.

bility of the new design to the compressibility phenomena. Here again the N.A.C.A. discovered any fundamental design flaws which might have been made early in the design of the new airplane, and recommended corrective measures. Supplementing these investigations of small-scale models of the new airplane, the N.A.C.A. launched separate studies of various components of the airplane, such as the wing and airfoil section, the control surfaces and the engine installation. These tests, which might be conducted in several of the numerous N.A.C.A. wind tunnels, often provided information not only applicable to the particular design being investigated, but of value to aeronautical design in general.

At the same time that work was in progress with the various components of the airframe of the new design, research would be under way to develop the most efficient installation of the engine. This was especially important because of the possibility of eliminating large performance losses by reducing drag and reducing or eliminating the amount of flight test time necessary to make the power plant system function as planned. The performance losses could come from the great horsepowers necessary to meet the military requirements for taking off with large loads, for attaining high rates of climb, and for high speed. The studies, therefore, had to include superchargers, fuels and lubricants, and engine cooling. Facilities at the Cleveland Laboratory permitted the N.A.C.A. to simulate conditions encountered by an airplane flying at several hundred miles an hour at more than 40,000 feet altitude with an engine of 4,000 horsepower. Another wind tunnel nearing completion at the new engine laboratory early in 1943 was to permit the study under simulated flight conditions of the problem of the icing of the induction system of the carburetor, as well as other parts of the airplane.

Supplementing fundamental investigations of engine characteristics, the N.A.C.A. conducted exhaustive studies of ignition, the design of crankshafts, cylinders, pistons, piston rings and other components of the modern power plant.

When a full-size experimental airplane was completed, it then was flown to one of the N.A.C.A. laboratories where it was examined in a large wind tunnel to determine what improvements might be made in the aerodynamic "cleanness" of the airplane. This investigation consisted of locating any sources of high drag, such as protruding exhaust stacks, radio masts, landing gear, and other irregular contours, and developing alternate arrangements having superior performance. It was not uncommon for the top speed of a typical fighter plane to be increased 30 to 50 miles an hour as a result of changes made on the recommendation of the N.A.C.A.

Following the final wind tunnel examination of the airplane it was investigated in flight by the Committee's flight research section. Flyers who were recognized aeronautical engineers, as well as experienced

pilots, measured the maneuverability and handling qualities of the plane in the air by means of many ingenious recording devices developed by the N.A.C.A. The forces on the controls which the pilot must counteract, the loads on the wing and tail surfaces which the airplane structure must stand, as well as the visibility from the cockpit, were measured. At the same time, the performance of the power plant was noted with respect to cooling, supercharging and output under various operating conditions. Those observations provided a basis for making design changes to give improved performance in those features, and provide a basis for future designs.

The cumulative effect of each of the many refinements was to give American aircraft an all-important edge in performance. Our dive bomber pilots were able to evade a hail of anti-aircraft fire because of a margin of speed they possessed over other nations dive bombers. Our long-range patrol boat pilots carried out missions thousands of miles from their bases, comfortable in the knowledge that the aerodynamic "cleanness" of their craft permitted them to cruise at great fuel economy and return home; Japanese Zero pilots saw whole squadrons of their own forces destroyed by a comparatively few American fighters. Those facts proved the dominance of the factor of quality in successful combat operation of airplanes. The N.A.C.A., quietly and almost without notice, thus was working with the aircraft manufacturers on the most vital problems in aeronautics for the Army and Navy.

The National Inventors Council

The National Inventors Council was created late in August, 1940,

AT SPARTAN SCHOOL OF AERONAUTICS
Flight line at the school in Tulsa, Okla.

by the Secretary of Commerce with concurrence of the President. The Council commenced operations early in October of that year, following the selection of Council Members and the organization of a service staff. Council members comprised outstanding American inventors, scientists and industrialists having wide experience in the development and utilization of inventions. Primary duties were: (1) Encouraging the public to submit inventions or inventive ideas having potential value in the war effort; (2) Prompt evaluation of these inventions by a staff of engineers and by a system of technical committees so that useful ideas might be placed promptly in the hands of the military and naval bureaus.

By March 1, 1943, more than 135,000 inventions and inventive suggestions had been received and examined by the technical staff. They came from all parts of the world but mostly from the United States. By direction of the Army Chief of Staff, all inventions from officers and men in the Services were sent through channels to the Council for primary examination. Inventions from Navy personnel likewise were sent to the Council.

Inventions or suggestions thought to be of value in the war effort, after review by the Council, were forwarded to the Army or Navy, or both, for their consideration and ultimate adoption, if they were found acceptable. The appropriate branches of the Army or bureaus of the Navy then dealt directly with the inventor in arranging for use of his invention. The Council itself did not consider the question of compensation or contracts in respect to the use of an invention or inventive suggestion.

Of the 135,000 cases examined by March 1, 1943, 30 per cent were in the aeronautic classification. They embraced suggestions and inventions relating to all types of aircraft and aircraft parts, heavier and lighter than air, power plants and accessories, instruments, armor and armament, airport and airway equipment and facilities and flying equipment such as clothing. As might be expected, only a relatively small percentage of the total merited further study or trial. But while the percentage was small, the total number accepted was important. While war conditions prevented revelation of the details, the important inventions concerned improvements in the size and performance of engines and power plant accessories; steam and jet-propulsion power plants; improved and new types of airfoils, control surfaces, new instruments for both aviation and combat use; instruments and instrument board simplification; aviation aids, including portable blind-landing apparatus; all types of armament, both guns and bombs; airport equipment, both fixed and portable and, of course, new types of combat and transport planes.

Primary examination by the Council relieved Army and Navy officers from this onerous duty, in respect to thousands of useless suggestions. The system of processing promising inventions assured their

being given ample consideration by the Services. Several were found acceptable and some were in use in the combat areas early in 1943. This proved the fallacy of the common belief that inventive ideas in war cannot be put to practical use because of time lost in development. New inventions were helping to win this war.

Petroleum Administration for War

One of the major objectives of the earlier defense programs was the manufacture of a large number of airplanes, the engines for which required the use of 100 octane aviation gasoline. It was obvious to those in authority in the program that the airplane engines would be useless unless there was sufficient fuel for them. However, when the airplane construction program was put into effect, there was a temporary surplus of aviation gasoline available, rather than a dearth of the product.

More than a dozen large petroleum refining companies had installed expensive special equipment, and productive capacity had overrun actual consumption. Substantial amounts were being supplied or contracted for by Great Britain and France, but the use of aviation gasoline by American air forces required only a small proportion of the available production.

Nevertheless, it was evident to the oil industry and certain members of the national defense councils that embarkation by the United States in any major war would create a serious supply deficiency.

AT DALLAS AVIATION SCHOOL

Flight instructor with students before a cross-country flight.

Too many people could not realize that it takes as long or longer to erect a plant for making 100 octane aviation gasoline as it does to erect a plant to manufacture airplanes. The idea was all too prevalent that 100 octane aviation gasoline was "just gasoline," or at least that the oil companies, by modifying their ordinary manufacturing procedures, could turn out large quantities of it within a short time after they received the "go" signal. Actually, 100 octane aviation gasoline can be produced only as a by-product of normal petroleum refining operations and then only if special and expensive equipment is installed. This equipment takes a year or more to build. In fact, the average 100 octane plant is as difficult to build as a destroyer and takes the same kind of critical construction materials—steel plate, alloy tubes, heat exchangers, motors, compressors, valves and instruments.

Fortunately for the United States, some of the refiners, who already had more 100 octane equipment available than was necessary to supply the then small market, responded to the urgings of Government and commenced the erection of additional equipment at their own expense.

One of the first steps taken by Secretary of the Interior Harold Ickes, upon appointment as Petroleum Coordinator in May, 1941, was to arrange for doubling the national productive capacity. Priorities for the necessary equipment were granted promptly by the predecessor of the W.P.B. Within a few months, as the result of joint persuasion of Secretary Ickes and Under Secretary of War Patterson, authorization was given for further increases in productive capacity which would more than quadruple the peacetime output of the United States. All this occurred before Pearl Harbor.

Months before Pearl Harbor, Secretary Ickes had organized the technologists of the oil industry to make an exhaustive survey of the possibilities of producing immense quantities of aviation gasoline. It was on the basis of this survey that the Petroleum Coordinator (later the Petroleum Administrator) and the industry were able to take prompt action to avert what otherwise might have been a catastrophe. Authorization of priorities, however, was only the first step in a production program. The fact that 100 octane aviation gasoline could be made only as a by-product of existing refining operations made it unwise if not impossible to carry out a production program independent of available sources of crude oil and available refining equipment. Arrangement was made whereby the Government, through Defense Supplies Corporation, a Reconstruction Finance Corporation subsidiary, was able to contract for supplies of 100 octane over a period of three years.

Loss of the Dutch East Indies refineries and oil fields was a serious blow to the aviation gasoline productive capacity of the United Nations. Closing of the Burma Road with its consequent

air freighting of supplies to beleaguered China increased the supply tension. Cargo plane routes to the far corners of the earth, put into effect as a part of the global war, also added to the production load required. To cap the climax, it became necessary for the oil industry, largely the American oil industry, to make great improvements in the quality of 100 octane gasoline as well as large increases in quantity.

It was not until May, 1942, that the Petroleum Coordinator's organization was able to secure a satisfactory allotment of steel from the W.P.B. at a rate sufficient to support the construction program. During the Summer of 1942, the program suffered as did most other programs, as the result of actions scheduling immediate production of the combat tools needed in the southwest Pacific and in Africa.

Additional units to produce 100 octane gasoline planned and started by the oil companies with their own funds prior to Pearl Harbor had come into production by February, 1943. Each month that followed was to see more of the units contracted for after Pearl Harbor coming into production. Twenty large refining companies and 35 smaller refining companies were playing major roles in this program. It was interesting to note that about a quarter of all productive capacity was in the hands of relatively small refining organizations well distributed through the country.

In addition to those refineries which played a major role in the 100 octane program, scores more, large and small, converted some units of their existing equipment to produce special ingredients for 100 octane gasoline. Only a few of the new units placed in operation

RYAN PT-25 PRIMARY TRAINER

Built of plastic-bonded plywood, it was powered by a 185 h.p. Lycoming engine.

during 1942 were large ones. In spite of that, the industry was able, by ingenious schemes, to more than triple its output of 100 octane gasoline. Moreover it was able at the same time to give the Army a better product than had ever been produced before in the United States. All the catalytic cracking units except one which had been built prior to the war for ordinary competitive purposes by the various oil companies were rebuilt and modified in lesser or greater degrees to produce aviation base stock, and that one was being converted early in 1943. New ingredients were invented as a result of which marked capacity increases were obtained.

Reconstruction Finance Corporation

The most extensive domestic procurement program instituted by Defense Supplies Corporation, a subsidiary of R.F.C., was that involving high octane aviation gasoline. In order to assure adequate supplies of this most important material, Defense Supplies Corporation, at the request of the Army, Navy, and the Office of the Petroleum Coordinator for War, entered into contracts with substantially all refineries which were, or expected to be, equipped to produce aviation gasoline, and in consideration of their agreement to produce aviation gasoline on a large scale, the Corporation contracted to purchase their production. This production, which was to involve substantially the entire quantity of 100 octane aviation gasoline produced in the United States and its territories, was to be distributed to the armed forces and the Allies. The contracts were made with the cooperation of the Office of the Petroleum Coordinator for War.

With the approval of the President, Defense Supplies Corporation appropriated $1,488,600 for the purpose of training citizens of the other American Republics as aviation pilots and technicians. Of several hundred trainees who were brought to this country at the beginning of the year, about 40 per cent completed their training and returned to their homes, or were awaiting transportation. A substantial number of pilots completed their training in 1942, and the rest, instructor mechanics and aeronautical engineers, continued their training into 1943. Advanced courses beyond the training which was contemplated in the original program were offered to about half of the trainees.

On April 28, 1941, the President allocated the sum of $8,000,000 to the Federal Loan Administrator for the principal purpose of eliminating Axis control, equipment and personnel from Latin-American air lines. At that time there were about 15,000 miles of Axis-controlled air lines in South America. By making available American equipment, personnel and financial assistance, the Axis-controlled air lines in Bolivia, Ecuador, Peru and Brazil were eliminated. The Italian air line (LATI) flying between Brazil and Europe was eliminated by substitution of a better service by an American company with Amer-

ican planes and personnel. The Italian planes with spare motors and spare parts used in this service were acquired by the Brazilian Government from LATI and purchased by Defense Supplies Corporation for $350,000. The United States Army Air Forces indicated their desire to acquire these planes. There are no Axis-controlled air lines remaining in South America.

Commitments made by Defense Plant Corporation, a subsidiary of R.F.C., included $2,448,477,447 for the production of aircraft and parts, including $18,000,000 to Henry Kaiser and Howard Hughes for the design and construction of three cargo planes; $1,826,230,695 for the manufacture or purchase of machine tools; $459,449,896 for the production of ordnance; $195,754,536 for the construction and equipment of shipyards and vessels; $51,025,728 for the manufacture of radio and scientific equipment; $189,662,963 for production of aviation gasoline; and numerous other items.

Smithsonian Institution

The National Museum traces its origin back to 1846 when Congress provided for a museum of the nation in the law establishing the Smithsonian Institution. Within six months of the passage of that Act, August 10, 1846, a plan of operations for a museum was drawn up, including within its scope the progress of useful inventions, industry and manufactures. Aeronautics became a definite part of the National Museum's section of transportation in 1889 when a reproduction of James Stringfellow's prize winning steam-powered model airplane of 1868 as well as the original engine were acquired by the Smithsonian Institution and exhibited. They became exhibits 1 and 2 of the National Aircraft Collection.

EXHIBIT AT SMITHSONIAN INSTITUTION

The succeeding 25 years were extremely slow in the Museum as far as aeronautics was concerned. It did, however, include an original Lilienthal glider, Langley's steam-powered models, and the Army's first airplane, which was the Wright brothers' 1908-1909 machine. By 1931 the collection numbered 1,266 items including a Spad XII; General Mitchell's Spad XVI; a captured Fokker D-7; a LePere and a Curtiss Jenny and many models of the war period; the hull of the Navy-Curtiss NC-4, first to fly the Atlantic, the transcontinental record-breaker Fokker T-2 of 1923; the Douglas Cruiser "Chicago" of the Army's world flight in 1924; the Loening amphibion "San Francisco" of the 1926 Pan American good will flight; Lindbergh's "Spirit of St. Louis"; the first autogiro in America and an extensive collection of models of historic and current aircraft; original aircraft engines, propellers, and flying instruments, together with extensive files of aircraft documents and photographs. Additions after 1931 included Wiley Post's Lockheed "Winnie Mae"; Lincoln Ellsworth's Lockheed "Polar Star"; the gondola of the altitude record-breaking balloon "Explorer II"; Frank Hawk's transcontinental glider "Eaglet"; and extensive series of accurate models, largely to the same scale, visualizing the modern developments in Army and Navy war craft and commercial air transport. Interspersed with these were accounts of the accomplishments of America's aircraft pioneers, illustrated with a variety of unique documents and specimens. The total volume of the collection was 2,609 items by the end of 1942. But the most important airplane in the world was missing from the collection.

The first real airplane, the first plane created which was capable, and which actually proved capable of flying and carrying a man to control it, was the plane which the Wright brothers, Wilbur and Orville, invented and flew successfully—the first in history—on December 17, 1903. That plane was in England, where Orville Wright had sent it several years previously after he had become convinced that the Smithsonian was still inclined to credit Dr. Langley's "aerodrome" with being the first real airplane. The Langley machine had been wrecked in an attempt to make it fly only a few days before the Wrights flew their machine in 1903. Smithsonian reports at various times credited the Langley machine with being the first airplane; thus, while admitting that the Wrights were the first to fly, actually keeping from them its official credit for being the inventors of the world's first flying machine.

On October 24, 1942, Dr. C. G. Abbot, Secretary of the Smithsonian, published an official bulletin—Smithsonian Miscellaneous Collections, Volume 103, Number 8, Publication 3699—signed by Dr. Abbot and, to quote Capt. Earl N. Findley in his U. S. Air Services Magazine for November, 1942, "giving full credit to the Wright brothers as the true pioneers in airplane invention, as freely as for 28

years it firmly withheld this credit in favor of Dr. Langley."

Because of its historical importance the Smithsonian bulletin of October 24, 1942, is reproduced here in full.

"THE 1914 TESTS OF THE LANGLEY "AERODROME" [1]

By C. G. ABBOT

Secretary, Smithsonian Institution

NOTE—This paper has been submitted to Dr. Orville Wright, and under date of October 8, 1942, he states that the paper as now prepared will be acceptable to him if given adequate publication.

"It is everywhere acknowledged that the Wright brothers were the first to make sustained flights in a heavier-than-air machine at Kitty Hawk, North Carolina, on December 17, 1903.

"Mainly because of acts and statements of former officers of the Smithsonian Institution, arising from tests made with the reconditioned Langley plane of 1903 at Hammondsport, New York, in 1914, Dr. Orville Wright feels that the Institution adopted an unfair and injurious attitude. He therefore sent the original Wright Kitty Hawk plane to England in 1928. The nature of the acts and statements referred to are as follows:

"In March, 1914, Secretary Walcott contracted with Glenn H. Curtiss to attempt a flight with the Langley machine. This action seems ill considered and open to criticism. For in January, 1914, the United States Court of Appeals, Second Circuit, had handed down a decision recognizing the Wrights as "pioneers in the practical art of flying with heavier-than-air machines" and pronouncing Glenn H. Curtiss an infringer of their patent. Hence, in view of probable further litigation, the Wrights stood to lose in fame and revenue and Curtiss stood to gain pecuniarily, should the experiments at Hammondsport indicate that Langley's plane was capable of sustained flight in 1903, previous to the successful flights made December 17, 1903, by the Wrights at Kitty Hawk, N. C.

"The machine was shipped to Curtiss at Hammondsport, N. Y. in April. Dr. Zahm, the Recorder of the Langley Aerodynamical Laboratory and expert witness for Curtiss in the patent litigation, was at Hammondsport as official representative of the Smithsonian Institution during the time the machine was being reconstructed and tested. In the reconstruction the machine was changed from what it was in 1903 in a number of particulars as given in Dr. Wright's list of differences which appears later in this paper. On the 28th of May and the 2d of June, 1914, attempts to fly were made. After

[1] For an account of early Langley and Wright aeronautical investigations, see Smithsonian Report for 1900 and The Century Magazine of September 1908.

acquiring speed by running on hydroplane floats on the surface of Lake Keuka the machine lifted into the air several different times. The longest time off the water with the Langley motor was approximately five seconds. Dr. Zahm stated that "it was apparent that owing to the great weight which had been given to the structure by adding the floats it was necessary to increase the propeller thrust". So no further attempts were made to fly with the Langley 52 HP engine.

"It is to be regretted that the Institution published statements repeatedly[2] to the effect that these experiments of 1914 demonstrated that Langley's plane of 1903 without essential modification was the first heavier-than-air machine capable of maintaining sustained human flight.

"As first exhibited in the United States National Museum, January 15, 1918, the restored Langley plane of 1903 bore the following label:

THE ORIGINAL, FULL-SIZE
LANGLEY FLYING MACHINE, 1903

For this simple label others were later substituted containing the claim that Langley's machine "was the first man-carrying aeroplane in the history of the world capable of sustained free flight."

"Though the matter of the label is not now an issue, it seems only fair to the Institution to say that in September 1928, Secretary Abbot finally caused the label of the Langley machine to be changed to read simply as follows:

LANGLEY AERODROME

THE ORIGINAL SAMUEL PIERPONT LANGLEY
FLYING MACHINE OF 1903, RESTORED.

Deposited by
The Smithsonian Institution

301,613

This change has frequently been overlooked by writers on the controversy.

"In January 1942, Mr. Fred C. Kelly, of Peninsula, Ohio, communicated to me a list of differences between the Langley plane as tested in 1914 and as tested in 1903, which he had received from Dr. Wright. This list is given verbatim below. The Institution accepts Dr. Wright's statement as correct in point of facts. Inferences from the comparisons are primarily the province of interested experts and are not discussed here.

[2] Smithsonian Reports: 1914, pp. 9, 219, 221, 222; 1915, pp. 14, 121; 1917, p. 4; 1918, pp. 3, 28, 114, 166. Report of U. S. National Museum, 1914, pp. 46 and 47.

COMPARISON OF THE LANGLEY MACHINE OF 1903 WITH THE HAMMONDSPORT MACHINE OF MAY-JUNE, 1914.

	LANGLEY, 1903.	HAMMONDSPORT, 1914.
	WINGS.	
1	SIZE: 11'6" x 22'6" (L.M. p. 206)	SIZE: 10'11¾" x 22'6"
2	AREA: 1040 sq. ft. (L.M. p. 206)	AREA: 988 sq. ft.
3	ASPECT RATIO: 1.96	ASPECT RATIO: 2.05
4	CAMBER: 1/12 (L.M. p. 205)	CAMBER: 1/18
5	LEADING EDGE: Wire 1/16" diameter (L.M. Pl.66)	LEADING EDGE: Cylindrical spar 1½" dia. at inner end, tapering to 1" dia. at outer end.
6	COVERING: Cotton fabric, not varnished.	COVERING: Cotton fabric, varnished.
7	CENTER SPAR: Cylindrical wooden spar, measuring 1½" dia. for half its length and tapering to 1" at its tip. (L.M. p. 204). Located on upper side of wing.	CENTER SPAR: Cylindrical spar about 1½" dia. at inner end, tapering to about 1" dia. at outer end. Located on upper side of wing. This center spar was reinforced (1) by an extra wooden member on the under side of the wing, which measured 1" x 1½" and extended to the 7th rib from the center of the machine; and (2) by another wooden reinforcement on the under side extending out about one-fourth of the length of the wing.
8	RIBS: Hollow box construction. (L. M. Plates 66,67)	RIBS: Most of the original Langley box ribs were replaced with others made at Hammondsport. (Manly letter, 1914). The Hammondsport ribs were of solid construction and made of laminated wood. That part of the rib in front of the forward spar was entirely omitted.
9	LOWER GUY-POSTS: A single round wooden post for each pair of wings, 1¼" in dia. 6½' long. (L.M. Plate 62, p. 184).	LOWER GUY-POSTS: Four for each pair of wings, two of which were of streamline form measuring 1¼" x 3½" x 54" long; and two measuring 2" x 2" with rounded corners, 3'9" long.
10	The front wing guy-post was located 28½" in front of the main center spar. (L.M. Plate 53).	The front wing guy-posts were located directly underneath the main center spar, 28½" further rearward than in 1903.
11	The rear wing guy-post was located 31½" in front of the main center spar. (L.M. Plate 53).	The rear wing guy-posts were located directly under the main center spar, 31½" further rearward than in 1903.

12	UPPER GUY-POSTS: For each pair of wings a single steel tube ¾" dia., 43" long. (L.M. p. 184, pl. 62).	UPPER GUY-POSTS: For each pair of wings, two streamline wooden posts each 1¼" x 3½", 76" long, forming an inverted V.
13	Front wing upper guy-post located 28½" in front of the main center spar. (L.M. pl. 53).	Front wing upper guy-posts located directly over main spar, 28½" further rearward than in 1903.
14	The rear wing upper guy-post was located 31½" in front of the main center spar. (L.M. pl. 53).	The rear wing guy-posts were located directly over the main center spar, 31½" further rearward than in 1903.
15	TRUSSING: The wing trussing wires were attached to the spars at the 5th, 7th and 9th ribs out from the center (L.M. pl. 54).	TRUSSING: A different system of wing trussing was used, and the wing trussing wires were attached to the spars at the 3rd, 6th and 9th ribs from the center. The angles between these wires and the spars to which they were attached were all different from those in the original Langley machine.

CONTROL SURFACES.

16	VANE RUDDER: A split vane composed of two surfaces united at their leading edges and separated 15" at their trailing edges, thus forming a wedge. Each surface measured 2'3" x 4'6", with aspect ratio .5. (L.M. p. 214, pls. 53,54).	VERTICAL RUDDER: The Langley vane rudder was replaced by a single plane vertical rudder which measured 3'6" x 5', with aspect ratio of .7.
17	Operated by means of a wheel located slightly in front of the pilot at his right side and at the height of his shoulder (L.M. p. 216; pls. 53,54).	Operated at Hammondsport through the Curtiss steering wheel in some tests, (Zahm affidavit pp. 5, 6), through the Curtiss shoulder yoke in some others (Manly letter, 1914), and fixed so as not to be operable at all in still others, (Zahm affidavit p. 7).
18	Used for steering only. (L.M. p. 214).	Used "as a vertical aileron to control the lateral poise of the machine", (Zahm affidavit p. 6) as well as for steering, (Zahm affidavit p. 7).
19	PENAUD TAIL: This was a dart-shaped tail having a vertical and a horizontal surface (Penaud tail), each measuring 95 sq. ft. It was located in the rear of the main frame.	TAIL RUDDER: Same size and construction as in 1903.
20	Attached to a bracket extending below the main frame.	Attached to same bracket at a point about 8" higher than in 1903.

21	"Normally inactive", (L. M. p. 216) but adjustable about a transverse horizontal axis by means of a self-locking wheel located at the right side of the pilot, even with his back, and at the height of his shoulder. (L.M. pls. 51, 53).	Operable about a transverse horizontal axis and connected to a regular Curtiss elevator control post directly in front of the pilot (Zahm affidavit p. 5).
22	Immovable about a vertical axis. (L.M. p. 214, pl.56, Fig. 1). No means were provided for adjusting this rudder about a vertical axis in flight. "Although it was necessary that the large aerodrome should be capable of being steered in a horizontal direction, it was felt to be unwise to give the Penaud tail and rudder motion in the horizontal plane in order to attain this end". (L.M. p. 214).	Immovable about a vertical axis on May 28, 1914, only. Thereafter it was made movable about a vertical axis and was connected through cables to a Curtiss steering wheel mounted on a Curtiss control post directly in front of the pilot.
23	KEEL: A fixed vertical surface underneath the main frame measuring 3'2" in height by 6' average length. Area 19 sq. ft. (L.M. pl. 53).	KEEL: Entirely omitted.

SYSTEM OF CONTROL.

24	LATERAL STABILITY: The dihedral only was used for maintaining lateral balance. (L.M. p. 45).	LATERAL STABILITY: Three means were used for securing lateral balance at Hammondsport: The dihedral angle as used by Langley, a rudder which "serves as a vertical aileron" (Zahm affidavit p. 6), and the Penaud tail rudder. The last two constituted a system "identical in principle with that of Complainant's [Wright] combined warping of the wings and the use of the vertical rudder". (Zahm affidavit p. 6).
25	LONGITUDINAL STABILITY: Langley relied upon the Penaud system of inherent stability for maintaining the longitudinal equilibrium. "For the preservation of the equilibrium [longitudinal] of the aerodrome, though the aviator might assist by such slight movements as he was able to make in the limited space of the aviator's car, the main reliance was upon the Penaud tail," (L.M. p. 215),	LONGITUDINAL STABILITY: At Hammondsport the Penaud inherent longitudinal stability was supplemented with an elevator system of control.

26	STEERING: Steering in the horizontal plane was done entirely by the split-vane steering rudder located underneath the main frame. (L.M. p. 214).	STEERING: On one day, May 28, 1914, steering in the horizontal plane was done with the vertical rudder which had been substituted for the original Langley split-vane steering rudder. After May 28th the steering was done by the vertical surface of the tail rudder (Zahm affidavit p. 7), which in 1903 was immovable about a vertical axis, (L.M. p. 214).

POWER PLANT.

27	MOTOR: Langley 5 cylinder radial.	MOTOR: Langley motor modified.
28	IGNITION: Jump spark with dry cell batteries. (L.M. p. 262).	IGNITION: Jump spark with magneto.
29	CARBURETOR: Balzer carburetor consisting of a chamber filled with lumps of porous cellular wood saturated with gasoline. The air was drawn through this wood. There was no float feed. (L.M. p. 225).	CARBURETOR: Automobile type with float feed.
30	RADIATOR: Tubes with radiating fins.	RADIATOR: Automobile radiator of honeycomb type.
31	PROPELLERS: Langley propellers (L.M. pl.53, pp. 178-182).	PROPELLERS: Langley propellers modified "after fashion of early Wright blades".

LAUNCHING AND FLOATS.

32	LAUNCHING: Catapult mounted on a houseboat.	LAUNCHING: Hydroplanes, developed 1909-1914, attached to the machine.
33	FLOATS: Five cylindrical tin floats, with conical ends, attached to underside of main frame at appropriate points, and about six feet above lowest part of machine.	FLOATS: Two wooden hydroplane floats, mounted beneath and about 6 feet to either side of the center of the machine at the lateral extremities of the Pratt system of trussing used for bracing the wing spars of the forward wings; and one (part of the time two) tin cylindrical floats with conical ends, similar to but larger than the Langley floats, mounted at the center of the Pratt system of trussing used for bracing the rear wings. All of the floats were mounted from four to five feet lower than the floats of the original Langley, thus keeping the entire machine above the water.

WEIGHT.

34	TOTAL WEIGHT: With pilot 850 pounds (L.M. p. 256).	TOTAL WEIGHT: With pilot, 1170 pounds.
35	CENTER GRAVITY: 3/8" above line of thrust.	CENTER GRAVITY: About one foot below line of thrust.

"Since I became Secretary, in 1928, I have made many efforts to compose the Smithsonian-Wright controversy, which I inherited. I will now, speaking for the Smithsonian Institution, make the following statement in an attempt to correct as far as now possible acts and assertions of former Smithsonian officials that may have been misleading or are held to be detrimental to the Wrights.

"1. I sincerely regret that the Institution employed to make the tests of 1914 an agent who had been an unsuccessful defendant in patent litigation brought against him by the Wrights.

"2. I sincerely regret that statements were repeatedly made by officers of the Institution that the Langley machine was flown in 1914 'with certain changes of the machine necessary to use pontoons,' without mentioning the other changes included in Dr. Wright's list.

"3. I point out that Assistant Secretary Rathbun was misinformed when he stated that the Langley machine 'without modification' made 'successful flights.'

"4. I sincerely regret the public statement by officers of the Institution that 'The tests' [of 1914] showed 'that the late Secretary Langley had succeeded in building the first aeroplane capable of sustained free flight with a man.'

"5. Leaving to experts to formulate the conclusions arising from the 1914 tests as a whole, in view of all the facts, I repeat in substance, but with amendments, what I have already published in Smithsonian Scientific Series, Vol. 12, 1932, page 227:

> The flights of the Langley aerodrome at Hammondsport in 1914, having been made long after flying had become a common art, and with changes of the machine indicated by Dr. Wright's comparison as given above, did not warrant the statements published by the Smithsonian Institution that these tests proved that the large Langley machine of 1903 was capable of sustained flight carrying a man.

"6. If the publication of this paper should clear the way for Dr. Wright to bring back to America the Kitty Hawk machine to which all the world awards first place, it will be a source of profound and enduring gratification to his countrymen everywhere. Should he decide to deposit the plane in the United States National Museum, it would be given the highest place of honor, which is its due."

A VULTEE VENGEANCE FROM BELOW
One of the dive bombers with the Army Air Forces.

U. S. Forest Service

Forest Service aerial activities were keyed to the war effort. Engineering facilities were called upon by the Army Corps of Engineers for a large volume of aerial photography, photogrammetry and topographic-mapping work. The Federal and State networks of forest fire lookout stations constituted an important part of the Army's aircraft warning system for the protection of coastal areas. Before Pearl Harbor, the Forest Service had cooperated with the Air Defense Command in aircraft detection tests and in the development of over-all plans. By the end of 1942 several hundred lookout stations were manned 24 hours a day by trained observers.

Of pressing concern to the Army was the protection of coastal approach areas against blanketing by dense smoke, such as created by major forest fires which could mask the approach of enemy airplanes,

and impede operations of American aircraft. To combat the smoke menace as well as to protect vital resources and safeguard against the disruption of important communication and transportation facilities and war industries, the U. S. Forest Service and State foresters stepped up their forest fire protection work, and completed emergency mobilization plans against forest fire sabotage in the coastal areas. The only enemy bomb that landed in the United States in 1942 was dropped by a Japanese plane in an attempt to fire the forests in Southern Oregon.

Volunteer pilots and planes of the Civil Air Patrol were made available for forest protection services through an agreement with the Office of Civilian Defense, under which C.A.P. was organized. In several areas the Forest Service and State foresters provided training for cooperating Civil Air Patrol personnel in the special types of work involved in forest protection, including detection, reporting and dispatching practices, forest communication methods, packaging, loading and dropping of cargo, familiarity with terrain and behavior of mountain air currents.

Forest Service experience in dropping personnel and supplies from planes for forest fire fighting proved of value to the Army in the organization of American parachute troops. Ski paratroopers training in the Rocky Mountains also were aided by Forest officers, and Forest Service methods of dropping fire fighting equipment by means of burlap parachutes were studied by the Army in making plans for dropping supplies to paratroopers.

For the third year, the Forest Service maintained a crew of 40 parachute jumping fire fighters in the Northern Rocky Mountain region, and the "smoke jumpers" again demonstrated their value in meeting the problem of inaccessible fires. They fought or helped fight a total of 35 back-country fires during the season. On 16 of these fires, for which comparable estimates could be made, a saving of $66,000 was estimated as compared with what control costs would have been with ground crews alone.

The Forest Service supervised the work of a score of conscientious objectors' camps in forest areas. A number of the conscientious objectors volunteered for training as "smoke jumpers" in 1943.

Handicapped by a shortage of fire-fighter manpower, the Forest Service relied heavily on aircraft for forest fire control on the Superior National Forest in Northern Minnesota. In this area of many lakes a small seaplane was used. One or two men, equipped with a portable power pump and 600 feet of fire hose could be flown to remote and otherwise inaccessible parts of the forest a few minutes after a fire was spotted, whereas a crew of firefighters dispatched by trail or boat might require several hours for the same trip.

An important part of the work of the Forest Products Laboratory, maintained by the Forest Service at Madison, Wis., had to do

with aircraft research. The Laboratory supplied the Army, Navy, and the aircraft industry with extensive data on the design and fabrication of wooden airplane parts. The Aeronautical Board also was assisted in preparing aircraft specifications covering such items as structural lumber, propeller lumber, plywood, kiln drying, and cold-setting resin glues. Accelerated drying schedules for lumber for aircraft stock were prepared. "Compreg," a new material formed by the compression and impregnation of wood with phenolic resins, was a Forest Products Laboratory development for which an increasing number of war and peace uses was indicated. It was developed for use in spar plates, propellers, fuselages, and landing wheels of airplanes. In a highly compressed state, the material had strength properties comparable to mild steel. A paper plastic for possible use in aircraft construction also was developed experimentally, which approached steel in tensile strength. In connection with its work on boxing and packaging problems for Army ordnance and lend-lease supplies, the Laboratory prepared new light-weight container designs for transport of equipment and materials by air. Requirements and supplies of veneer plywood for airplane construction and other war uses were surveyed by the Forest Service during the year, and a check was made on the diversion of badly needed yellow birch logs from veneer plants to sawmills.

Sitka spruce for airplane construction was a critical war need in 1942, and available supplies of spruce of airplane quality in the Pacific Northwest were insufficient to maintain the production needed. Looking to additional sources, the Forest Service launched a large-scale project to draw on the spruce stands of the Tongass National Forest in Alaska. The Commodity Credit Corporation made available a revolving fund to cover field operations of the enterprise, and the Forest Service contracted the logging to independent logging concerns, and arranged for rafting the logs to mills in the Puget Sound area. On January 15, 1943, the first huge raft, containing nearly a million board feet of Alaska spruce arrived at the mill at Anacortes, Wash., after a storm-harassed journey of 900 miles from the Alaska logging site. The Forest Service set as a goal the production of 10 million feet of high grade logs a month. The project involved many risks, both physical and financial, but the foresters felt that the risks were justified by the need to help "Keep 'Em Flying."

Forest Service officers were assigned to a number of other projects of direct service to war operations, such as assistance in camouflage plantings and revegetation of air fields.

U. S. Public Health Service

The United States Public Health Service is constantly concerned with aircraft in connection with its administration of quarantine laws to prevent the introduction into the United States of dangerous disease

and disease carriers, both human and insect. Extension of airplane traffic to all parts of the world increased to a great degree the danger of the introduction into the United States of exotic insect vectors of disease and required much additional quarantine service of the most expert type at airports of entry in this country. Efforts were directed especially to preventing the introduction of Aedes aegypti mosquitoes from areas in which yellow fever was endemic or epidemic, and at excluding the Anopheles gambiae, a native of Africa and a highly efficient carrier of malaria.

The fundamental principles of aircraft quarantine were in most respects comparable to those governing maritime quarantine, except for the added health hazard which air transport introduced by bringing persons into the country before the incubation period of disease to which they might have been exposed had elapsed. Quarantine measures included medical inspection of airplane passengers and crews, supplemented by medical surveillance of persons arriving from foreign areas where a quarantinable disease was present, until the incubation period had passed.

As the speed and volume of air travel increased, it was obvious

AT MIRA LOMA FLIGHT ACADEMY

Parachute instruction at the school in Oxnard, Calif.

that greater vigilance on the part of quarantine officers became necessary for the protection of infectible ports and areas in the United States.

All commercial aircraft arriving at United States airports from ports located on the African continent between 16 degrees north and 12 degrees south latitude, or from the South American continent between 13 degrees north and 30 degrees south latitude, were required to be disinsectized without preliminary inspection, immediately after disembarkation of passengers and crew and before baggage, merchandise and mail were discharged. The Surgeon General could designate any foreign area as dangerous because of the presence of exotic insect vectors of disease. Planes arriving from areas so designated were required to be disinsectized prior to the discharge of passengers and cargo. In addition, operators of commercial aircraft were encouraged to continue the practice of spraying aircraft in flight as a means of safeguarding passengers and flight personnel.

In order to meet wartime military requirements, the Surgeon General was given discretionary authority, when requested by competent military officials, to designate the senior medical officer of an Army or Navy air base to serve as quarantine officer for the inspection and treatment of military aircraft carrying military personnel and proceeding on confidential missions.

At the Miami Quarantine Station a standard procedure for the disinsectization of aircraft was developed which reduced to a marked degree the exposure time required to kill mosquitoes. This procedure relieved both military and commercial aircraft of much of the delay incident to procedure previously followed.

U. S. Weather Bureau

Practically all developments and changes in the national weather service during 1942 were directly for war production or operations. In most cases they were closely related to aviation. Radio censorship on weather information required use of codes in advice to pilots during difficult landing weather at terminals. The need for national uniformity in weather maps and analyses produced the master analysis system, under which each six-hourly synoptic collection of weather reports was analyzed and distributed throughout the United States from a single analysis center. The loss of personnel to the military services required training and assignment of a large number of young women as airport observers. The tremendously increased manufacture of aircraft for wartime purposes required the assignment of Weather Bureau personnel to some of the larger plants to facilitate and safeguard test flights.

Military demands for more detailed upper-air information produced a much-needed increase in the number of radiosonde stations within and beyond our national borders. To meet military transport

and ferrying requirements, weather service for transoceanic air traffic was increased and improved considerably, and detailed meteorological studies, available only to the military services, were completed for the guidance and handling of this traffic in foreign areas.

Five new forecast stations were established. Twelve new radiosonde stations were set up—six in Alaska, Canada and Mexico. Eight new pilot-balloon stations were established, including three in Alaska. Hourly weather reports were begun from 27 new stations, the majority on the West Coast and in Alaska. Part-time service was established at 26 additional stations, a majority of which were in Alaska. An extensive net work of special cooperative stations for reporting thunderstorm and tornado activity was established in the South-Central and Southwestern States for protection of munition and ordnance plants, and ferrying of airplanes.

Plans were completed during the year for a change in the contents of aviation weather forecasts to give actual expected times of occurrence of weather minimums at terminals, and more specific description of impending conditions over flying routes.

A long step was taken also towards solution of the difficult problem of accurate observations of day-time ceiling heights. The Instrument Division of the Weather Bureau in Washington fostered the development of a ceiling-light projector which, for the first time, operated in daylight as well as at night. One such instrument was in operation at the Washington National Airport, and early installations were contemplated for Chicago, LaGuardia Field, Kansas City, Seattle and San Francisco.

War Production Board

Experience in battle and the plans of the military and naval command determine the kinds and numbers of airplanes turned out to defeat the enemy. On December 9, 1942, there was formed within the War Production Board, the Aircraft Production Board, charged

TAYLORCRAFT ARMY TRAINING GLIDER

GRUMMAN MARTLET FIGHTER

Its wings folded, it is being lowered from the flight deck to the hangar aboard the British carrier, "Illustrious."

with central control over aircraft production, with the Army and Navy represented. The Aircraft Production Board, in turn, set up as its executive arm the Aircraft Resources Control Office, in which were also representatives of the Army and Navy.

As requirements of the Services were set, the demand for planes was translated into schedules to produce major airplane parts. The first schedules worked out were for airframes. The schedules for airplane engines, propellers and other parts were planned to correspond to the anticipated production of planes. The schedules were set after consultation with a committee on which the Services were represented. The decisions were submitted to the Aircraft Production Board, and after approval they became directives for the manufacturers.

While airframes, engines and propellers thus were scheduled, other components were supplied to the manufacturers by the Government, including generators, flying instruments and starters.

The A.R.C.O. was responsible for the requirements of the industry for materials, machine tools and manpower. In the case of machine tools, a W.P.B. order, issued by the Machine Tools Division which operated outside the Aircraft Production Board, allocated a substantial percentage of the total output to the aircraft builders. Within this allocation, orders for machine tools were graded by the A.R.C.O. with respect to urgency. The general direction of machine tool production was set by the Machine Tools Division. Requirements for

and distribution of materials to the aircraft industry were handled by the A.R.C.O. within the framework of general orders and directives issued by the materials divisions of W.P.B.

The task of handling manpower problems of the industry was largely advisory. Work of the A.R.C.O. was carried on in close cooperation with Selective Service and with the Manpower Commission. A.R.C.O. forecast the industry's requirements and submitted them to the War Manpower Commission.

Throughout all the war industries, it was necessary to substitute more readily available materials for those which were critical, to standardize the designs of goods being produced and, whenever possible, to simplify them. With aircraft the job was complicated by factors which appeared less frequently in other industries. Because every part of an airplane is subjected to stresses and strains while in flight, when materials constituting these parts were changed, actual flight test of the substitution is necessary. Similar trial in action was necessary when designs of parts were changed. Because of this close interdependence of airplane components, the work of conserving materials was carried on in close cooperation with the Services.

Under the A.R.C.O. was a unit charged with finding substitutes for scarce materials, of standardizing parts, and simplifying both parts and designs, with the cooperation of the Services and the in-

AERONCA MIDGET CARGO PLANE

dustry. As both branches of the Services agreed on standards, manufacturers were able to produce components without respect to whether they were to enter Army or Navy planes. This resulted in simplified processes of manufacture and higher output.

The A.R.C.O. in December, 1942, took over direction of substitutions of materials. In cooperation with the Services, it passed upon the many proposals for changes in the use of materials coming from Governmental and other units. Directives on substitutions were issued directly to individual aircraft companies. They superseded the clauses in the production contracts to which they were relevant, so that new exchanges of drawings and other exhibits were unnecessary.

CARGO GLIDER PICK-UP

A Vultee Stinson Reliant in All-American Aviation service picks up the towline of the glider on the ground at the right.

CHAPTER VIII

THE AIR LINES IN WAR TRANSPORT

The Air Lines Enter the Military Transport Service While Maintaining Many of Their Peacetime Activities—American Operations Throughout the World—Higher Performance on New Routes—The Air Mail Service—The Air Express—Individual Company Operations.

THE air lines of the United States went through many drastic changes under the faster tempo of the full-out war effort. They were not militarized, as many at first thought they would be; but rather, they were placed under contract with the Services to carry on military transport while devoting their remaining facilities to civilian schedules. They could carry all the civilian passengers and express that their planes would accommodate, provided, of course, that passengers and express connected with the war program had priority on any plane at any time.

The domestic air lines had 359 transport planes at the time of Pearl Harbor. The Services bought all except 176, and took over those being built on orders received from the lines. The 176 remained frozen as the number which the lines could use in their regular services over the domestic air transport systems. In May, 1942, the load factor had been 67.87 per cent, meaning that the planes were operating an average of 67.87 per cent of their absolute capacity. By the end of the year, the load factor had passed 80 per cent—a very high average. During the same period the average daily miles flown per plane jumped from 1,200 to more than 1,500.

When the Government bought equipment from the domestic lines, it left them only two types, Douglas DC-3 and Lockheed Lodestar transports; and this proved to be a boon, because the lines could concentrate their service facilities on the two types instead of maintaining overhaul and repair facilities for several others, as in the past. This, with the higher load factor, developed greater economy of operations, something which the lines hoped to retain after the war.

While military operations of the lines are described in the chapters on the Army and Navy air forces, it may be said here that the lines flew more mileage and carried a greater tonnage in those air cargo contract operations than on their regularly scheduled domestic routes.

The contracts with the Government were on a cost plus basis. They covered the entire United States, the North and South Atlantic, the Pacific, Alaska, Brazil and Panama. This work was carried on with an exceptionally high degree of efficiency, with very few accidents. It was extremely good experience, too, pointing the way for even higher performance in peacetime operations.

As the military transport service demanded ever more from the air lines, it was realized that if they were to operate all the cargo equipment which the Government had available for such operations, the lines would have to secure more pilots, navigators, radio operators, flight engineers and ground mechanics. They attacked the problem by setting up the Airlines War Training Institute for training sufficient personnel in each classification.

Despite the 50 per cent decrease in equipment, the domestic lines in 1942 carried 3,532,950 passengers as compared to 4,060,545 in 1941, a decrease of only 4.7 per cent; while revenue miles flown declined only from 133,022,679 in 1941 to 110,102,860 in 1942. All this, of course, did not take into consideration the actual war service under Government contracts which had these lines by the beginning of 1943 flying men, munitions, medical supplies, food and other essentials over the greater part of the earth. The adventurous development of that service had to remain shrouded in military secrecy for the duration.

Postmaster General Frank C. Walker, in his report for the fiscal year 1942, made these comments about the air mail service under wartime conditions:

"I have visited personally many of our larger post offices and Army and Navy mail concentration centers and shall continue to do so. On the whole conditions are found to be satisfactory, but the best service will be had only through constant vigilance. It is in the interest of the public and our fighting forces that the Post Office Department shall have complete and exact knowledge as to the handling of mail after it has left its hands and has been placed in the possession of the military authorities, for it is to the Post Office Department that the people look for an adequate and satisfactory postal service to our soldiers and sailors. This is understood by and is agreeable to the War and Navy Departments.

"Incident to improving the mail service for our armed forces and aiding in the problems of the war, the overseas two-way transmission of letters on photographic micro-film, known as V-mail, was begun June 15, 1942. This was brought about as the result of cooperative planning and action by the Post Office, War, and Navy Departments. The purpose was to conserve cargo space for war material and supplies. As an example of the saving of weight and space, a dispatch of 150,000 1-sheet letters requires 37 mail sacks and weighs 2,575 pounds. When these letters are micro-filmed the 2,575 pounds are reduced to 45 pounds and the 37 mail sacks are reduced to 1, leaving the

saved space available for other vital military needs. The regular domestic postage rates apply to V-mail.

"Realizing the need for a reasonable and uniform air-mail rate to and from the personnel of our armed forces outside the continental United States, many at secret stations, I approved a modified and uniform rate of 6 cents a half ounce. This has resulted in a large increase in volume. The former rates ranged from 10 cents to 70 cents a half ounce.

"Effective March 27, 1942, letters sent by ordinary mail by members of the armed forces were accorded free transmission. Tests prior to that time indicated mailings from the individual members averaged three a week. Since that date the average per man has been more than four and one-half letters.

"The problems that confronted the Department in mail transportation were varied and difficult. There was decreased service on some railway lines, while other lines were discontinued entirely. An insufficient number of mail storage cars made it necessary to consolidate mail by holding it over so that cars might be used to the fullest advantage. The Army and Navy found it necessary to take over a considerable number of mail-carrying airplanes. Coastwise and transoceanic mail services were greatly curtailed. Star route and mail messenger services were disturbed to an extent because of the difficulty of contractors in obtaining adequate equipment. The Post Office Department contractors had the same difficulty with rubber rationing as

U. S. Navy photo

JAPS BUILT IT. WE USED IT

U. S. Marine Corps and Navy fliers used this pagoda at Henderson Field until the Japs wrecked it with a near miss.

did private concerns. The cost of mail contracts increased commensurately with increased costs for manpower, supplies, equipment and materials. Notwithstanding all these difficulties an adequate service was given as is indicated by the very few criticisms received.

"There was paid to railroad companies during the fiscal year 1942, $110,817,961, as compared with $106,420,136 in 1941. The cost of mail-messenger service between post offices and railway stations was $7,460,648, as compared with $7,099,634 for 1941. These increased costs are due to increased mail volume, extended services, and higher rates of bidding.

"On June 30, 1942, there were 44,623 miles of domestic air mail routes, an increase of 1,212 miles over 1941. The total cost was $22,775,781, an increase of $2,262,240. Three new domestic air routes were established and there was an increase of approximately 40 per cent in the volume of mail transported. The number of miles flown, 89,410,021, was 14,154,813 more than in 1941. A number of transport aircraft available for mail service on domestic routes was transferred to the military service near the close of the fiscal year 1942, but a program for the most intensive use of the remaining equipment was organized which permitted the maintenance of essential routes and schedules and the transportation of an increased volume of air mail with reasonable expedition.

"War activities brought increased demands, which were met, for airplane service to military and naval outposts in Alaska. Contracts for service in the far western section of the United States and Alaska were relet. The cost under the expired contracts was $175,424 for 44 routes, while the new contracts for the same number of routes will cost $214,457, an increase of 22.25 per cent. The route between Seattle, Wash., and Seward, Alaska, and five routes operating among the Hawaiian Islands were not relet.

"Our international mail service has been seriously affected but through the cooperation of the Army and Navy authorities and the War Shipping Administration, service has been maintained in a fairly satisfactory manner to most allied and neutral countries.

"The need for cargo space in connection with the war resulted in the commandeering of the faster mail-carrying steamships. The amount of space for mail has been greatly curtailed and as a rule slower vessels are used.

"While our foreign air mail routes have been necessarily curtailed, extensions, on the other hand, have been made to certain areas and the frequency of service has been materially increased to the Latin-American countries and to Hawaii and Alaska.

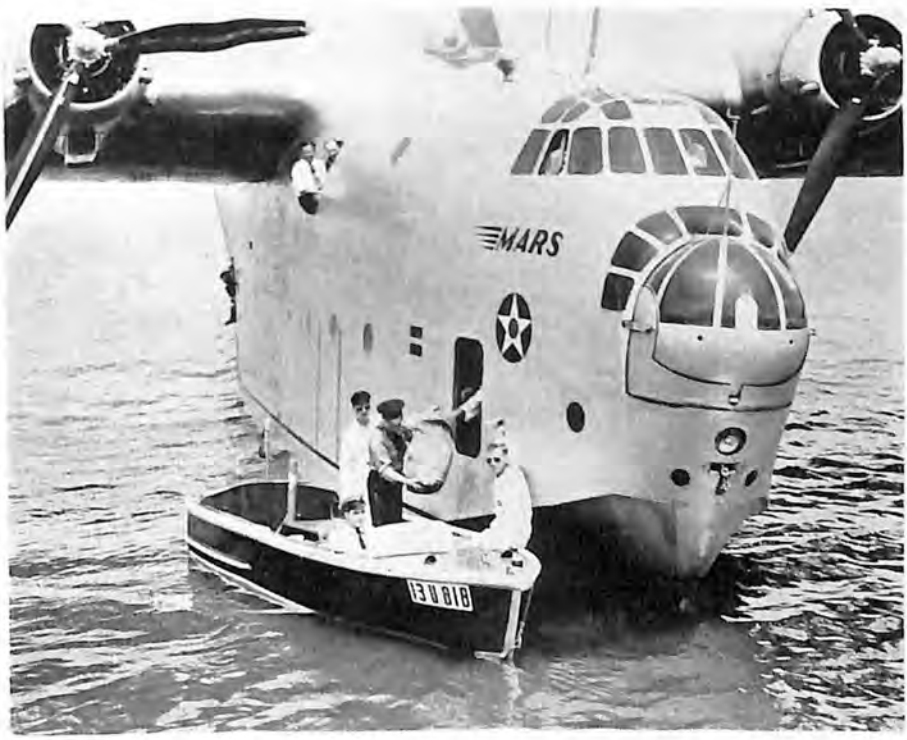
"The Railway Mail Service continues to be the backbone of our transportation system. It has been augmented by experimental highway post office service, performed in specially constructed motor vehicles, with postal clerks making a distribution of the mail similar

to that performed in railway post-office cars. Three experimental routes now in operation are meeting the need for additional postal service in areas where train service does not furnish an adequate mail supply."

Air Express had its biggest year in 1942, the 15th anniversary of regularly-scheduled air express service in the United States. More than 10,500 tons were handled by the Air Express Division of Railway Express on the domestic commercial air lines, an increase of 93 per cent over 1941. Shipments totaled 1,405,320, up 7.5 per cent over the previous year, while gross revenue was up 111 per cent compared with 1941. An average of 35 tons of air express a day was being flown at the beginning of 1943.

As the country swung into all-out war production, air express cargoes consisted more and more of heavier shipments vital to the war effort and less of the normal peacetime traffic such as printed matter, films, electrotypes, flowers and style goods. The average weight per shipment was about 15½ pounds, almost double that of the previous year, while shipments weighing 100 pounds or more became still more frequent.

Actually, the country's air express system, operated over a net-



BOW OF THE MARTIN MARS

Showing size of one of the largest flying machines ever built anywhere. Her hull has the space of an average 15-room house.

work of 45,000 miles of airways, served as a three-mile-a-minute assembly line between subcontractors and accessories plants for the movement of a multiplicity of items to the major assembling plants. Despite the release of almost half of their planes to the Army early in 1942, the air lines, by rearranging schedules, increasing plane hours per day, and stepping up plane maintenance and servicing, equalled and even surpassed pre-war performance. Average express load flown per revenue mile increased to 207 pounds from 74 pounds for the previous year.

Two air lines operating twin-engine transports started exclusive mail and express schedules in 1942, one operating between New York and Salt Lake City, the other between New York and Miami. Exclusive mail and express schedules also were operated by three other lines with single-motored equipment.

The 15th year of commercial air express found the air lines and the Railway Express Agency, which pioneered in the carriage of express by air as far back as 1919, engrossed in the important job of transporting vital materials essential to the war effort. Linked to direct air express facilities at 350 airport cities were the 23,000 off-airline offices served by Railway Express Agency, which furnished the pick-up and delivery service for air and rail-air shipments. To perform this necessary ground service at point of origin and destination, the Express Agency maintained a nation-wide fleet of 15,000 motor vehicles.

Traffic handled in combination rail-air express service was an important part of the air transport picture during 1942. Plants and factories located at points not directly on air line routes, utilized rail-air service to bring them raw and semi-finished materials, spare parts and sub-assemblies, as well as to dispatch their manufactured products to other industrial centers in the nation-wide chain of war production and supply.

Shipments moved in combination rail-air service increased 24.3 per cent over 1941. It was estimated that 30 per cent of all air express originated at or was destined to an off-airline point, or moved part way by rail.

In October, 1942, an extension of air line schedules provided additional direct air express service from the 350 airport cities in the United States and Canada, to Monterrey and Mexico City. This service was handled through gateways at Los Angeles, El Paso and Fort Worth.

The suspension of coastwise shipping because of the submarine hazard and other war causes brought many new shipments to the international air express routes. The result was that the volume of traffic often exceeded available plane space. Eventually, air transportation priorities were established between the United States and foreign destinations, to control the flow of that traffic.

International air express shipments, including those handled in the Monterrey-Mexico City service, amounted to 182,000 in 1942, an increase of 27 per cent over 1941. Revenue of that traffic was up 97 per cent.

New records in both weight and gross revenue were established. Movement of heavier shipments, consisting mostly of war production materials, boosted monthly poundage figures to new highs. In July, total weight of shipments carried by the domestic air lines broke the two-million pound mark for the first time in the 15-year history of the service. In the remaining five months of 1942, total weight of shipments also advanced well above the two-million pounds monthly.

Emphasizing the heavier-shipment, longer-haul type of air traffic handled during the year were the gross revenue figures. The gross revenue for October, the heaviest month, approached a million dollars.

In June an air transportation priority system, supervised by the Army's Air Transport Command, was started to give precedence to the movement of vital materials by Air Express. Regional priority offices, opened in key cities and staffed by Army personnel, were authorized to issue priorities for the expeditious movement of men and materials.

Further to facilitate the movement of air express both the Express Agency and the air lines urged shippers to "ship when ready", preferably early in the day, instead of holding their express for the more heavily-loaded night schedules.

At LaGuardia Field, New York, through which more than 40 per cent of the country's air express moved, a total of 3,900,000 pounds

PIPER NAVY HE-1

A single litter ambulance plane with 100 h.p. Lycoming engine used by the Navy to pick up crash victims in small fields and rush them to base hospitals.

were handled in 1942. It represented an increase of 1,530,000 pounds over 1941. There were 598,197 shipments flown in and out of the municipal airport during the year. At Newark Airport, a total of 19,352 shipments weighing 282,896 pounds were handled from January to mid-June, when that airport suspended commercial operation.

Normal civilian shipments showed a decrease. However, this traffic was more than offset by the movement through the New York airport of heavier traffic, including machinery, tools, aircraft parts and other manufactured products.

All American Aviation, Inc., originators and operators of the Air Pick-up system, increased traffic over its air pick-up lines, expanded its system and developed new adaptations for air pick-up. Carrying a total of 301,117 pounds of air mail and 106,303 pounds of air express in 1942, representing an over-all increase of over 100 per cent in air mail and nearly 400 per cent in air express volume. All American flew 847,563 revenue miles with an operating percentage of 93.5. With daily round trip schedules between 115 communities on five routes totaling 1,386 miles in Delaware, Kentucky, New York, Ohio, Pennsylvania and West Virginia, All American increased daily schedule mileage, due to the addition of extra round trip schedules on two of these routes, from 2,772 to 3,532 miles.

Improving the operation of the system, All American installed radio receivers at each ground station, establishing a plane to ground communications system whereby each of the station points could be informed quickly of schedule changes due to delays or cancellations.

In May, 1942, utilizing an adaptation of the air mail pick-up system, gliders were picked up successfully from the ground by an airplane in flight. This new system for launching gliders later was demonstrated to the Army Air Forces at Wright Field, Dayton, O., and before the end of 1942, had been developed to where it was possible to pick-up and tow large troop carrying and cargo gliders. The pick-up system also made gliders quickly retrievable in field operations.

In July, 1942, All American started daily service over an Army Cargo Route established by the Army Air Forces. On December 31, 1942, approximately 300,000 miles had been flown over these routes, transporting needed supplies and equipment between various Army air depots.

American Airlines worked with the Air Transport Command on many confidential operations, and its contribution in the successful delivery of cargo to the armed forces all over the world was recognized officially as an important achievement in the war effort. Besides the actual transportation of cargo to distant points American Airlines conducted schools to help the Services in a comprehensive training program. Starting in March, 1942, approximately 50 Navy pilots a month studied operations and technique in flying the big transports.

The 30-day intensive ground course under the guidance of veteran American Airlines captains, covered instrument flying, navigation, preparation of flight plans and logs, and practical handling of the huge cargo planes. After the 30-day period came an additional training course of 30 more days, seeing the transports in action and assisting in the flying. A similar school for Army pilots was started in November, 1942. Other schools were installed for ground operations men, flight controllers, flight radio officers, navigators and mechanics.

Despite extensive military operations handled in 1942, crippling the Flagship fleet equipment considerably, American had a highly successful year in maintaining its regular domestic service. This was due to greater efficiency in operations plans and maintenance, and to a willingness on the part of AA employees to sacrifice personal time to the problem of carrying everything and everyone needing air transportation within the United States. Maintenance methods, recognized as among the soundest in recent years, jumped to a new high.

Although American, like other air lines, was severely handicapped

INTERSTATE L-6 LIAISON PLANE

These Army liaison planes are powered by 115 h.p. Franklin engines and built by Interstate Aircraft and Engineering Corp.

by reduction of equipment because of military needs, the number of revenue passengers approached the 1941 figure, which was a record.

	1942	*1941*
Revenue passengers carried	869,531	1,043,377
Revenue passenger miles flown	402,298,900	409,400,652

American Airlines flew 14,634,679 pounds of air mail in 1942, compared with 9,523,248 in 1941, with a net increase of 53.7 per cent. The astronomical pound mile figures were over nine billions for 1942 as against five and one half billions during the previous year. The largest increase was shown in air express, with 11,971,155 pounds carried in 1942; 5,513,496 pounds carried in 1941; 5,984,971,821 pound miles of air express were flown in 1942, 120.2 per cent more than in 1941.

A new transatlantic air line, American Export Airlines, started service between New York and Europe during 1942. Six years in preparation, American Export was ready immediately to turn its entire facilities into the war effort at a time when dependable means of communication between the United States and Europe were most urgently needed. Six months after starting scheduled operations, American Export Airlines had completed 100 crossings of the Atlantic, carrying capacity loads of passengers, air mail and a great variety of cargo, including air express.

The company put into service a fleet of large, long-range, four-engine Vought-Sikorsky flying boats, known as "Flying Aces." They were designed and built to fly the Atlantic non-stop. The American Export Airlines first flight to Europe, May 30-31, 1942, added a new chapter to aviation history, as this flight was made non-stop with 16 passengers, in addition to the crew of 11. During the year, the time required to cover the U.S.A.-Europe route was reduced time and again. Early in 1943 the American Export record was 16 hours, eight minutes.

Continental Air Lines went all-out for war service in 1942, but its civil transport activities were maintained. With approximately half as much equipment on hand to service rapidly expanding routes and schedules, Continental carried half again more passengers than the year before, a great proportion of them Army personnel and others on war errands. Denver and the Rocky Mountain region were drawn closer to Latin America when Continental's southern service to El Paso was extended to Mexico City and connections to South America by a new American Air Lines schedule south from El Paso.

Although Continental's revenue miles increased by only 15.1 per cent during 1942, the number of passengers increased by 60 per cent, pounds of air express handled increased 64 per cent and air mail 45 per cent. To handle this increased business, Continental's personnel was increased 63 per cent, not taking into account the hundreds of

maintenance and shop workmen in its Army bomber modification center in Denver, Colo.

Eastern Air Lines, like other domestic companies, turned over 50 per cent of its equipment to the Government, yet during the last seven months of 1942, Eastern flew 66 per cent of the previous scheduled mileage. Some schedules were discontinued by Government order. The line actually carried more mail in 1942 than during the first nine years of operations, while air express, approximately 3,000,000 pounds, was more than the two previous years combined. About 600 employees entered the Services. Women replaced men in traffic, operations, radio and in some of the ground crews.

Hawaiian Airlines, formerly Inter-Island Airways, Ltd., of Hawaii completed 13 years of operation November 11, 1942, with a record of carrying more than 350,000 passengers over water without accident. After Pearl Harbor, all passenger steamer service between the Hawaiian Islands was canceled, leaving to the Airlines the task of providing transportation for the six major islands of the group. Commercial aviation, always of primary importance in Hawaii, met this emergency splendidly. Operating in an active combat zone, the Airlines, with the cooperation of the Army and the Navy, was able to maintain service commensurate with the needs of both military and civilians, and it flew a substantial increase in passenger traffic without adding to flying equipment.

Critical food shortages resulting from suspended steamer service during the early war days were alleviated by use of Vought-Sikorsky S-43 transports to carry fresh meat and vegetables from various

AMERICAN EXPORT AIRLINES

One of the fleet of Vought-Sikorsky 44A four-engine Atlantic flying boats in American Export Airlines service over the Atlantic. They are powered by Pratt & Whitney Double Wasp engines and Hamilton Standard Hydromatic propellers.

islands to Honolulu. Scheduled air freight was started in May, 1942, although scores of charter freight flights had pioneered the way. Daily freight schedules were started July 1, 1942.

Several airports were eliminated from regular schedules, and other shifts in operations for military reasons were handled without undue inconvenience. Hawaiian Airlines was the only domestic air line flying exclusively in a combat area. It operated three Douglas DC-3s and three Vought-Sikorsky S-43s. One DC-3 and an S-43 were damaged by machine gun fire during the Jap attack on Honolulu. Repairs were completed within a short period and both planes returned to service. Hangars also were punctured by the Jap machine gunners, but personnel and passengers escaped injury. Daily scheduled round trips were operated among the islands.

Northwest Airlines operated its route between Chicago and Seattle, contributing to the war effort by maintaining fast schedules between cities on the route and facilitating delivery of much needed materials to wartime manufacturing centers.

Pan American Airways after Pearl Harbor devoted most of its equipment, facilities and manpower directly or indirectly to war activities. Curtailment of surface shipping because of the war meant that Western Hemisphere nations and allied nations across the seas had to depend largely on service by air for the essential requirements of communication and transport. To meet these most efficiently, planes already in service were stripped to barest flying essentials or redesigned to carry every possible pound of load. New maintenance procedures were developed. For example, bases on Pan American Airway's world-wide network of air lines operated on a 24-hour round-the-clock basis to cut the time aircraft must spend on the ground. Total effect of these and other technical advances pioneered by Pan American Airways doubled the capacity available for normal peacetime traffic, by speeding up flying time and increasing schedules. With the experience of more than 200,000,000 miles of overseas flying and 15 years of operations behind it, Pan American Airways was well equipped to fulfill its war-imposed tasks of swiftly knitting together the United Nations by its far-flung network of air lines during the year after Pearl Harbor.

Although the number of aircraft available increased only five per cent during the year, total mileage flown by all divisions during 1942 over Pan American's 100,000 miles of airways was 46 per cent greater than in 1941, while ton mileage increased 54.6 per cent. The percentages did not include operations of such special services as P.A.A.-Africa, Ltd. and P.A.A. Air Ferries, the record of which appears later in these pages.

Extra demands imposed on Pan American Airways because of the war resulted in some almost unbelievable records involving long stretches of continuous flying. Shortly after one of P.A.A.'s giant

transatlantic Clippers set a record with six ocean crossings in 10 days, a sister ship made the same number of hops in seven and one-half days, and one Clipper shuttled across 2,000 miles of the Atlantic a dozen times in 13 days. Proof of the regularity and potentialities of transatlantic traveling was the record established before the end of 1942 by the Yankee Clipper in logging its first 1,000,000 miles of flight across the ocean during a "routine flight" with a vital military load aboard. At the time, the ship had completed some 231 crossings and since starting Atlantic service in May, 1939, had been in the air over the Atlantic more than 8,024 hours. In command at the time, was Capt. Francis Scott Key Lewis, P.A.A. veteran with 7,200 hours of flying to his credit.

By the end of 1942, P.A.A. transatlantic Clippers had chalked up the enviable mark of 1,219 successful crossings in the three and one-half years of scheduled Atlantic operations, with passengers, mail, and cargo, without incident. War needs more than doubled Atlantic mileage, necessitating keeping the big planes in the air an average of one hour more per day than in 1941. Even before the Japanese struck at Pearl Harbor on December 7, 1941, P.A.A.'s giant four-motored transatlantic Boeing clippers had been operating heavy schedules on a priority basis to insure carrying only the most vital cargoes and personnel across the Atlantic on overnight schedule. Although air express was a relatively new undertaking in the transoceanic activities of Pan American, 1942 express tonnage as compared with that of the previous

PAN AMERICAN AIRWAYS CLIPPER

One of the Boeing 314 flying boats in Pan American service. The Pacific Clipper is moored at New York's air terminal marine base after her westward flight around the world to escape the Japs in the Far East war zone.

year showed a skyrocketing climb of 18,900 per cent. Outstanding in express movements was the shipment by Clipper of a single item that tipped the scales at more than 2,200 pounds. In a single day in August a record was set with the arrival by Clipper of 7,300 pounds of air express. The arrival and departure of 12 transatlantic Boeings in the span of 48 hours during the latter part of August was a significant highlight in the year's activities of the Atlantic division. Approximately 560 passengers passed through the LaGuardia Field marine terminal in these two-day operations.

To handle properly the vital assignment of keeping wartime Clippers flying, wide expansion was necessary in flight and maintenance personnel, as well as facilities at home and abroad. At the Atlantic division's home hangar on December 7, 1941, there were 1,230 employees; during 1942 this number was raised to over 2,300. Abroad, approximately 1,000 foreign nationals and 180 Americans were engaged in similar tasks.

To replace men advanced to more responsible posts or assigned to foreign duty, women were tried out experimentally early in 1941 for work at the New York terminal. Early in 1943, 180 women were working as technicians in the operations and maintenance departments or as mechanics' helpers in the hangars. Expanded facilities in the seaplane hangar were completed, adding 110,000 square feet of shops and offices.

Pan American Airways' vast experience in ocean flying, and its trained personnel and well-equipped aircraft proved of considerable value to the military and naval forces. Technical and mechanical staffs both at home and at foreign stations rendered important maintenance services to the armed forces. Supplying gasoline, major repairs to fuselages and engines and landing and take-off areas made up a large share of Pan American's cooperation with the personnel of the Army and Navy.

In addition to the transportation of important military and civilian personnel, P.A.A. Clippers on practically every trip carried many vital cargoes, some bound for the theaters of war, others inbound to production centers in the United States.

The great, but (for military reasons) little-publicized, air line constructed in record time across the heart of the African continent in 1941, and militarized in the latter part of 1942, established an enviable record during its period of operation by Pan American Airways-Africa Ltd. Over that line flew many military planes bound for the Middle East war theater and manned by Pan American Airways personnel, by the U. S. Army Air Forces, by the R.A.F. and the South African Air Forces. This route was to prove invaluable during the year for the swift and efficient delivery of war cargoes (military and diplomatic personnel, important dispatches, and vital express) to and from fighting zones.

While the exact amount of travel over this highly-important route cannot be disclosed, it can be stated that military personnel and material flown over the route were credited with turning the tide of battle in the North African campaign. The efficiency basis of the air line was rated the equal of that of any line in the world. This route was operated in conjunction with the military ferry service established by P.A.A. across the Atlantic, and was extended well into Asia.

By July, 1942, Pan American Airways was flying 31,058 miles a month to Kingston, Jamaica, compared to 20,700 miles a year before; 31,018 miles a month between Miami and Barranquilla over to Balboa, and operating 96 flights a month between Miami and San Juan. Pan American Airways was covering 345,800 miles a month to and from Buenos Aires along the east coast, compared to 148,200 a year previous and Panagra flew 325,112 miles a month to and from Buenos Aires along the west coast, compared to 92,892 miles a month the year before.

In the Far East, CNAC (China National Aviation Corporation), Pan American Airways' Chinese affiliate, although its routes were necessarily changed as the areas under Japanese domination shifted, continued to render valuable service to the Chinese, American, and British Governments by maintaining thousands of miles of air routes within China as well as a "Burma Road of the Air" between India and China in conjunction with the U. S. Air Transport Command. In addition to carrying thousands of tons of freight and strategic war materials between India and China, CNAC in 1942 made available to the U. S. Air Transport Command its airport facilities, communication aids and years of war "know how".

Transcontinental and Western Air reported that its planes were doing 89 per cent more work than a year previously, by flying more

THE DOUGLAS SKYTRAIN

The U. S. Army Air Forces C-47 two-engine cargo transport.

hours per day, by making more frequent stops to permit smaller fuel loads and greater useful loads, and by careful scheduling to achieve maximum use of equipment. In September, 1942, for instance, T.W.A.'s maintenance hours per plane totaled 3,167 as compared to 2,535 in September, 1941.

First assignment in the enlarged sphere of Army Air Transport operations was handed to T.W.A. early in the war when its fleet of 38-passenger, four-engine Boeing Stratoliners was detached from domestic service and began paying regular calls at major military airfields on four continents.

United Air Lines had four main wartime activities—operation of extensive military contract services, maintenance of its regular passenger-mail-express schedules, the modification of bombing planes and contract training of military personnel. Military missions included the operation of contract routes for the Army Air Transport Command between the mid-west and California as well as to points outside the continental United States, modification of bombing planes preparatory to combat duty, the training of Army Air Forces mechanics and pilots, and conduct of special research projects.

In scheduled services during 1942, United registered gains over 1941 of approximately eight per cent in revenue passenger miles, 81 per cent in air mail ton miles and 130 per cent in express ton miles. The figures applied only to United's regularly scheduled operations and not to the large-scale flying done by the company under direct contract with the Air Transport Command. With December figures estimated, United's revenue passenger miles for 1942 were given as 293,000,000 as against 271,908,353 in 1941; mail ton miles, 6,747,000 as against 3,724,701, and express ton miles, 3,732,000 as against 1,623,840 for last year. The gains were registered despite a 16 per cent decrease in revenue airplane miles flown—a decrease due largely to turning over a number of the company's planes to the Government for military operations.

PIPER TG-8 TRAINING GLIDER

A three-place tandem machine used by the Army to train glider transport pilots.

CHAPTER IX

MISCELLANEOUS ACTIVITIES

Aeronautical Chamber of Commerce of America—Aircraft Owners and Pilots Association—Aircraft War Production Council—Aircraft War Production Council, East Coast—The American Society of Mechanical Engineers—Institute of the Aeronautical Sciences—Manufacturers Aircraft Association—National Aeronautic Association—Society of Automotive Engineers.

THE full-out war effort received impetus in many important ways from the activities of the more important national aviation organizations, as described in the following pages from special reports which they submitted for this edition of The Aircraft Year Book.

Aeronautical Chamber of Commerce of America

The Aeronautical Chamber of Commerce of America, national trade association of the aircraft manufacturing industry, with 200 members, including the airplane, aircraft engine and leading manufacturers of parts and accessories, after 22 years of peacetime activity, was realigned to meet the exigencies of wartime economy in the various branches of civil aviation development. At the same time the Chamber perfected its organization structure to respond more effectively to the abnormal demands of an industry in full-out production of more and better warplanes.

Chamber members organized the functions of the trade association into five principal departments, administrative, technical, traffic, economic development and information.

The program of reorganization amply provided for close working relationships with the regional Aircraft War Production Councils, most of whose members also are affiliated with the Chamber. The realignment assured a logical continuation of the services heretofore performed by the Chamber for its members and included acting in liaison capacity, in a coordination sense, with Government bureaus in Washington, and close cooperation with the Army and Navy, as well as special attention to the activities of such agencies as the War Production Board, the War Manpower Commission, the Office of Price Administration, Controlled Materials Plan executives and other

offices concerned with legislation and supervision of aviation activities directly affecting the industry.

James P. Murray, president of the Chamber and vice-president of Boeing Aircraft Company, said, shortly after taking office in February, 1943: "I should like to acknowledge for the aircraft manufacturers the excellent cooperation afforded the industry by the aeronautical agencies of the Federal Government, including the use of our trade association facilities. The Aeronautical Chamber will continue, as in the past, to cooperate in and help accellerate the Government's program for war production."

The administrative work of the Chamber was directed by Irving H. Taylor, General Manager.

The Technical Department, in addition to its work through the Chamber's Airplane Technical Committee and subcommittees, including the National Aircraft Standards Committee, and the Engine Technical Committee, also projected work for the aviation mechanics schools in the Chamber's membership.

The Chamber's Aircraft Technical Committee rendered service to the industry as a whole and the aeronautical agencies of the Government through the prosecution of engineering work in these categories: (1) Industrial recommendations regarding the general airplane procurement specifications of the Army Air Forces and Naval Aviation; (2) industrial cooperation with the program of the Army-Navy-Civil Committee on aircraft design criteria; (3) airplane and engine company collaboration in regard to powerplant installation problems; (4) exchange of engineering and research data in industry; (5) National Aircraft Standards Committee; (6) research and development and (7) industrial recommendations in regard to safety regulations promulgated by the Civil Aeronautics Board and administered by the Civil Aeronautics Administration.

The work of the National Aircraft Standards Committee and the aircraft industry's cooperation in reducing the number of materials and the sizes and shapes required in each material was of direct assistance to the producers of prefabricated items such as tubing, sheet and extrusions. This assistance by the industry through the Aircraft Standards Committee made possible production of larger quantities of important materials, which in turn improved the industry's chances of meeting production goals. The department collaborated actively with airplane and engine company engineering executives in solving powerplant installation problems. The Chamber's Engine Technical Committee continued its function of promulgating the engine industry's recommendations for revisions to existing Army-Navy procurement specifications.

The Traffic Department, organized to coordinate the work of the industry's traffic executives, put forth a united industry front in these particular categories: (1) In relations with the Army, Navy and

other Government agencies; (2) in negotiations with carriers respecting rates and classifications of materials entering into the construction of aircraft; (3) in the study of loading and packing requirements to assure safety in transportation. The Traffic Department cooperated with the Army and Navy in securing rate adjustments, examined rate increase proposals of the carriers, and took steps to represent the membership before regulatory commissions.

The Economic Development Department concentrated on postwar developments, studied, analyzed and reported on postwar aeronautical problems not of a competitive nature, and worked toward a coordinated viewpoint of the manufacturers. Trade development coordination activities were continued and the department assisted in the establishment of the place of light planes in the war effort. Following reorganization, this activity evolved into a study of the postwar probabilities of private flying.

The Information Department kept Chamber members informed and advised on all matters of importance affecting the industry generally, and met special requests of members for specific information. The department assisted in keeping members informed on developments in materials procurement, wage stabilization, labor relations, the manpower situation, legislation, developments in Congress, pilot training, O.P.A. regulations and personnel changes in Government agencies as they concerned the industry. Information, on request, was provided to writers, press, radio and the public generally.

Aircraft Owners and Pilots Association

Organized in 1939 for the purpose of furthering the interests of civilian fliers and aircraft owners, exclusive of air line pilots, the Aircraft Owners and Pilots Association was composed of many thousands

THE AERONCA TG-5 GLIDER

of members, all of whom were licensed pilots. For the duration, the Association was directing its efforts to acquainting members with the many ways in which they might utilize their piloting skill in the war effort. The formation of the "Air Guard" in 1940, and subsequent pioneering work undertaken by the Association, culminated in the Civil Air Patrol organization. In addition to servicing daily the many individual problems and requests of its membership, AOPA assisted in processing pilot certificates for reinstatement through 180 units located throughout the country. To "Keep 'Em All Flying," the Association supplied members with current information regarding airports where they could keep up their flying practice. It also planned cross-country flights for members. The tremendous increase in membership service requests was processed by AOPA's full-time staffs in Washington and Chicago.

The Association fought successfully for enactment of regulations beneficial to civil aviation and, at the same time, was instrumental in elimination of rules which would curtail non-scheduled flying without material benefit to the war effort.

Aircraft War Production Council

The Aircraft War Production Council, Inc., was organized in March, 1942, by eight Southern California airplane companies—Consolidated Aircraft Corporation, Douglas Aircraft Company, Lockheed Aircraft Corporation, North American Aviation, Inc., Northrop Aircraft, Inc., Ryan Aeronautical Company, Vega Aircraft Corporation and Vultee Aircraft, Inc. It was the first regional war production group organized by the aircraft industry to expedite production of warplanes. During its year of independent activity the Council made practical application of its policy of cooperative effort. Activities were coordinated with those of the Army, Navy and other Government and regional industrial groups, solving mutual problems of engineering, materials, manpower, transportation and direct production. The senior officers of member companies formed the directorate of the Council. Their policy of industrial team work was projected nationally through frequent interchange of information with the Automotive Council for War Production, East Coast Aircraft War Production Council, which was organized seven months after the West Coast group, the Aeronautical Chamber of Commerce of America and other industrial organizations. The Council had 10 committees, members of which were key men in their own companies armed with authority to act. Policy questions were referred to the Board of Directors, which met once a month, as did the committees and subcommittees, with special meetings when occasion required.

During its first year the Council records showed these notable accomplishments:

1. Coordination with the War Manpower Commission and Selec-

tive Service in an effort to achieve orderly withdrawal of workers called to military service and to prevent undue labor migration which threatened seriously to impair production. Representatives of Council companies met many times with Government officials and planned to continue this cooperation for better manpower allocation.

2. Coordination of company activity with Government directives, first under the Production Requirements Plan and later under the new Controlled Materials Plan, to seek solution of the critical materials problems. By preparation of industry, rather than individual company material needs, and through numerous meetings with W.P.B. and Army and Navy officials, the Council sought to relieve difficult material problems. Continuation of this close cooperation through 1943 was assured following meetings of Government and Council representatives early in February, 1943, on details of the Controlled Materials Plan.

3. Establishment of employee transportation departments in each company, in cooperation with Government agencies controlling transportation, as a means of assuring transportation to and from work for employees.

4. Discovery of production shortcuts through study by production specialists of member companies.

5. Prevention of production bottlenecks through emergency exchanges of materials.

FAIRCHILD DURAMOLD FUSELAGE

Finishing a Duramold fuselage skin for an AT-14, preparatory to installation on frame of the plane.

6. Advancement of aeronautical engineering theory and practice through exchange of technical research reports which normally would not have been available to anyone but the experimenting company.

7. Establishment of extremely close liaison between Government and industry, thus assisting both in finding answers to major problems of production.

The 10 major committees, with subcommittees, were holding an average of 25 meetings a month at the beginning of the Council's second year. These groups were organized into Production and Manpower divisions. A third division, the Information Exchange Division, coordinated exchange of information between committees, among companies, with Governmental agencies and with other industrial groups. Staff work was in charge of John C. Lee, general manager. Divisional activities and achievements were:

Production Division—1. Advisory Committee on Production: Direct problems of manufacturing procedures, production control, inspection methods, tooling coordination, machine utilization, plant layout and manufacturing records constantly were under study. In numerous cases, this committee arranged on short notice for emergency production work of one company to be done by facilities of another. These jobs, usually made necessary by machine breakdown at one plant, were done on a straight cost basis. This ability to adapt production of one company to needs of another for an emergency job made it possible to avoid production slowdowns which normally would result from mechanical failures. The committee exchanged machine listings as a means of saving time in locating a company able to do emergency production work of this type. At the request of the W.P.B. War Metallurgy Committee, the Council group made an analysis of methods used in forming of aluminum alloys for aircraft construction.

2. Advisory Committee on Engineering and Standards: In less than a year, this committee exchanged 1,734 normally confidential technical reports. Exchange of these reports was increased to an average of 400 a month—407 in January, 1943; 403 in February, 1943. To inform each other of the reports available, the committee established an index reference system whereby all reports of each company were listed on index cards for other companies. This indexing system was operated by the Pacific Aeronautical Library under supervision of the Council staff. On seven occasions the committee pooled all information on specific subjects and compiled a master report containing all available research information, thus giving summary conclusions on a collective basis. These information pools then were turned over to engineers of each company. Through this committee, requests from W.P.B. and the Services for testing proposed substitute materials were allocated to the company best equipped to make the tests, thus avoiding duplication of research. The same

procedure was followed for investigation and analysis of new products and services offered to the industry.

One of the most difficult problems plaguing this group was the shortage of engineering personnel and the apparent lack of personnel being trained. Throughout 1943 this committee was to devote much of its time to establishing workable engineering training programs to offset shortages.

3. Advisory Committee on Materiel: Reports to the Services and Governmental agencies were coordinated. Management problems within large materiel departments were studied. At the start of 1943, the committee was working with W.P.B. to help make effective the new Controlled Materials Plan. The committee developed a simplified procedure for exchanging materials to help each other over shortage periods, thus circumventing possible production delays. In less than a year 16,338 such exchanges were made, about half to member companies and half to outside companies. These exchanges were averaging more than 2,500 a month.

Faced by a shortage of steel re-draw work, the committee developed local sources for emergency work. The group reported that it had established a uniform basis of certification for physical and chemical reports.

4. Advisory Committee on Subcontracting and Outside Production: One of the newest committees of the Council, this group was formed to help equalize subcontractor shop-loading and to coordinate problems involved in the manufacture of both small items and major

VULTEE'S STINSON SENTINEL

Produced for Army liaison, these planes can take-off almost straight up from small fields.

subassemblies outside the prime contracting plants. It worked closely with Materiel and Production committees.

5. Special Committee on Spare Parts: By tackling the two major problems of manufacture and distribution of spare parts, the committee worked out in cooperation with Governmental agencies a procedure facilitating simultaneous production of spares with aircraft units. Some of the member companies, as a result of Council activities, were operating distribution warehouses for the Services. One step taken by the committee resulted in delivery of critical spares to fighting fronts at the same time that planes were delivered. Council companies through committee members had individual responsibility for coordinating the selection of spares for concurrent manufacture with airplanes on the basis of field requirements.

6. Advisory Committee on Accounting: In addition to normal accounting procedures to be correlated between companies, the committee studied and interpreted Government rulings and directives. Fiscal aspects of Council exchanges were facilitated.

The committee worked closely with Government agencies in connection with amortization, withholding tax, issuance of war bonds and modernization of Government accounting procedures.

Manpower Division—1. Advisory Committee on Industrial and Public Relations, Industrial Relations Section: Labor supply, recruitment, Selective Service withdrawals, turnover problems, absenteeism, requirements for education and training, special problems of women employees, safety and health problems were among the matters handled. As a result of close cooperation with the War Manpower Commission and Selective Service, the committee worked out methods to help control military terminations of aircraft workers. Through a special subcommittee, this group worked with State and Federal groups for facilities to care for children of working mothers.

In order to assist member companies to maintain the best possible conditions for employees, the committee coordinated safety and industrial medicine problems through special subcommittees.

Public Relations Section: Both employee and public morale projects were undertaken through this committee. Army, Navy and other Governmental public relations bureaus were kept informed of activities within Council companies. The Committee started work on an expanded industrial information service in conjunction with the Army Bureau of Public Relations.

2. Advisory Committee on Industrial Training: As one of its major projects, this committee established a sizeable training film library and produced two training films. These visual education aids were made available to both member and non-member companies to speed up the job of training thousands of new employees. When advised of new hiring schedules, the committee developed specific training curricula. Information regarding specialized engineering and

technical training courses was exchanged. Two seminar courses for management and supervisory personnel were conducted and additional courses were to be held from time to time as the need became known. Training of mechanics and other maintenance personnel for the Services by member companies was facilitated by exchange of methods and through cooperative work with the Army and Navy.

3. Advisory Committee on Transportation and Housing: Working closely with Governmental agencies, the committee developed means of handling gasoline mileage rationing within the aircraft plants to avoid lost time by employees in obtaining gasoline cards. Public carrier transportation problems were coordinated with private companies in Southern California. Closest possible contact was maintained with all Government agencies concerned with both rubber-borne and rail transportation, as well as service agencies responsible for maintenance of aircraft production, and therefore interested in the uninterrupted transportation of war workers. Early in 1943 the group began work with Federal agencies to help relieve critical housing shortages.

4. Advisory Committee on Plant Defense. Primary problem of this committee during the past year was the transition made necessary when all plant police became auxiliary members of the Military Police. Coordinatng in-Company changes with Service requirements, the committee effected a smooth change-over. In addition, the committee members exchanged information on compliance with air raid

CHANCE VOUGHT OS2U-3

The Navy Kingfisher scout plane, with Pratt & Whitney Wasp Junior engine and Hamilton Standard constant speed propeller.

precautions and training of personnel. Other information exchanged covered the work of plant police and fire departments.

Information Exchange Division—In coordinating information exchanges, both within the Council and with outside organizations, the division was building a library of general industry information, with specific emphasis on material required for wartime operations. Queries from other industries and other sections of the aircraft industry were checked with proper sources. Release of industry information was coordinated with Army, Navy and other Government agencies. Special projects assigned by committees, such as the report exchange project of the engineering committee and the film library project of the industrial training group, were supervised by this division.

The Council maintained the closest possible liaison with the Services and other Government agencies. Representatives of such agencies regularly attended several meetings of committees each month in order to assist Council companies in fulfilling requirements.

One of the major steps taken by the Council as a means of facilitating this liaison was the establishment in February, 1943, of a Washington office. Through this office key men at Washington were able to relay information directly to persons concerned within the Council companies by a single communication, thus avoiding unnecessary delays.

Aircraft War Production Council, East Coast

The Aircraft War Production Council, East Coast, Inc., was organized in October, 1942, for the purpose of interchanging information on all phases of aircraft manufacture with the West Coast Council and with other industry groups. The eight members participating in forming the East Coast Council were Aviation Corporation, Bell Aircraft Corporation, Brewster Aeronautical Corporation, Curtiss-Wright Corporation, Eastern Aircraft Division of General Motors Corporation, Fairchild Engine and Airplane Corporation, The Glenn L. Martin Company, and Republic Aviation Corporation. In addition, Curtiss-Wright's Propeller Division, American Propeller Division of Aviation Corporation, Lycoming Engine Division of Aviation Corporation, Ranger Engine Division of Fairchild and Wright Aeronautical Corporation became members in March, 1943.

All policies of the East Coast Council were determined by a Board of Directors, composed of presidents of the member companies. In addition, the seven central advisory committees and their subcommittees carried on the work of expediting aircraft production by interchanges of informaton, developments, materials and other phases necessary to maintain Government manufacturing schedules.

The advisory committee on production obtained improved methods of subcontracting, production control, diversion of machine tools,

stockroom practices, employee relations, work measurement and other related problems through the Council's interchange system and co-operation with Government agencies. The advisory committee on engineering exchanged data on uses of metals and alloys, made loans of testing and other engineering equipment between companies, studied training materials and achieved greater application of non-strategic materials in aircraft manufacture. A plan for exchange of engineering manhours was evolved as the result of an experiment made by The Glenn L. Martin Company in using a considerable number of engineers employed by the Otis Elevator Company. Martin engineering supervisors took up headquarters at the Otis offices in New York, guided the Otis Company engineers in preparing work required by the Martin Company. Following this system, companies whose engineering personnel was not working at full capacity were able to retain these experts and place them in use for work in war industries. The advisory committee on material met with the aircraft scheduling unit to define methods of redistributing surplus and obsolete materials. The simplification of various reports and questionnaires also occupied the attention of that group. The advisory committee on plant defense met frequently with Army, Navy and other interested agencies to provide uniform methods of plant protection. The advisory committee on service arranged for battlefront company servicemen to assist their colleagues in the maintenance of war planes of any and all types. Thus, servicemen representing individual companies were instructed to give full aid to all other company representatives wherever possible. The committee also devoted much time to preparing service manuals which provided standards of official and personal conduct in the field. The advisory committee on industrial relations concentrated on Selective Service, absenteeism, housing, transportation, training, elimination of employee pirating

THE COMMONWEALTH CLOUDSTER

It is powered by a 120 h.p. Ken-Royce engine. Model 8125 is a two-place, side by side, and Model 8135 is a three-place plane.

and standardization of job titles and training. The interchange methods of the East Coast Council enabled member companies, as well as non-member companies and other groups, to benefit from the results of the committee's work. The advisory committee on public relations completed an intensive survey of absenteeism. It enabled the Council to meet with Army, Navy, Maritime Commission, W.P.B., W.M.C. and O.W.I. and project methods for a national campaign to curb absenteeism in aircraft and other war industry plants. Subcommittees on salvage, transportation and other matters performed numerous services in the solution of complex problems. In all cases, the information gathered by Council committees was made available to all outside sources which requested it.

The American Society of Mechanical Engineers

The American Society of Mechanical Engineers appointed Dr. John E. Younger, Professor and Chairman of Mechanical Engineering of the University of Maryland, permanent secretary of its aviation division; and the headquarters of the aviation division, accordingly, was moved to the University.

The work of the aviation division was organized to take advantage of the expert talent in the other 14 professional divisions of the Society, such as production engineering, applied mechanics, wood-industries, metals and management. Committees were appointed to facilitate liaison with other professional divisions to aid the war effort.

The aviation division contributed to the war effort in many ways, notably by the arrangement of discussion sessions for groups of technical men interested in the same line of war production. This was especially beneficial to manufacturers new in the field of aviation.

At the semi-annual meeting in Cleveland, a round table discussion was arranged on conservation, reclamation and substitution in aircraft and aircraft accessories manufacture. The session was secret, and was attended by 165 engineers. A free discussion of timely war production problems and their solution resulted. It came at a time when the problem of materials was beginning to be a major factor, and resulted in great benefit to the industry.

As airplanes became larger, faster and more complicated, the aeronautical engineer became essentially a mechanical engineer who must have the technical background found in all the technical divisions of mechanical engineering, such as in mechanics, hydraulics, heat transfer, production engineering and metals. Committees were appointed for the study of the problems of standard practices in the various fields of aeronautical engineering and the manufacture of airplanes and airplane accessories.

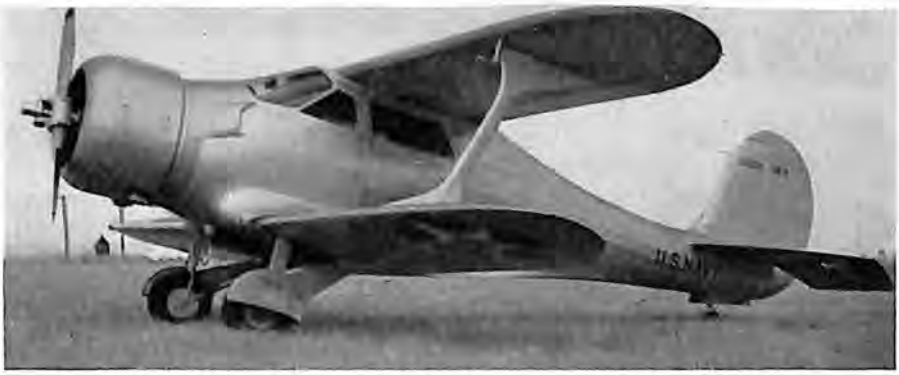
Institute of the Aeronautical Sciences

The Institute of the Aeronautical Sciences on January 26, 1943,

presented its awards for 1942 as follows: The Sylvanus Albert Reed Award was made to Igor I. Sikorsky, Sikorsky Aircraft Division, United Aircraft Corporation, "for creation and reduction to successful practice of a helicopter of superior controllability." The Octave Chanute Award for scientific achievement by a pilot was awarded to A. L. MacClain, Head, Installation Flight Test Group, Pratt & Whitney Aircraft Division, United Aircraft Corporation, "for outstanding work in flight testing of aircraft engines and development of the engine torque indicator." The Lawrence Sperry Award for young men went to Edward C. Wells, Assistant Chief Engineer, Boeing Aircraft Company, "for outstanding contributions to the art of airplane design with special reference to four-engine aircraft." The John Jeffries Award for advancement of aeronautics through medical research was conferred on Dr. Edward C. Schneider, Professor of Biology, Wesleyan University, "for pioneering research in the field of aviation medicine with particular reference to the development of the Schneider Physical Fitness Index." The Robert M. Losey Award in recognition of outstanding contributions to the science of meteorology as applied to aeronautics, was given to F. W. Reichelderfer, Chief, U. S. Weather Bureau, "for pioneering work and continuing activity in advancing the science and practice of meteorology as applied to aeronautics."

At engineering sessions of the Institute 62 technical papers were presented by specialists on aerodynamics, aircraft production, airplane design, air transport, materials, meteorology, physiologic problems, power plants and propellers, radio and instruments, rotating wing aircraft and structures. The meteorological sessions were held in cooperation with the American Meteorological Society.

Institute membership increased to a total of 5,203. Of that number, 1,580 were student members organized in branches at 43 schools and colleges. The Sixth Wright Brothers Lecture was presented in New York on December 17, 1942, by Edmund T. Allen



NAVY BEECHCRAFT GB-2

A personnel transport similar to the commercial Beechcraft D17S.

of the Boeing Aircraft Company whose subject was "Flight Testing for Performance and Stability."

Manufacturers Aircraft Association

At no time since the Cross-License Agreement was adopted nearly 26 years ago, has the practicability and importance of the plan administered by the Manufacturers Aircraft Association been realized more fully than during the year 1942. As pointed out in previous issues of The Aircraft Year Book, the primary function of the Association since the date of its formation during the first World War in 1917, has been to administer the various patent cross-license agreements and license contracts under which the aircraft manufacturing industry has operated since that date. In accordance with the provisions of these agreements, reports of the patents are made to the Association, and patent licenses are granted to members of the Association and also to the United States Government. The Association serves as a receiving and disbursing agency for the payments required to be made under such agreements and contracts, and in addition, develops a specialized procedure which enabled arbitration proceedings to be conducted in connection with claims for compensation on patents reported by members, and in the settlement of the relatively few disputes in regard to such matters which have occurred within the aircraft industry. The payments on account of the original patents expired some years ago. Accordingly, the only royalty payments currently required are those resulting from the appraisal of new patents issued to member companies.

During 1942, a total of 95 airplane patents were acquired by members of the Association, and 1,293 patents had been brought under the operation of the Agreement up to that date, thereby continuing to carry out the original policy of making licenses on the same terms available to all airplane manufacturers in the United States. As in previous years, a further important objective of the cross-license plan, namely, the prevention of wasteful patent litigation within the industry, was attained, no suits for patent infringement having been filed under any of the patents coming within the operation of the Cross-License Agreement. The contract relationship between the Association and the United States Government, which enabled the War and Navy Departments to obtain licenses on the same terms as members of the Association placed the Government in the same favorable position as regards all airplane developments which originated within the industry.

Incident to administration of the Cross-License Agreement, and also in order to supplement other services rendered to members, the Association has had the foresight to acquire throughout the last 20 years, and now maintains, a private library devoted to engineering research and technical developments in the field of aeronautics. Well

over 400 volumes of books and periodicals were acquired during 1942, either by purchase or by gifts from various companies and individuals. In addition, a complete file of aircraft patents issued in the United States, and as many as have been obtainable from Great Britain and other countries, is maintained by the Association, including an extensive classification and indexing system, which is not only unique from the point of view of research in the patent art, but is peculiarly adapted to the needs of members.

During the early years, the industry recognized that the facilities of the Association might be used to advantage in connection with the development of worthwhile inventions, and to obtain the protection afforded by patents and recognition of design rights, but little was actually accomplished in this direction until the formation of the Patent Research Division shortly after the adoption of the Amended Cross-License Agreement. Since then the services rendered by this Division have been developed and expanded until it now comprises one of the most important functions of the Association. The publication of a comprehensive Digest of all aircraft patents and such British patents as may become available, including abstracts of the specifications and official drawings, kept members informed regarding patented developments in the United States and foreign countries. The Patent Research Division also advised members in so far as practicable regarding the trend of technical developments, with a view to minimizing infringement claims, and as a basis for the possible acquisition of patents, licenses and design rights. The result was that advancement of the art was encouraged by making the important technical progress available to the engineering departments of all companies. This aspect of the service proved to be particularly

MARTIN BRITISH BOMBER

The 187 Baltimore, built in quantity for the R. A. F. It is powered by two Wright Cyclone engines.

valuable during the War when the equivalent of several years of normal research and development were crowded into a period of a few months.

The offices of the Association also provided facilities for maintaining relations with non-member patent owners. Submissions of outstanding developments by all inventors in the field of aviation were given careful consideration and might be called to the attention of the membership, or kept on file so as to be readily available in case of inquiry. Some inventors felt disposed to file complete data such as blueprints, photographs and experimental and test records in regard to their patented inventions, so as to be assured that Association members had some indication of the real nature of constructive improvement offered for purchase or license. It was likewise of advantage from the same point of view that the Association be advised of terms which would be acceptable to the respective patentees. At the same time no submission of a confidential nature was solicited or received from others than members of the Association.

A further important service rendered in connection with non-member patent owners was the substitution of friendly arbitration proceedings for costly court litigation. Therefore, as in the case of the elimination of patent litigation between members as a result of the operation of the Cross-License Agreement, the Association also succeeded in establishing a somewhat similar situation as regards the relationship with non-member patent owners desiring to make worthwhile inventions available to the aircraft industry.

The advantages of the Cross-License Agreement to the industry, to the Government and to the public were an important contribution to the War effort. By continuing to make important technical progress available to all manufacturers, the Association encouraged engineering development and research until the leadership of the United States in this field became generally recognized by all other countries. Membership in the Association was not restricted. No qualified applicant was refused the right to acquire licenses under the terms of the Agreement. There were no withdrawals from the Association, except in the case of companies which either had gone out of business or had ceased the manufacture of aircraft. Patents of lesser consequence were licensed free of charge, while inventions of a more basic character which otherwise might have been held by individual companies to dominate the industry or withheld for the purpose of preventing competition, were made available at low rates of royalty permitting unlimited use by every member of the Association of all inventions coming within the operation of the Agreement.

National Aeronautic Association

Founded in 1922, the National Aeronautic Association completed its second decade of service with an active program for aviation

development and promotion. Emphasis was placed on promotion of a Federal Department of Defense; development of a long-range policy in Congress to insure a postwar return to free private enterprise for domestic and foreign air commerce; promotion of a Government scientific research program for the development of aeronautic equipment to meet the postwar needs of commerce and industry; and sponsoring of aviation education for the youth of America.

Affiliated with the National Aeronautic Association were several active organizations. The National Aviation Training Association, composed of some 250 aviation training organizations of which a large number were Civilian Pilot Training Program operators, worked for the smooth coordination of flight and ground training for the armed forces. Another N.A.A. affiliate, the Ninety-Nines, international organization of licensed women pilots, listed the majority of its members as C.A.P. volunteers, W.A.F.S. ferry pilots, British A.T.A. ferry pilots, C.P.T.P. instructors, A.T.C. traffic control operators, and as trainees for those and other wartime activities.

The Air Youth Division of N.A.A. promoted youth aviation education in the public schools and in other youth organizations such as the Boy Scouts, Girl Scouts and Camp Fire Girls. It established the Junior Air Reserve as an Air Youth training organization, and membership totaled 5,000. The Academy of Model Aeronautics had licensed some 200,000 model fliers.

Society of Automotive Engineers

The aeronautic activities of the Society of Automotive Engineers continued with vastly accelerated tempo and increased scope during 1943. These aeronautical activities included the Aeronautical Standards and large scale national aeronautic production and engineering meetings. During 1942, the S.A.E. Aircraft Standardization Pro-

G & A AUTOGIRO PA-36

gram included coordination for the aircraft industry of a broad aeronautical standardization program covering the fields of aircraft engines, propellers, accessories and equipment, and the materials and processes used in the production of airframes and aircraft engines, propellers, accessories and equipment. In the standardization of aeronautical materials and processes, 283 specifications of the A.M.S. series were completed. In development of these specifications new and revised specifications were prepared and issued immediately as required by the flexible and expanding needs of the industry.

During 1942, 16 A.M.S. covering aeronautical alternate steels recommended by the War Production Board Technical Advisory Committee for Alternate Steels, 24 specifications covering synthetic rubbers required by the aircraft industry, seven for felt and many for other materials used by the aircraft industry, were issued. Over a million and a quarter of these specifications were distributed throughout the industry to more than 3,000 users. Eighty Aeronautical Standards and Aeronautical Recommended Practices were issued after thorough coordination with interested groups in the aircraft industry. Two Aeronautical Information Reports containing useful technical data and engineering information also were used.

In 1942, 94 papers covering a variety of aeronautical engineering and aircraft production and operation subjects were delivered before the Society of Automotive Engineers national and sectional meetings. Approximately one-third of the 8,200 members of the Society were connected directly with the aircraft industry.

BREWSTER BERMUDA DIVE BOMBERS
Awaiting final flight tests before joining the British R.A.F.

CHAPTER X

THE AIRCRAFT MANUFACTURING INDUSTRY

Manufacturers of Planes, Engines and Accessories Report New Developments in War Equipment—The Industry Expands Plant Facilities and Increases Personnel—Growth of Subcontracting—Work of the Individual Companies.

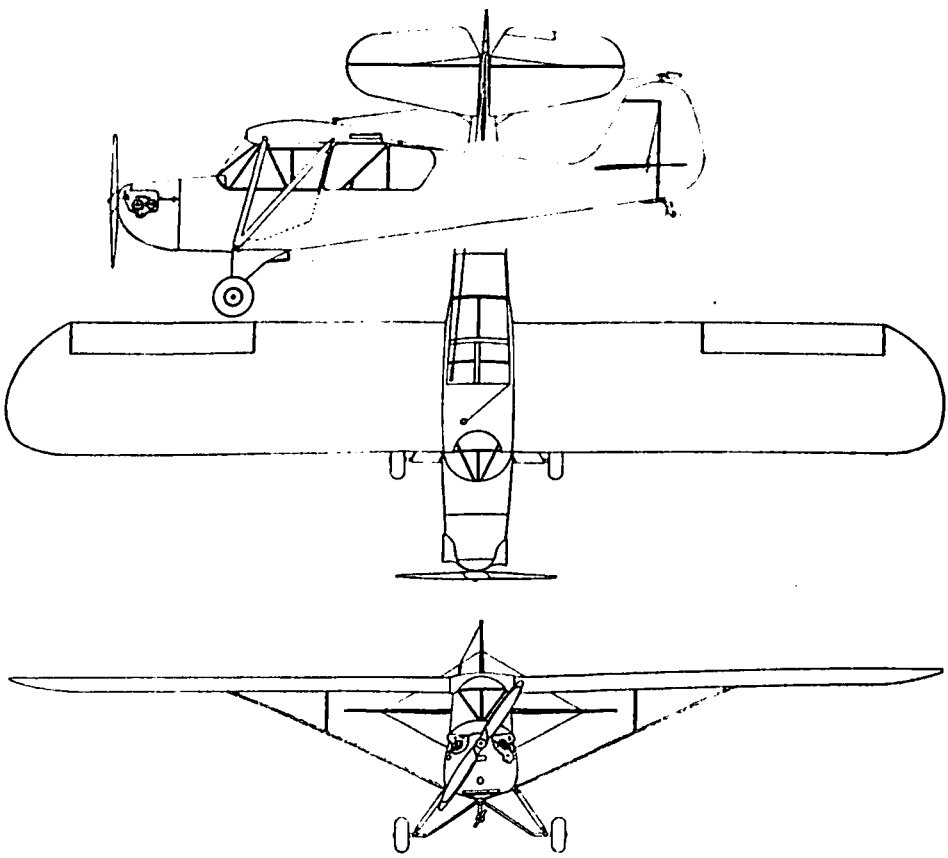
THE aircraft manufacturing industry won its full share of Army-Navy E awards in its all-out production efforts after Pearl Harbor. Employees joined with management in taking great pride in the results of their work as the dispatches came back from the war zones telling of the superior performance of planes toward which they themselves had contributed something in the form of efficiency, whether it was in the plane itself, its engine or one of the thousands of parts and accessories that make up a military flying machine. The following pages give in all possible detail the contribution which each company made toward American superiority in the air.

Manufacturers of Aircraft

Aeronca Aircraft Corporation, Middletown, O., produced the L-3 series, the TG-5 training glider and the PT-23 Army primary trainer —all for the Army Air Forces. Facilities were practically doubled. A monorail conveyor system was installed in the plant, and a system of victory awards was set up to increase production. Aeronca also built a light cargo plane for Army test, and designed a special ambulance ship. Built around the Aeronca L-3 Super Chief commercial model, the ambulance plane had the same flight characteristics and performance. It was powered by a 65 h.p. engine, had a cruising speed of 100 m.p.h., gas consumption of 5 gal. per hr. and range of 350 mi.

The Aeronca training glider, TG-5, was a 3-place high-wing type with 35 ft. wing span and length of 23 ft. 10 in. The PT-23AE Army primary trainer was a 2-place open cantilever low-wing tandem plane with 220 h.p. Continental radial engine. The Aeronca 65 CA and LB was a 2-place, side by side, high-wing monoplane with 65 h.p. Continental or Lycoming engine.

Beech Aircraft Corporation, Wichita, Kans., greatly accelerated its production of Beechcraft twin-engine monoplane advanced trainers



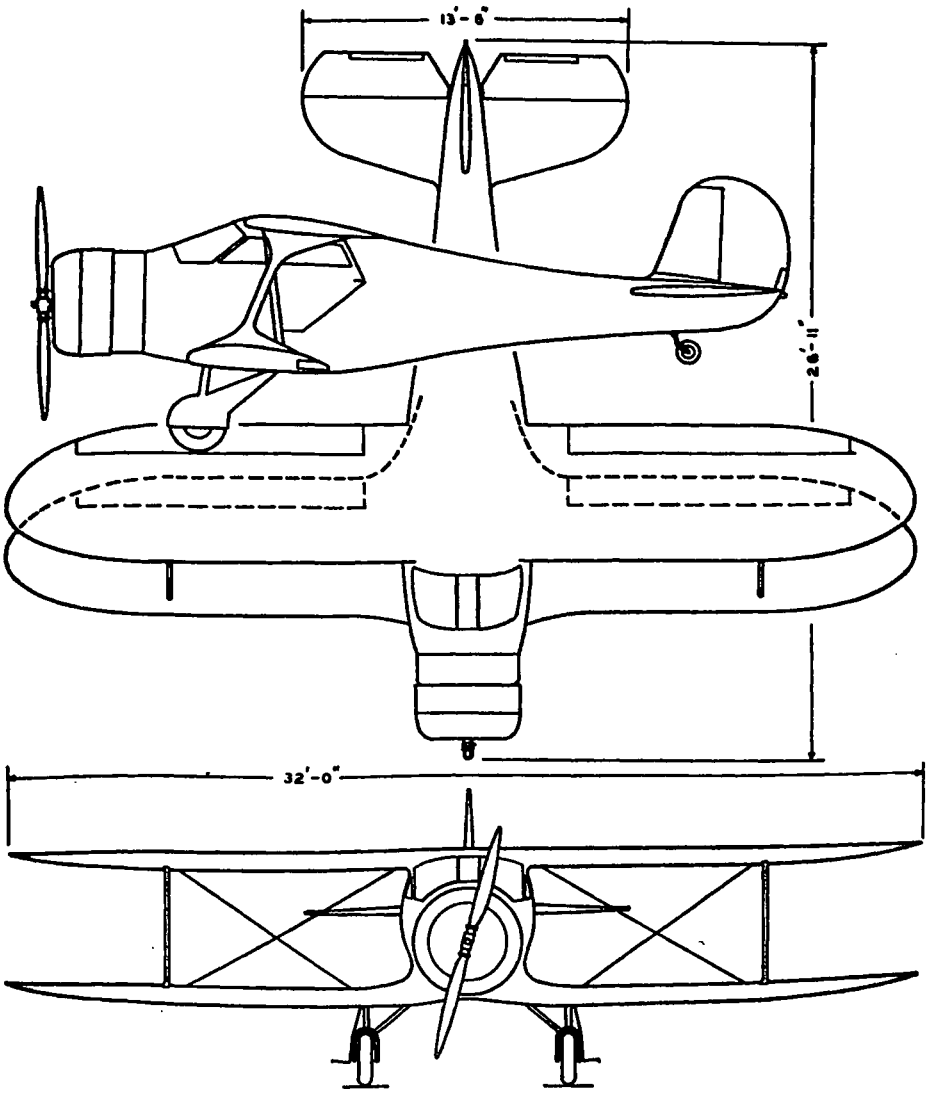
AERONCA LIAISON PLANE

Army Air Forces Type L-3B. A two-place plane with a Continental 65 h.p. engine.

and single-engine biplane transports for the U. S. Army Air Forces and Navy Bureau of Aeronautics. A 780 per cent increase in delivered sales over 1941 was achieved in the first ten months of America's total war, through intensive effort and cooperation of employees and management, without major additions to the manufacturing area or facilities which were available in 1941. Principal factor in this increase was the intangible one of morale. The desire of Beechcrafters to do their part to win the war found expression on the production line, and in many other ways. Employees spontaneously organized a "Whiskers Club" early in 1942, pledging themselves not to shave until a certain level of production was reached. They soon achieved and passed that level; but the spirit of constant striving persisted. After working hours, they organized and staged a benefit carnival which raised over $15,000 for servicemen's charities; they founded a voluntary organization, a thousand strong, of "Reserve Guards," "Reserve Guardettes," and "Volunteer Firemen," operating along military

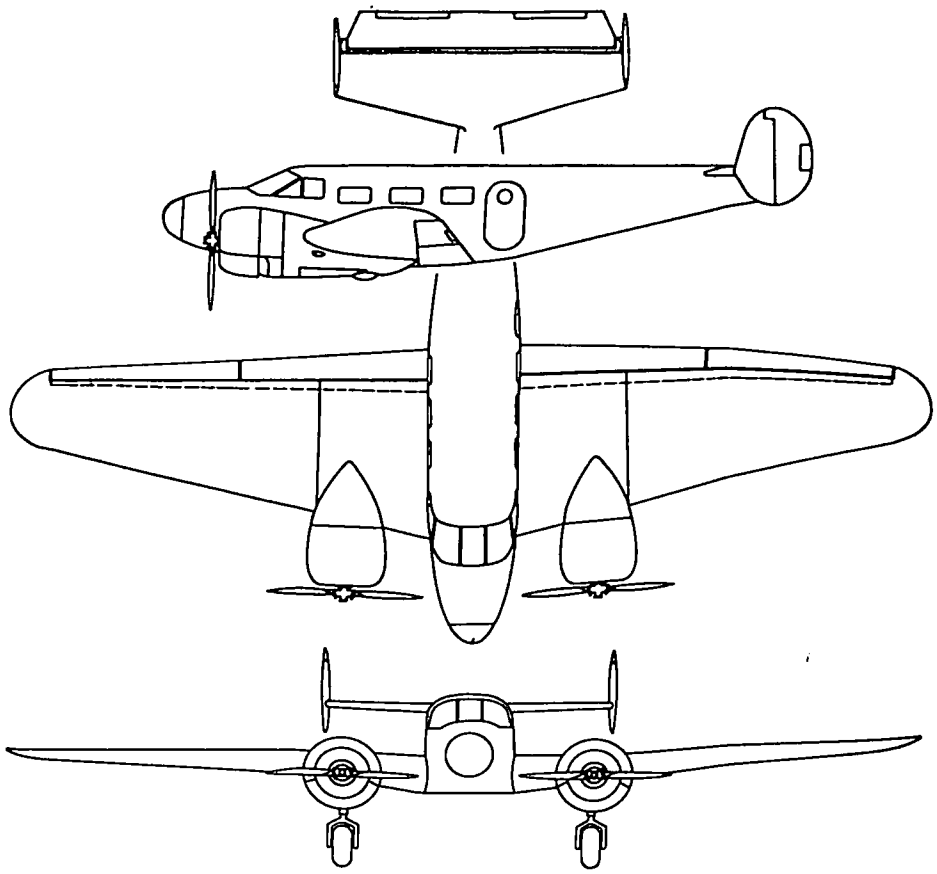
lines to protect the Beech plant in case of any emergency; and they boosted their voluntary purchases of U.S. War Bonds to a figure equalling 20 per cent of the company's total payroll. The Army-Navy E for excellence in production also was conferred on Beechcraft during the year.

Subcontracting helped materially to accelerate Beech production. An extensive subcontracting program, started by Beech in 1939 and constantly expanded in 1940 and 1941, grew in 1942 to a point where 85 per cent of one principal model, and over 40 per cent of the



BEECHCRAFT PERSONNEL TRANSPORT

Used as a utility transport also, the Army designation is C-43 and the Navy designation GB-2.



BEECHCRAFT MODEL 18

Various adaptations of this twin-engine monoplane are used by the Army Air Forces and Navy Air Forces as navigation or bombing trainer, utility or personnel transport, or photographic plane. It is powered by two 450 h.p. Pratt & Whitney Wasp Junior engines.

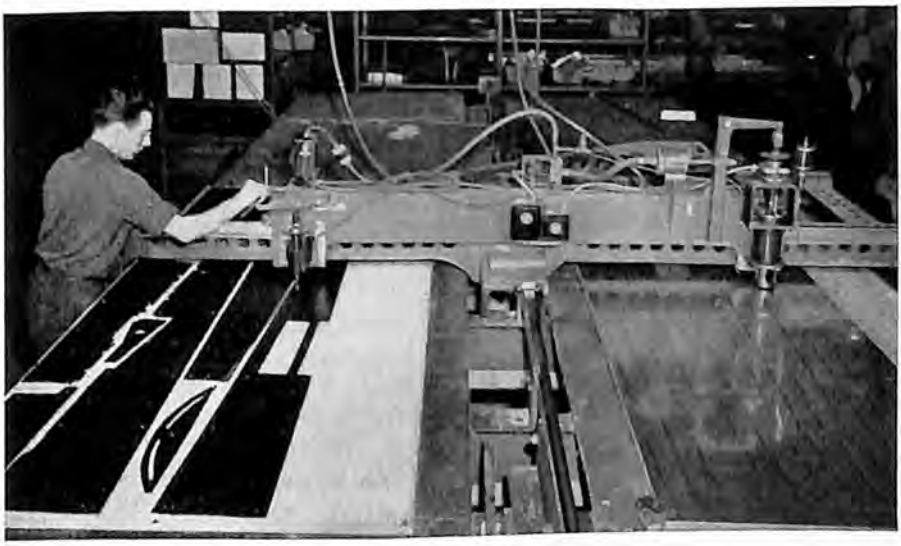
parts of each of two other principal types, were manufactured by subcontractors. The floor area devoted to Beech production by subcontractors far exceeded that in the Beech factory itself. The advantages of a three-year experience in engaging subcontractors and working closely with them in fabricating parts, tooling, and subassemblies, became apparent when the call came for all-out war production. Subcontractors, already well versed in Beech requirements, were able to expand their production without confusion, and maintain quality requirements throughout.

Production centered on four types of Beechcrafts. The Army type AT-7 (Navy type SNB-2) long-range navigation trainer, and the Army type AT-11 (Navy type SNB-1) bombing trainer, were the first planes ordered by the U.S. armed services for the special purposes of navigator and bombardier training. Both were adaptations of

the basic commercial model 18 Beechcraft all-metal low-wing twin-engine monoplane, using two 450 h.p. Pratt & Whitney Wasp Junior engines. The Army type C-43 (Navy type GB-2) personnel and utility transport, a single-engine biplane, was an adaptation of the commercial model 17 Beechcraft single-engine negative-stagger biplane, using one 450 h.p. engine. Only the Army type AT-10 Beechcraft advanced pilot trainer was a special military design. An all-wood low-wing twin-engine trainer simulating the performance and equipment of advanced multi-engine tactical aircraft, it was originated with the cooperation of the Army Air Forces to utilize a minimum of critical material, and to be readily adaptable to fast, economical mass production.

Bell Aircraft Corporation, Buffalo, N. Y., increased production of its P-39 Airacobra fighters for the Army Air Forces and others among the United Nations, while the Bell Aircraft Ordnance Division increased output of recoil-damping gun mounts. At the same time Bell produced large quantities of control surfaces and rear gun enclosures for the Boeing Flying Fortress.

Bell Aircraft moved swiftly forward also with plans for the manufacture of a new type bomber, designed by another company, in a huge new factory at Marietta, near Atlanta, Ga. Production facilities for this new project were nearing completion, early in 1943, and a comprehensive training program was under way to teach Southern labor how to build combat aircraft.



SPEEDING UP PRODUCTION

This is the pantagraph router with which Bell Aircraft Corporation daily turns out thousands of Airacobra parts. On the left a workman may be seen tracing templates. On the right, a cutting tool produces accurate copies of the patterns from sheets of aluminum alloy.

Bell Aircraft deliveries in 1942 were in excess of $120,000,000, compared with $5,000,000 in 1940. The company had more than 18 times the number of employees and 10 times the floor space of April, 1940. One of the first aircraft manufacturers to answer the President's call for all-out production with a seven-day-week, 24 hour day, Bell continued to incorporate improvements in its Airacobra design. Basically, the high performance fighter plane was built around a 37 mm. cannon firing either explosive or armor piercing shells. The cannon was mounted in the nose and fired directly forward through the hollow propeller hub. Other armament included light and heavy caliber machine guns installed in the fuselage and wings. The liquid-cooled Allison engine was mounted behind the pilot, and the propeller was powered by means of an extension drive shaft running from the engine, beneath the pilot's compartment to the propeller in the nose. Leak resistant fuel tanks, heavy armor plate and numerous other improvements, suggested by actual combat use, were built into the Airacobra.

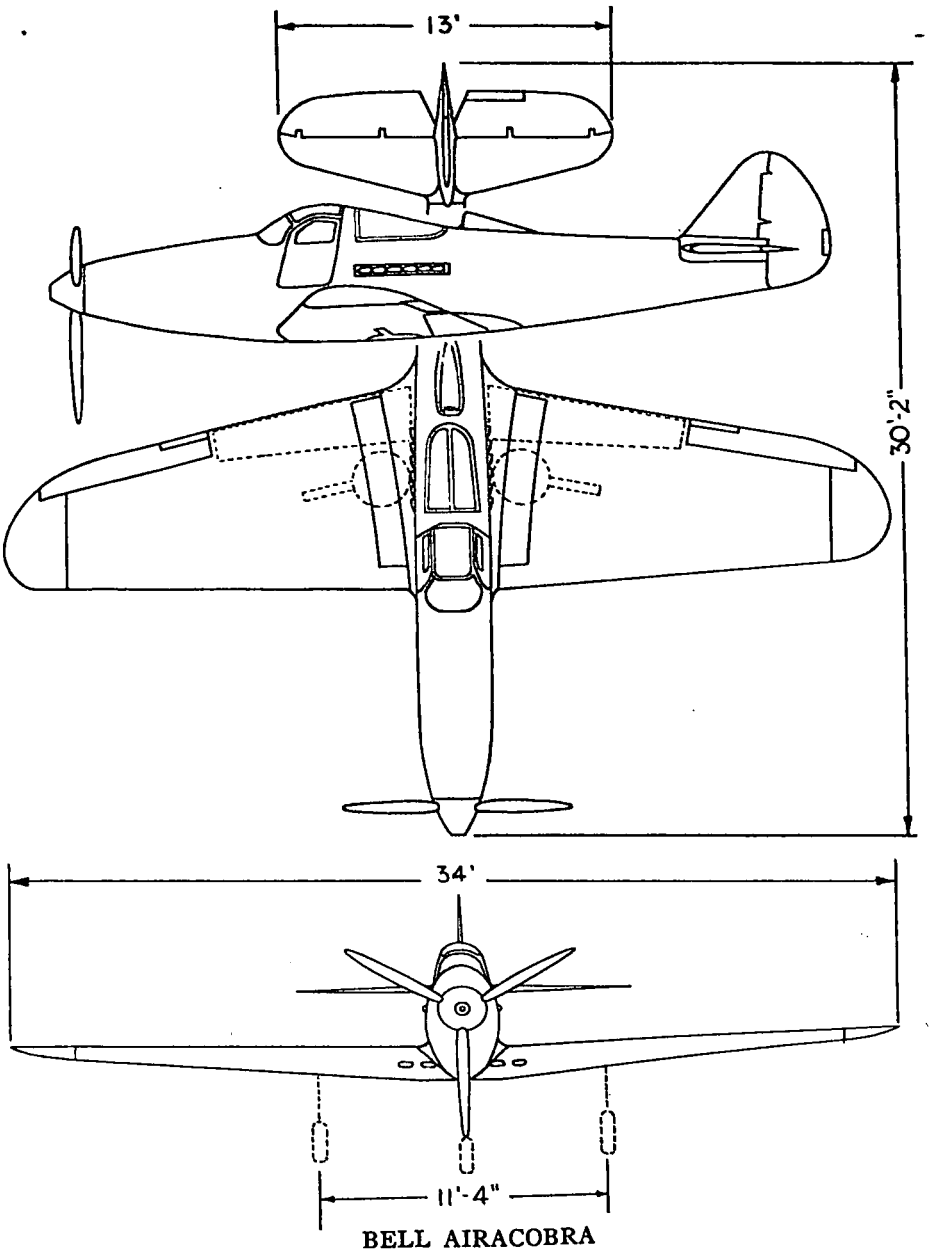
One of the steps necessary to achieve production acceleration was the simplification of the manufacturing processes so that thousands of unskilled workers could perform the required operations. Instead of seeking to upgrade the workers, it was necessary to downgrade the complexity but not the quality of the work so that available labor supply could be utilized. Without the company's use of 100 per cent lofting, this would have been impossible.

Another requirement was the maintenance of a smooth flow of the 9,000 and more parts making up the Airacobra. Production control methods which had been satisfactory in earlier days were inadequate, and in their place new methods were instituted which would assure the availability of parts in quantities needed to maintain the constantly increasing production schedules. To facilitate this work, miles of pneumatic tubing were installed in Bell Aircraft plants, to speed the delivery of the heavy paper work involved.

On December 7, 1941, not a single woman was doing production work at Bell Aircraft, but soon after, women shop workers were recruited, and by the beginning of 1943, nearly 50 per cent of all production employees were women, with the percentage continuing to increase. More difficult tasks were assigned to women, including such complicated work as engine run-up, operation of a 5,000-ton hydraulic press and numerous types of machine shop practice.

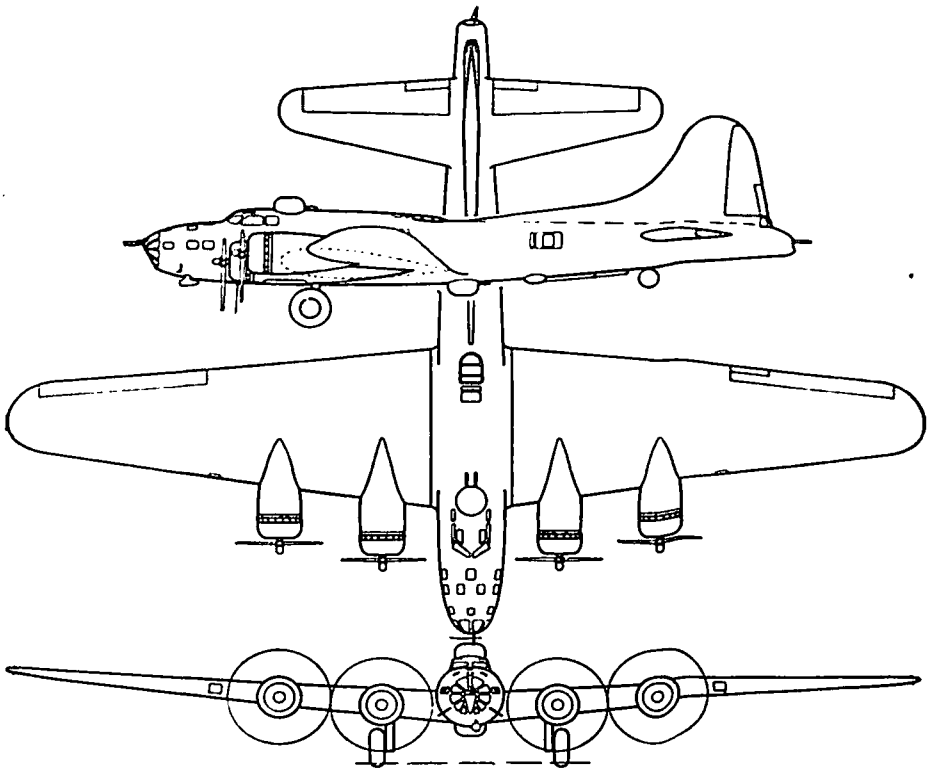
Successful operation, at the beginning of 1943, of power-driven wing lines marked another step in Bell Aircraft's pioneering with mechanical handling of materials and parts. In 1941, the company had gone beyond the straight line production methods with which it was building Airacobras, by using drag-chain conveyor lines to give constant motion to its final assembly lines. With the chains sunk into the floor, wheeled dollies carried the fuselages steadily forward as various

operations were performed, including attachment of engine, cabin and aft fuselage, and also the installation of electrical and hydraulic systems. On these new lines, Bell fabricated wings, as the link-belt, power-driven conveyor carried them from station to station. Bench work and machine work on subassemblies were accomplished parallel to the line, and synchronized to its forward motion. All operations



BELL AIRACOBRA

This single-seat interceptor fighter is powered with an Allison engine.



BOEING B17E AND B17F FLYING FORTRESS

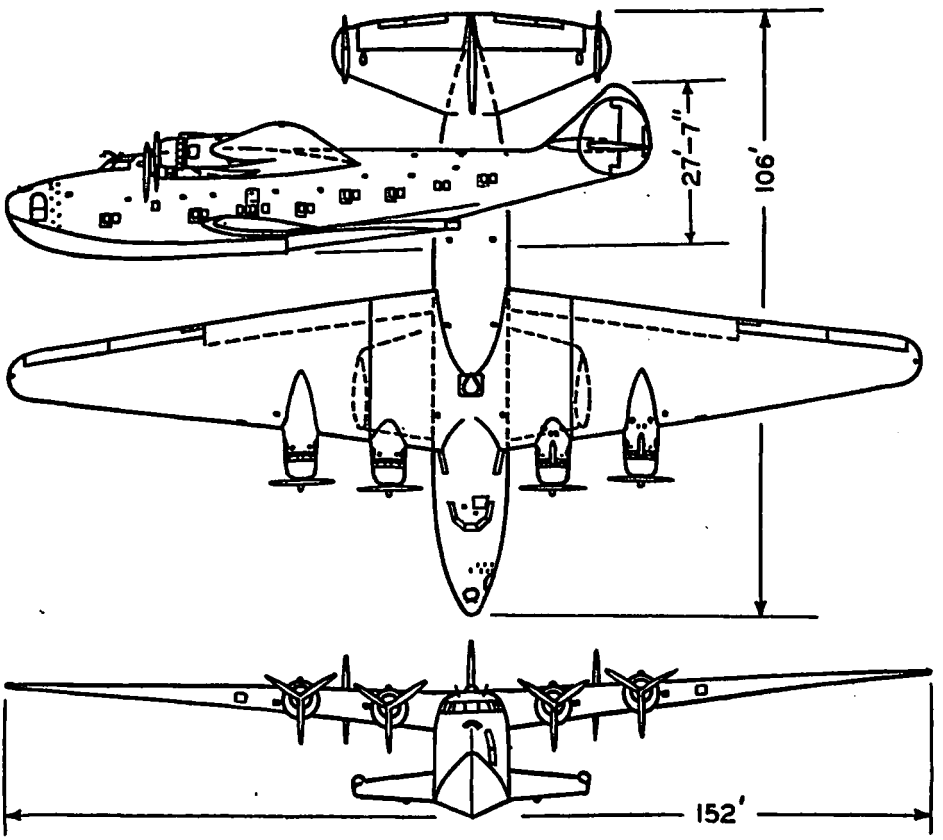
were planned for maximum simplification, each one clearly explained in minutest detail by words and pictures—right on the line—so the most inexperienced operator would know just what to do.

Boeing Aircraft Company, Seattle, Wash., devoted its entire production facilities to the building of the Boeing Flying Fortress, a four-engine long-range bomber specializing in precision bombardment from extreme high altitudes, and able to operate if necessary without fighter protection. During the first half of the year the Model B-17E was succeeded by the B-17F, the eighth series of the Flying Fortress.

A signal achievement in manufacturing was evidenced in the production changeover. The first of the B-17F's was test-flown on the day the final E model was delivered to the Army Air Forces. There was no stoppage or slowdown of production during the model change, although the new series with over four hundred design changes represented about a 20 per cent new airplane. Production of the new model followed that of the old through the various stages of manufacturing, evenly, and without noticeable interruption. This accomplishment, together with an outstanding record of production, was recognized by the award to Boeing of the aircraft industry's first Army-Navy E award.

Outwardly, the B-17F was almost identical to the B-17E, with the exception of an all plastic nose on the newest model. The other changes, for the most part of a secret nature, provided an even higher ceiling on this high altitude aircraft, a greater load carrying capacity, improved speed and still more effective armament. From Alaska to Europe, from the South Pacific to the Mediterranean, the Boeing Flying Fortress carried the war to the enemy. Over Europe Flying Fortresses established the phenomenally low casualty ratio of 1.6; or for each thousand bombers sent out to raid enemy territory, only 16 failed to return. Reports from the first seven raids over Europe indicated that about 70 per cent direct hits were made on selected targets, thereby demonstrating the effectiveness of precision daylight bombing. During the month of October, 1942, over Europe, of the 88 enemy planes destroyed, 70 were accounted for by the guns of Flying Fortresses. On one raid in Rabaul, Flying Fortresses sank or damaged 10 enemy ships.

The manufacturing achievement of Boeing, equally as significant



THE BOEING 314

Pan American Clipper ship for ocean passenger service, powered by four 1,500 h.p. Wright Cyclone engines.

as the outstanding performance of the Fortress, was marked by turning out these large bombers in quantities required under a continually accellerating schedule. Production at the beginning of 1943 was four times greater than at the time of Pearl Harbor. All production schedules were met in 1942, despite the problems of material and manpower shortages. Contributing to the success of production were coordination of timing between the hundreds of subcontractors and suppliers of parts and assemblies; the effectual efforts of the Boeing tooling department which turned out about a quarter of a million different tools specifically for the production of the Boeing Flying Fortress; and the over-all planning and coordination of tool facilities and methods which were incorporated in the Boeing-devised system of Multiline production.

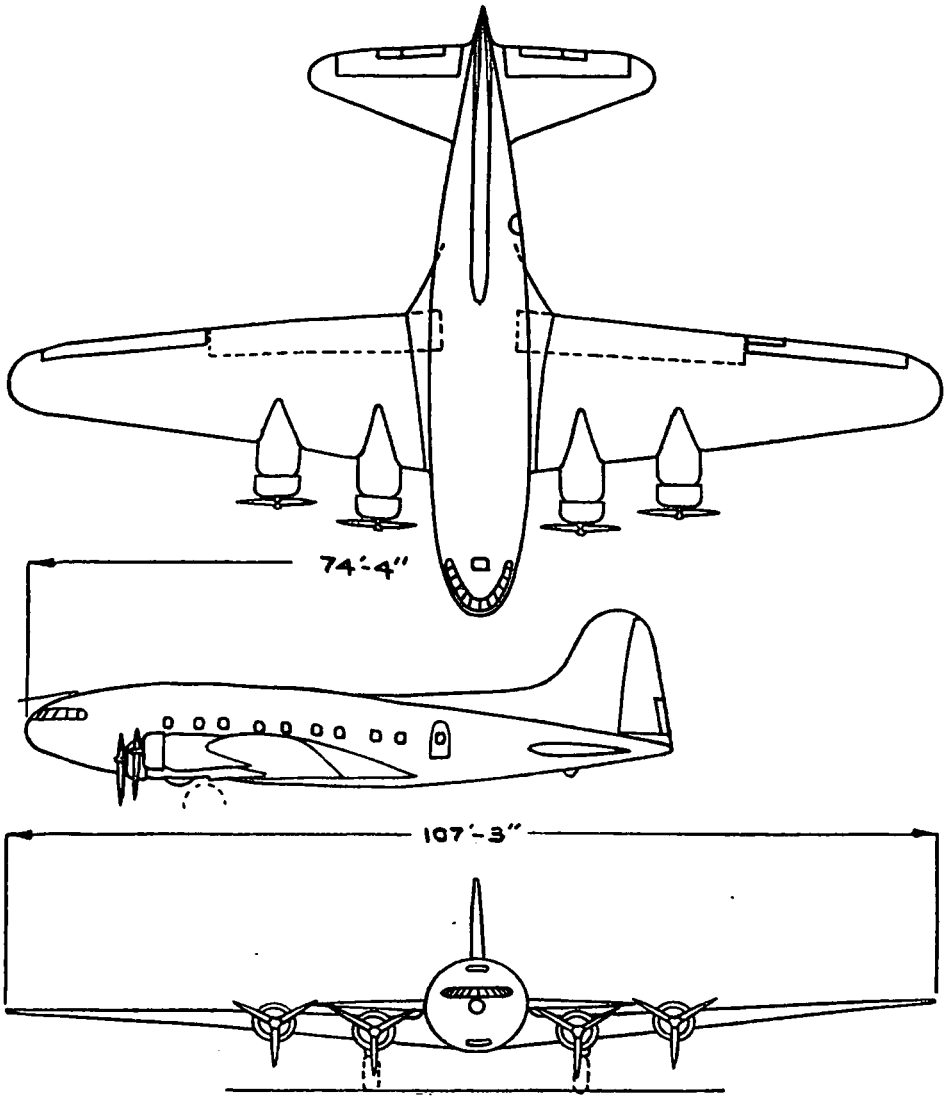
Multiline production was based on the unalterable premise that an aircraft of any kind is extremely extravagant of space. To assemble an aircraft into its final form at an early point in manufacturing is to waste factory space. Boeing divided its production into major units of the aircraft which could be arranged compactly in several production lines, each of which produced a precompleted portion of the Flying Fortress. Wings, for example, were fabricated in jigs, and set on the wing installation lines where the wings were made ready for flying. The gas tanks were added, the de-icer boots installed, the flaps put on, the various tubes, controls, wires and lights properly fitted, the landing gear installed, the engine and the cowl flap put on. When the wing left this line, it needed only to be connected with the rest of the completed aircraft, and the wires, tubes and controls hooked up, to be ready for flight. Other portions of the Flying Fortress were precompleted in a similar fashion.

Another outstanding accomplishment at Boeing was the maintaining of a continual month to month production schedule acceleration while assimilating and breaking in a large proportion of women workers. In April, 1942, Boeing employed about three per cent women, most of whom served in a clerical capacity. At the close of 1942, women employees totaled 46 per cent of all Boeing employees and in some of the production shops women made up 75 per cent of the employees.

Aside from Boeing production of the Boeing Flying Fortress, it also was being turned out in quantity by the Douglas Aircraft Company and the Vega Aircraft Corporation, under license from Boeing. In 1941 the Boeing-Douglas-Vega production pool was formed, with Boeing turning over to the cooperating companies all the engineering data, tool designs and blue prints for the Boeing Flying Fortress. A large number of Boeing engineers were kept busy making triplate changes, as requested by the Army Air Forces, which were forwarded to the cooperating companies.

Boeing engineers made considerable progress in conservation of

strategic materials, notably rubber, aluminum alloys, nickel, chromium and alloy steels, used in the Flying Fortress. Substitutes, generally speaking, were non-strategic materials such as wood and plastics, or less critical materials, such as plain carbon steels for special alloy steels. In all conservation changes, however, two principles prevailed; that there be no sacrifice in weight or efficiency of the Flying Fortress, and that re-designs be completely interchangeable with the parts being replaced. Typical examples of the use of wood included



THE BOEING STRATOLINER

A 38-place transport for substratosphere operations. It is powered by four Wright Cyclone engines of 1,100 h.p. each.

tables, doors, floors, seats, steps, ammunition boxes, oxygen bottle holders and the like. Approximately 22 pounds of rubber was eliminated from each ship without affecting the safety of the ship or the crew.

Boeing's flight testing department continued their research into the stratosphere regions, a program which had been under way for several years. This group of airmen spent several hundred manhours at altitudes in excess of 30,000 feet, and a large portion of this beyond 34,000 feet, perfecting the many functions which enabled the Flying Fortress to operate efficiently at high altitudes under military conditions. Among the problems solved by the Boeing flight test department was that of propeller stalling and tip speed losses at altitudes in excess of 35,000 feet, basic information which was incorporated into the design of spark plugs and ignition equipment for operation at high altitudes, specific fuel consumption data which proved aircraft operation economy at high altitudes, and improvements in the operation of hydromatic propellers above 35,000 feet. The complete range and operation limits of both single and dual turbo-superchargers were established.

In July, 1942, the Boeing Sea Ranger XPBB-1 made its debut, a unique flying boat, built for the U.S. Navy, which although in the four-engine aircraft size class, could operate on only two engines. Unusually clean aerodynamically and hydrodynamically, this aircraft proved to have excellent flying characteristics. The Sea Ranger featured extremely long range, weight lifting ability, and comfortable quarters for a crew of 10.

Boeing Stratoclippers, operated by Pan American Airways, maintained schedules in the Caribbean area, while the TWA fleet of Boeing Stratoliners took on olive drab and went to war with the Army Air Forces. The Boeing 247's, built in 1933-35, and operated formerly by United Airlines, also joined the Army. The big 89-place Boeing 314 Clippers maintained a close link with England, making trips regularly across the Atlantic Ocean. Three other clippers were operated by British Overseas Airways.

The Boeing Aircraft Company, Renton Division, grew rapidly. With the large new plant almost completely tooled, production was to be well under way early in 1943. Boeing Aircraft of Canada Limited, Vancouver, B. C., devoted its facilities to the production of patrol bombers for the United Nations.

Boeing Airplane Company's Wichita (Kans.) Division continued its expansion program preparatory to assuming an even greater position in wartime industry. The company maintained its schedules in production of primary trainers by supplying a record number of its models PT-17 to the Army and N2S3 and N2S4 to the Navy. Daily flights of these trainers were ferried to training schools, while

others found their way to Great Britain, Paraguay, Bolivia, Cuba, Peru, China and Canada.

The PT-17, N2S3 and N2S4 were powered by Continental 220 h.p. engines. All primary trainers produced by the Wichita Division were basically similar types. All were two-place biplanes featuring high maneuverability and rugged serviceability. They had a wing span of 32 ft. 2 in., height 9 ft. 4½ in., wing area 297.6 sq. ft., gross weight 2,700 lbs. Their stated high speed is 125 m.p.h. and cruising range from 400 to 425 mi.

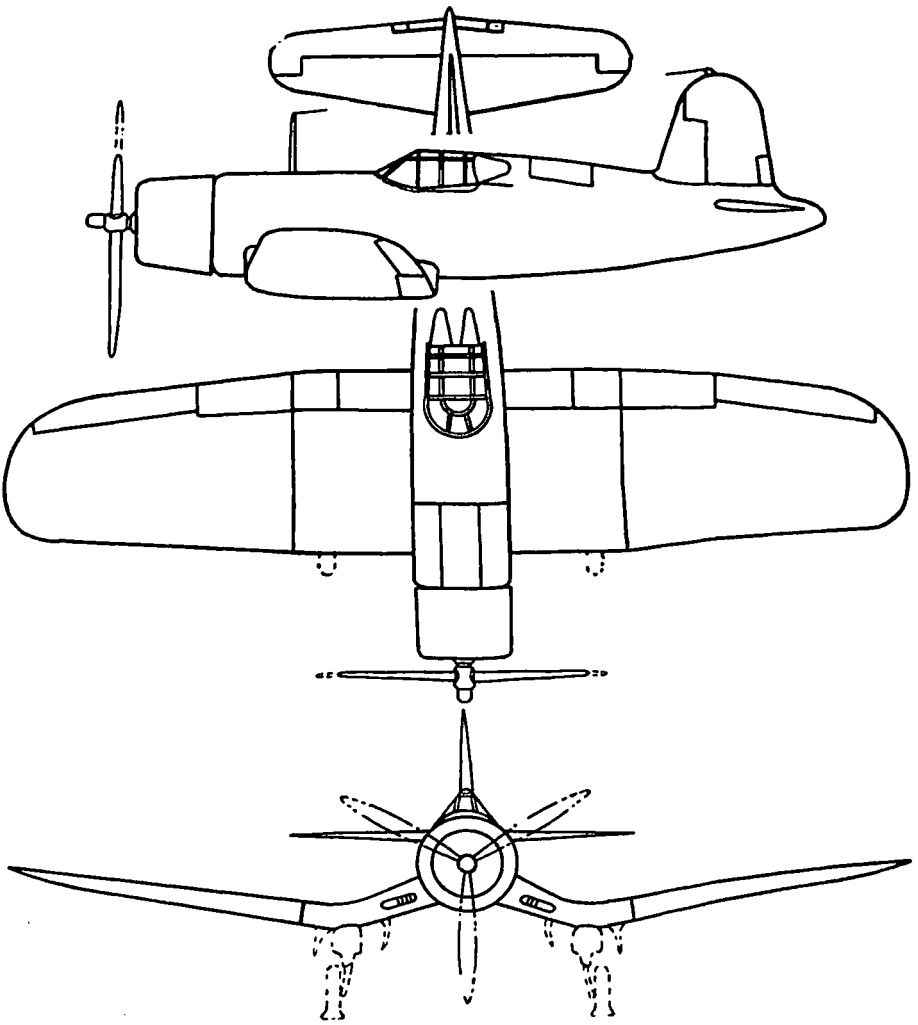
These primary trainers had a fuselage of welded steel frame, fabric covered, wings of spruce spars, spruce ribs and aluminum alloy channel drag struts, all fabric covered, interplane and cabane struts of streamlined aluminum alloy tubing and ailerons of riveted aluminum alloy construction, fabric covered. Welded steel tubing was used in the tail group with fixed stabilizers; horizontal trimming was provided by means of an elevator tab. Landing gear was of the full cantilever type.

A variation of the PT-17 model, the PT-27, was produced in quantity for Great Britain's training program and was adapted especially to operation in extreme cold weather. The PT-27 equipment included cockpit enclosure, cockpit heater and oil dilution system. It also was equipped with a blind flying hood for instrument training and a complete electrical installation for night flying.

Because of the Army's urgent need for cargo gliders and the Wichita Division's plant facilities and experienced personnel, it accepted subcontracts for construction of a large number of CG4A gliders. The glider program provided a typical example of the ingenuity and cooperation of Midwest plane builders. Boeing undertook the dual job and manufacturing and assembling. In addition to

THE BOEING SEA RANGER

An experimental two-engine long-range patrol bomber.



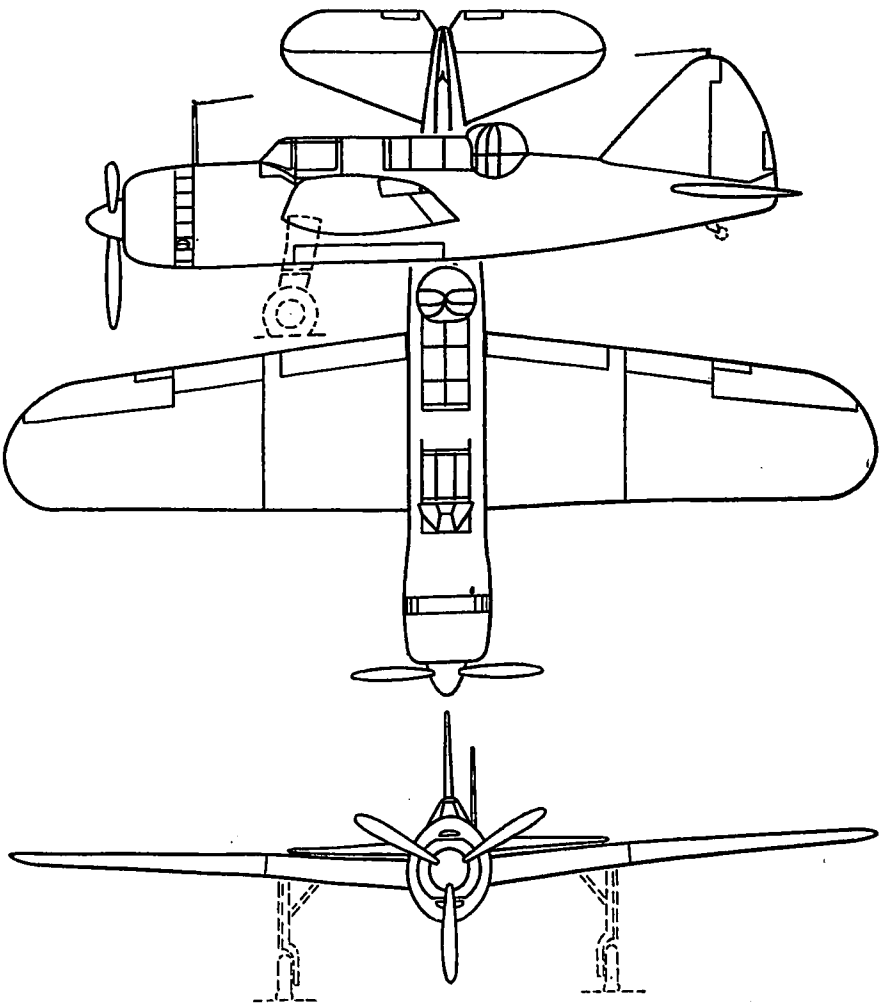
BREWSTER BATTLER
The F3A Navy Fighter.

the parts built within the Boeing plant, scores of small manufacturers, cabinet makers and craftsmen working in home shops contributed finished parts to swell the volume moving along production lines. The glider was developed around a fuselage of welded steel tubing and wooden wings, both fabric covered, from a design by the Waco Aircraft Company under the direction of the Army Air Forces at Wright Field.

Boeing's Wichita Division also designed and constructed a twin-motored crew trainer designated by the Army as the XAT-15. It was equipped with two Pratt and Whitney 550 h.p. engines. It had a steel tube, wood-faired, fabric covered fuselage and plywood covered wings

and tail surfaces. It had a wing span of approximately 59 ft. and a length of 42 ft., and a speed in excess of 200 m.p.h. To provide the desired training facilities for flight crews, the XAT-15 was equipped with constant speed propellers, radio compass, automatic pilot, full complement of flight and radio equipment, flexible machine gun, flexible camera gun, power turret and moderate capacity bomb bays. While the Wichita Division was producing trainers and gliders at an unprecedented rate, the bulk of personnel was engaged in the production of major assemblies for the Boeing Flying Fortress.

Brewster Aeronautical Corporation, Long Island City, New York, moved into full production on its new long-range dive bombers. In



BREWSTER BUCCANEER

A Navy dive bomber, designated the SB2A.

addition the company started 1943 with a new Navy fighter program well under way and new contracts to replace the completed wing work at its Newark, N. J., plant. Of paramount importance in the Brewster picture was the dive bomber program, including several models of the Buccaneer SB2A for the U.S. Navy and its export counterpart, the Bermuda, produced in quantity for the R.A.F. Prime contracts for a land based Buccaneer for the Netherlands East Indies were taken over by the Navy. Brewster continued manufacturing fuselages, center wing sections and component parts at Long Island City and shipping to the big new plant at Johnsville, Pa., for final assembly. Here the land and carrier-based Buccaneers were sent successfully through their dive tests along with the Bermudas.

The main difference between the Buccaneer and the Bermuda was in the engine horsepower. Each was a two-place mid-wing design with high fire power and exceptional maneuverability, powered by Wright Cyclone engines. The Navy models were slightly faster because they were equipped with a 2,000 h.p. Cyclone, while the British version carried a 1,700 h.p. Cyclone.

With the development of the folding wing the Buccaneers were ready for service with the aircraft carriers. They had a range of approximately 2,500 mi. and were capable of carrying upwards of 1,000 lb. bomb loads within the fuselage. External racks rigged beneath the wings increased the bomb load without creating drag.

Heavily armored, with leakproof fuel tanks, oil tanks and windshields, the dive bombers proved effective in keeping on their targets through the use of new braking flaps. As these planes began to roll off the production lines in force the Brewster plant at Johnsville was completed. Thus it was possible to set up separate assembly lines for the various models and also maintain a steady flow of deliveries. A new hangar was constructed on the modern airport adjacent to the Johnsville plant. This hangar, ready for occupancy early in 1943, permitted inside storage of flight test planes and also a modification center for quick and necessary changes.

Gas rationing and inadequate housing affected the personnel levels at Johnsville. The company instituted high school training programs and employed hundreds of women to replace men called into service.

Brewster initiated its Navy fighter program in its plants at Long Island City. The F3A was an exact counterpart of the Navy Vought Corsair F4U fighter and was to be used for carrier operations. The new fighter had a very high speed, was heavily armed and afforded good visibility. It was powered by a Pratt and Whitney 2,000 h.p. motor with Hamilton Standard propeller.

Brewster enlarged its Long Island City plants to put the fighter program into full swing. Two new buildings were obtained, and new methods in reproduction and tooling were adopted.

The doughty Brewster Buffalo which had proved itself so able for

the United States Navy as well as the British and the Dutch, although antiquated in comparison to the newer plane, nevertheless was an outstanding Navy fighter during 1942. The part Brewster Buffalos played in the Battle of Midway resulted in the decoration of pilots of Marine Fighting Squadron 221. In its official story of the Battle of Midway, the Navy reported: "On June 4, 1942 . . . the entire air defense of Midway fell to Fighting (Squadron) 221 when the Japs came over just after dawn. The Squadron took off, 25 strong, mostly Brewsters . . . pitted against an enemy force of more than 100 bomber and fighter planes. A terrific melee of planes ensued when Fighting 221 met the Jap formations head-on. Within a 30-mile radius of Midway planes began falling in flames one after another into the sea. Fighting 221 broke up the Jap bombing attack so effectively that the vital Midway airfield was never out of commission. Known Jap losses were 43 planes by fighter action alone."

The Brewster Buffalos had been assembled at Newark but even before this job was completed Brewster had undertaken to build the outer panels for Consolidated Catalina Flying Boats. As Consolidated contracts expired, Brewster obtained new work of a similar nature for Army war craft.

Cessna Aircraft Company, Wichita, Kans., built three different models of airplanes as its contribution to the war effort. The AT-17 Bobcat was a two-engine Army bomber-pilot trainer used by the Army Air Forces. The Cessna Crane was a similar plane with equipment for sub-zero operations by the Royal Canadian Air Force. The Cessna Army personnel transport was a twin-engine model known as C-78. It was constructed largely of plywood and fabric around a welded steel tubing fuselage, and seated 5 persons.

Commonwealth Aircraft, Inc., formerly Rearwin Aircraft & Engines, Inc., Kansas City, Kans., was building instrument training planes, Model 8135T, as well as gliders. Due to the large amount of war contracts, production was reduced during the latter half of the

BREWSTER BUCCANEER DIVE BOMBERS
Awaiting flight tests prior to operations with U. S. Navy.

CESSNA CRANES

Bomber crew trainers with the Canadian air forces.

year on the Cloudster and Instrument Trainer models. The Rearwin Cloudster proved very popular on Civil Air Patrol, while the Rearwin Instrument Trainers were used extensively on Civilian Pilot Training programs and for air line pilot training. The company was in production on CG3-A nine-place training gliders. Commonwealth also had a large contract for CG4-A 15-place troop carrying gliders. In the engine department, hydraulic units for aircraft companies, glider tow releases, and various ordnance items were being manufactured. The factory floor space was increased from approximately 50,000 sq. ft. to approximately 450,000, or a gain of 900 per cent. The name of Rearwin Aircraft & Engines, Inc. was changed to Commonwealth Aircraft, Inc., January 8, 1943.

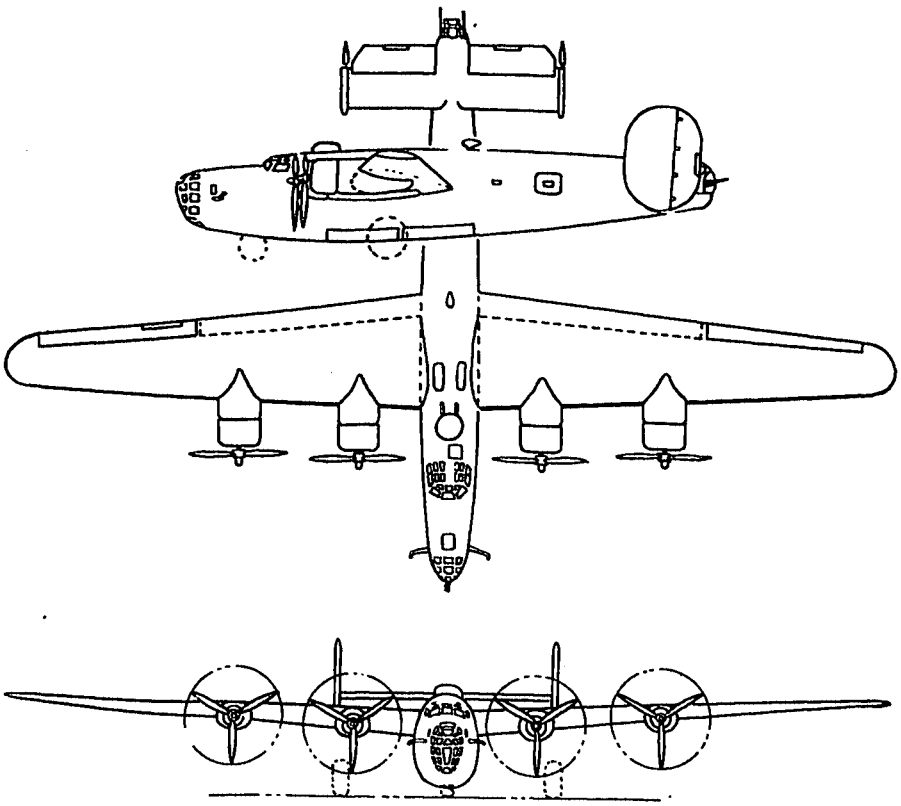
Consolidated Aircraft Corporation, San Diego, Calif., had a 200 per cent increase in production during 1942, and early in 1943 was producing the Consolidated Liberator, B-24D, the Consolidated Express, C-87, a cargo conversion of the long-range bomber, the Coronado, PB2Y-3, four-engine long-range patrol bomber, and the Catalina, PBY-5, utilizing plant facilities at San Diego and Fort Worth, Tex. The company also acquired the Nash-Kelvinator plant at New Orleans, La., for early production of an improved flying boat. In addition to these three plants, Consolidated established modification centers at Tucson, Ariz., and Elizabeth City, N. C.

The Fort Worth plant began actual production of the Liberator Express in April, 1942, 100 days ahead of schedule. The mechanized assembly line, proven at the San Diego plant, was installed. A system of production control similar to that pioneered by Vultee was put into effect at both the Fort Worth plant and at San Diego.

In the operations field, the company set up and operated a sched-

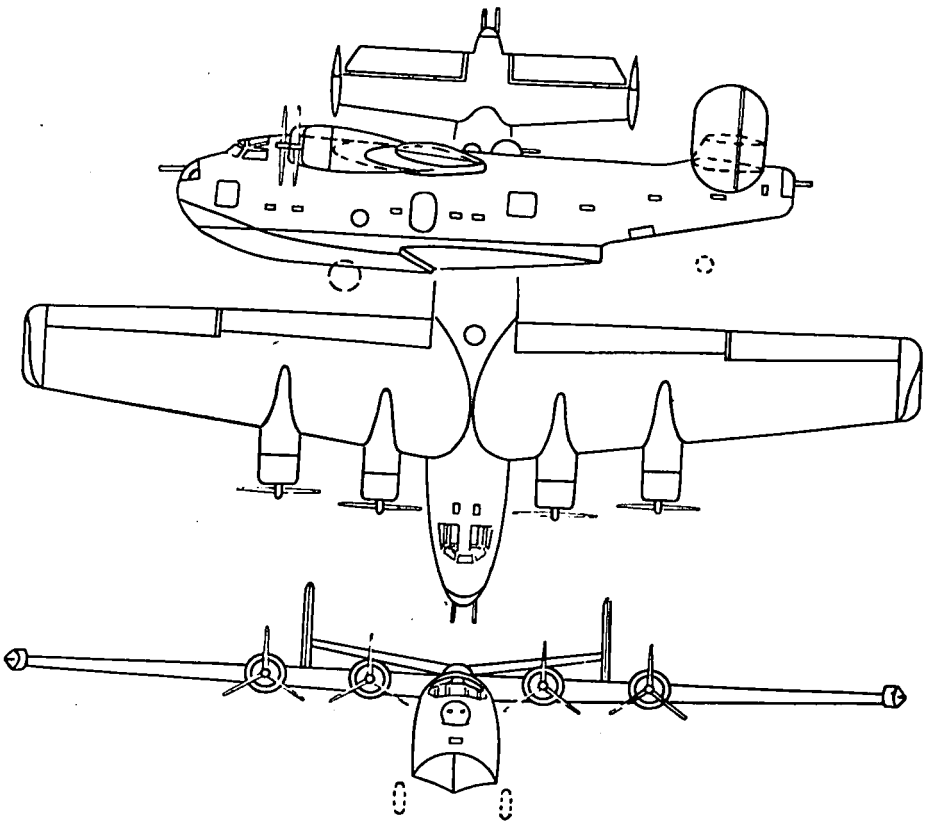
uled passenger and freight service between California and Australia. Another successful venture was the establishment of Camp Consair, and the lending of instructors and equipment for training Army Air Force mechanics for specialized maintenance of the Liberators. Three shifts at the camp trained several hundred men every 28 days.

Improved production methods were responsible for amazing gains in efficiency of manufacture. There was a 50 per cent manhour saving on the Liberator alone. Set up by the industrial engineering department, it not only standardized and streamlined manufacturing procedures but stepped up the employee suggestion system, developed cost improvement proposals and established a cost conversion bonus. Employee suggestions resulted in a net saving of 613,704 manhours from May 1, 1942, to January 1, 1943. Under the plan, 793 Consair employees received $4,669 in War Bonds or stamps and $22,603 in cash for their production ideas. Employees of both San Diego plants submitted 7,925 shop suggestions from employees. Of these, 793 received cash awards, 362 honorable mention, and 2,033 were pending.



CONSOLIDATED LIBERATOR

A long-range bomber powered by four Pratt & Whitney turbo-supercharged engines rated at 1,200 h.p. each. The Army Air Forces version is known as the B-24 while the Navy Air Forces designation is PB4Y1.



CONSOLIDATED CORONADO

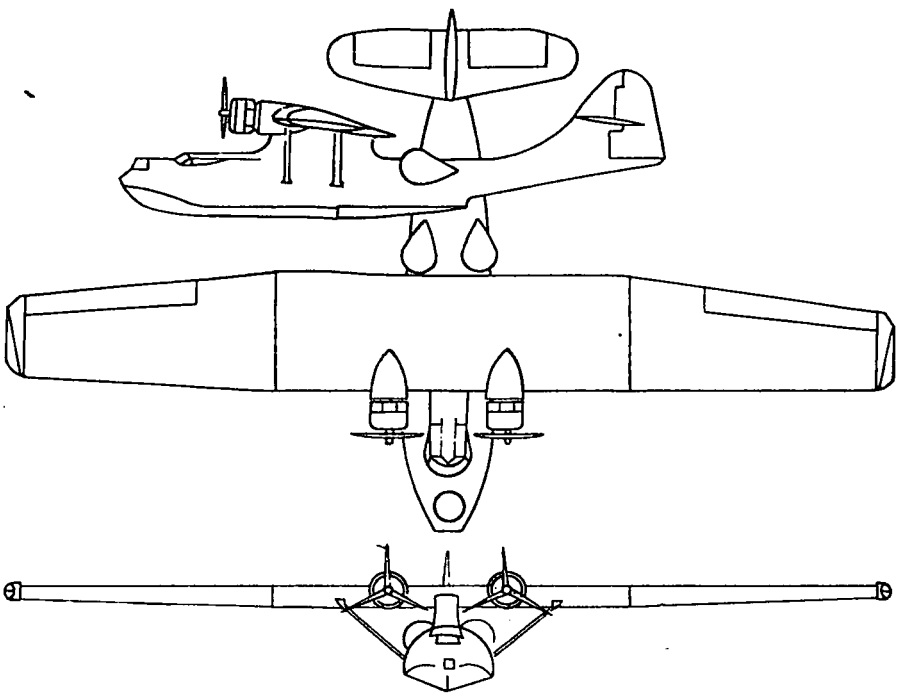
This Navy long-range patrol bomber, PB2Y-3, has four 1,200 h.p. Pratt & Whitney engines.

Huge manhour savings brought about by advanced production methods included: Combining of sections of skin-plating into larger sections of the Liberator nose section, 11,334 manhours; new motor mount lift tool for installing Liberator engines, 10,507 manhours; specially designed jigs for assembly of pilot's enclosure, Liberator, 15,930 manhours, and a drill and assembly fixture for upper nacelle fairing for the Liberator, 15,930 manhours. Cost improvement proposals, in which assistant foremen and those above participated, resulted in an indicated saving of 2,169,621 manhours. Approved proposals yet to be installed would add 1,523,874 manhours.

Savings effected were: Use of straight line production unit on a sound-proof panel operation, 72,000 manhours; substitution of vinylite tubing for friction tape as insulation on heavy cables, 15,950 manhours; re-arrangement of material handling for Liberator wing details, 13,485 manhours; subassembly for Catalina nacelle instead of piece-by-piece assembly, 12,000 manhours; subassembly of skin

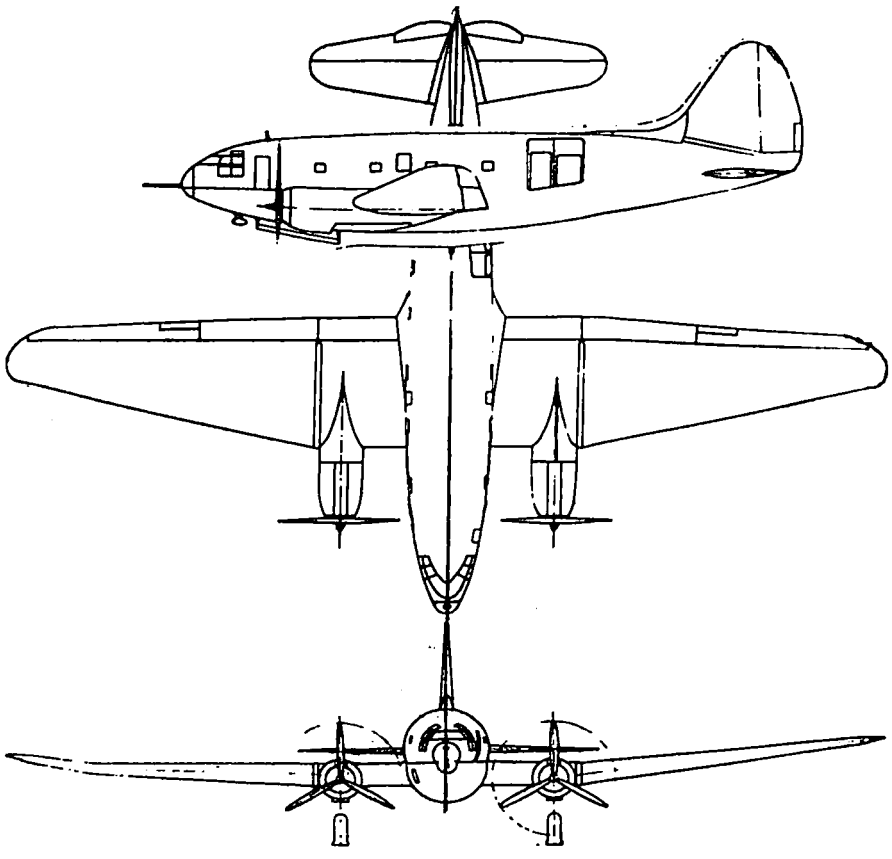
stringers and armament details on the Catalina center wing section, 75,000 manhours; use of Kennametal and Firthite-tipped turret tools, 17,020 manhours; pre-drilling and riveting of skin-slugs in subassembly fixture, 105,876 manhours; roller conveyors to handle platens on hydro presses, 28,800 manhours; subassembly method of station 6 to station 13 on the Liberator wing, 540,000 manhours; fixture to level Coronado wing while spot-facing and drilling forgings, 44,000 manhours; installation of automatic control valves for cooling system for anodizing tanks, 19,200 manhours; elimination of masking cables on Liberator, 13,600 manhours and on Catalina, 7,700 manhours; change in method of assembly of Catalina wing, 24,000 manhours, and changing hand-forming of 46 parts to machine stretched forming, 14,420 manhours.

Both the employee suggestion system and cost improvement proposal revealed the definite trend from job shop methods to complete mechanization. Employees, foremen and executives were made cost conscious through considerable plant publicity, and by awarding bonuses. The cost conversion bonus allowed assistant foremen and above to share in advances in efficiency within their departments on a month-to-month basis.



CONSOLIDATED CATALINA

This long-range patrol bomber is powered by two Pratt & Whitney engines rated at 1,200 h.p. each. As a flying boat it is known as the PBY5, while the amphibion is designated PBY5A.



CURTISS COMMANDO

The C-46 cargo transport.

The mechanized assembly line for the Liberator having proved itself, Consolidated engineers worked on the mechanization of the Catalina and Coronado assembly lines, and these were put into operation early in 1943. The assembly line in the Fort Worth plant was believed to be the longest in the world.

Pre-factory training for male workers in the mechanical category was virtually at a stand-still because individual operations were simplified and new employees were trained on the job. Women, however, were given pre-factory training. The percentage of women employed rose from less than one per cent to more than 38 per cent in 1942, and the percentage showed a steady increase early in 1943.

Extensive strides were made in training draftsmen, engineers and other highly skilled employees. More than 1,200 men and women were receiving instruction in college level subjects. Upgrading courses not only gave employees added incentive but helped to fill those holes in the ranks of skilled personnel brought about by the draft.

During the year the company was awarded the Army-Navy E for production excellence, the United States Treasury Minute Man flag for more than 90 per cent employee participation in payroll War Bond buying, and its Foremen's Club was selected as best in the nation by the National Association of Foremen.

While producing "the planes of today," the company was preparing for "planes of tomorrow." Test flights had been made with a heavier bomber of new design and superior performance. Looking into the future, there was in mock-up a radically new plane, both bomber and transport. On March 17, 1943, Consolidated and Vultee merged into one corporation as Consolidated Vultee Aircraft Corporation, with headquarters at San Diego, Calif.

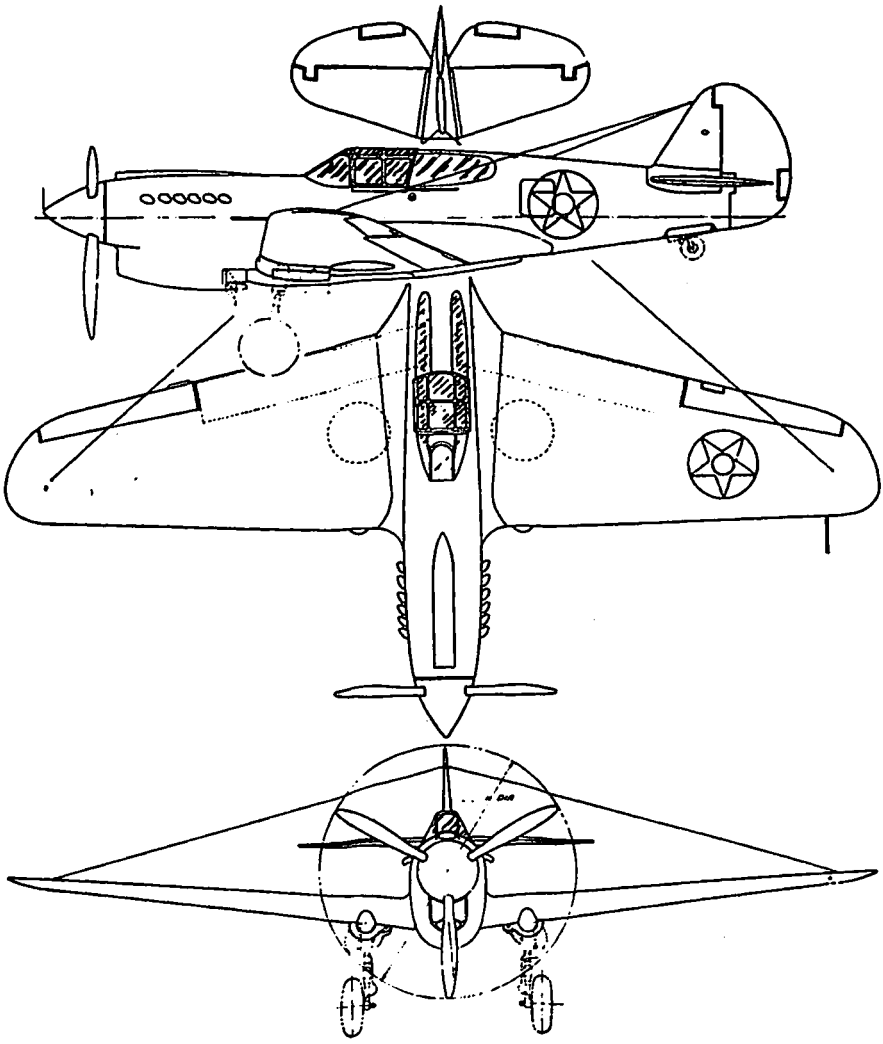
Culver Aircraft Corporation, Wichita, Kans., ceased building commercial models early in 1942, and devoted all facilities to secret work for the Army Air Forces.

Curtiss-Wright Corporation, Airplane Division, Buffalo, N. Y., with additional plants at Columbus, O., St. Louis, Mo., and another in Kentucky, was in production on combat and transport planes for the Army and Navy air services and Allied air forces. Having doubled its plant property in 1941, the Airplane Division was requested by the Army and Navy to increase its manufacturing facilities for 1942 by over 100 per cent. Notwithstanding the fact that this new construction was added to existing plants, the actual production of airplanes for the year 1942 increased over 300 per cent.

Concurrent with the increase in production and plant area was the problem of adding additional personnel to keep pace with production. Consequently, the total employment for the plants of the Airplane Division was more than doubled. In addition to the obvious problem of hiring new personnel, it was necessary to exceed the projected requirements because of the loss of employees to various branches of

CURTISS SO3C-1 SEAGULL

U. S. Navy scout observation for operations with the Fleet.



CURTISS KITTYHAWK

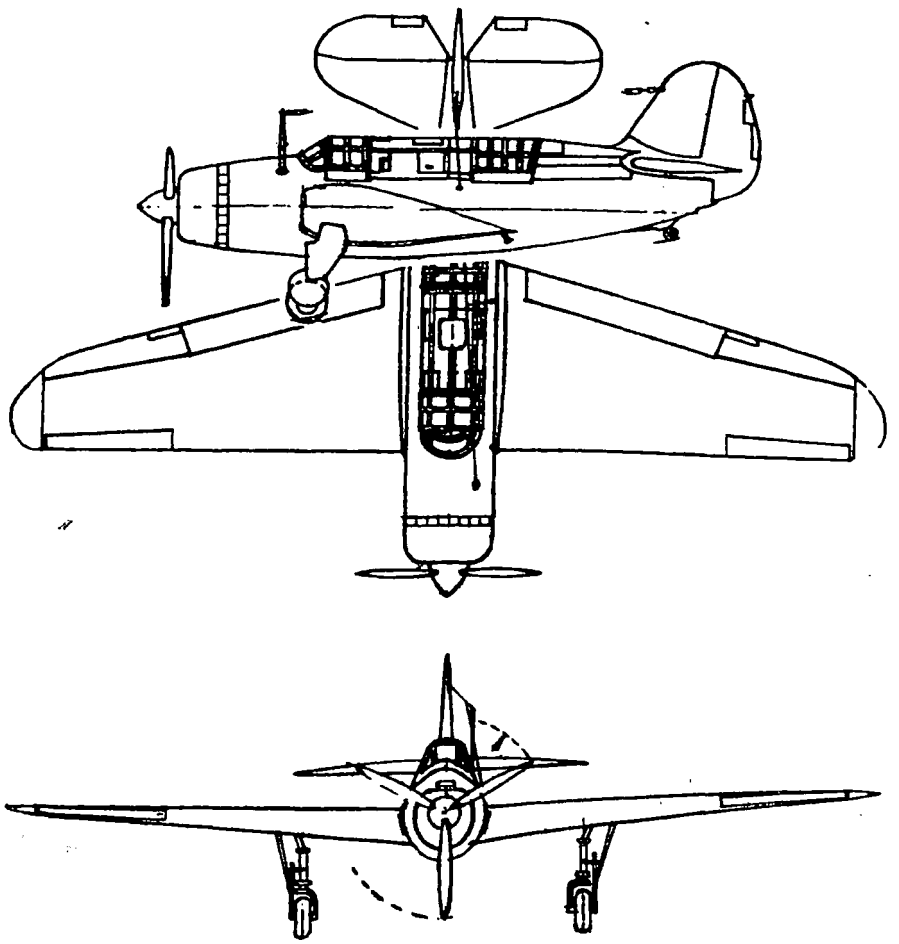
The P-40E, an Army Air Forces fighter, is powered by an 1,150 h.p. Allison engine.

the armed forces, which exceeded 9,000 employees in 1942. The facilities for training new employees were increased considerably and as a result separate training schools, situated away from the factories, were instituted. Of the trainees at these schools early in 1943, 99 per cent were women. About 50 per cent of the total number of employees were women by the end of the year. In addition to training schools organized for new employees, the Airplane Division had facilities for training of men for more responsible positions—foremanship classes, foreman's group meetings, service department, subcontractor, inspection, personnel counsellor and engineering training.

The Airplane Division of Curtiss-Wright Company was training over 500 service mechanics for the Army Air Forces at its Buffalo plant and contemplated similar schools at other plants.

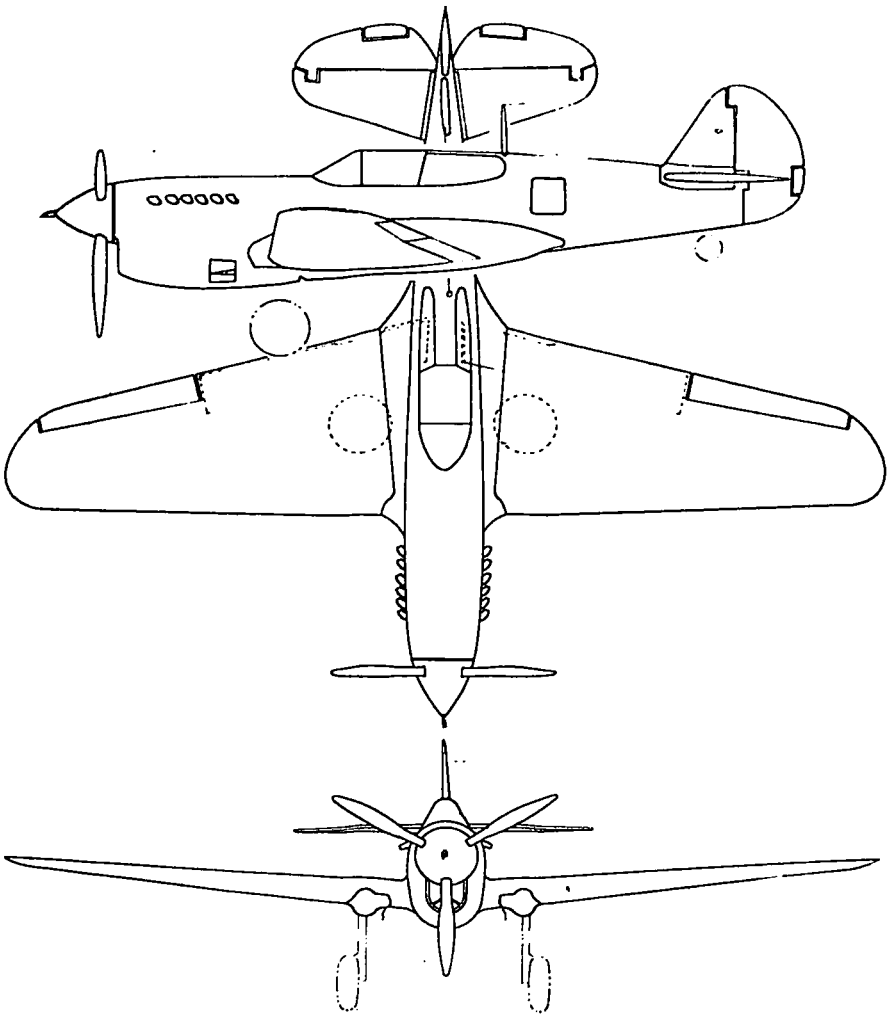
A new program designed for training and securing women college students as engineering assistants was announced. These Curtiss Cadettes were to be chosen from undergraduate classes of coeducational and women's colleges. At the expense of the company they were to be assigned to one of eight technical universities for a course of 10 months. Upon their successful completion of the course, they were to be employed by the Engineering Department.

A considerable portion of the total number of airplane units was awarded to subcontractors, many of whom had no previous experience in the airplane business. It was necessary to educate these firms more intimately in the business of making parts. Many of the



CURTISS HELLDIVER

A Navy dive bomber, designated as the SB2C-1.



CURTISS WARHAWK

The P-40F, powered by a Packard Rolls Royce Merlin engine, is an Army Air Forces fighter.

best mechanics of the Airplane Division either were loaned to these companies or actually went to work at the various subcontractors' plants in the capacity of lead men or subcontract expediters.

Following is a list of airplanes manufactured by the Airplane Division of the Curtiss-Wright Corporation: The Curtiss P-40 E, Kittyhawk, a low-wing monoplane, was a single-seat Army Air Forces fighter equipped with a 12-cyl., liquid-cooled Allison engine driving a Curtiss three-blade, constant speed propeller electrically controlled and full feathered; the P-40 F, Warhawk, was similar to the P-40 E with the exception of a few modifications, the most important of which

was the installation of a liquid-cooled Packard Rolls-Royce Merlin engine; the Curtiss Army Commando, C-46, twin-engine cargo transport designed to carry paratroops, light artillery and freight, powered by two 2,000 h.p. twin-row Pratt and Whitney engines, equipped with Hamilton Standard constant speed propellers; the Curtiss Army Caravan C-76, made almost exclusively of wood—plywood, laminates and plain lumber—a high-wing monoplane with conventional two spar box-type wings, powered by two 1,200 h.p. Pratt and Whitney engines; the Curtiss Navy Seagull, SO3C-1, a naval scout observation plane operating from land bases, destroyers and cruisers, powered by a 520 h.p. 12-cyl. V-type aircooled engine driving a two-blade constant speed propeller; the Curtiss Navy Helldiver, SB2C-1, a two-place, midwing monoplane dive bomber, powered by a Wright Cyclone 14-cyl. radial engine with a Curtiss constant speed full feathering propeller; the Curtiss Army A-25, Helldiver, the same airplane as the Navy SB2C-1; the Curtiss Army, AT-9, known as the "Jeep", a twin-engine, low-wing monoplane designed to help pilots in training bridge the gap between single-engine and multi-engine equipment before taking over the operation of bombers and other heavy types; the Curtiss Navy SNC-1, Falcon, a two-seat, low-wing advanced combat training monoplane, powered by a 450 h.p. 9-cyl. Wright Whirlwind engine.

Douglas Aircraft Company, Inc., Santa Monica, Calif. was in

DOUGLAS BOMBERS FOR BRITAIN

One of the famous DB-7B attack bombers which is making history with the R.A.F. on many fronts. At home in England the R.A.F. used it as a night fighter.

accelerated production on the deadly bombers and sturdy cargo craft which it had designed and produced in quantities before the American entry into the war. Every plane Douglas had on its production lines in 1941 became an essential war machine in 1942. The company claimed that its production for the year totaled one-sixth of the American output, by structural weight. To accomplish this production miracle, Douglas not only realized one of the greatest plant expansions in industrial history, but at the same time it trained thousands of men required to direct operations in these new plants without interrupting greatly accelerated production with existing facilities. The result was a vast production capacity realized in a matter of months despite the problems accompanying an unprecedented upswing in employment.

The planes that demanded the construction of four new superplants in America and others abroad, as well as vast expansion in existing plants, comprised many of the elements in a well-balanced air force. They included dive bombers, torpedo planes, swift attack bombers which served at the same time as fighters, interceptors, intruders and pursuit ships; and three types of cargo planes and troop transports, all capable of meeting the global requirements of this war.

In addition, because of company experience in big plane production, Douglas was commissioned to build an important share of the huge Boeing Flying Fortress and Consolidated Liberator four-motored bombers, making it, with its own Skymaster transport, the only company in America producing three of the Army's four-motored craft.

The Douglas planes which were ready for action at the time of Pearl Harbor were the SBD and A-24 Dauntless dive bombers; the TBD Devastator torpedo bomber; the A-20 attack bomber and night fighter, (Havoc for the Army and Navy and Boston for Lend-Lease); the C-47 Skytrain and the C-53 Skytrooper. The C-54 Skymaster combat-transport rolled off the assembly lines in February, 1942. Each Douglas model played a major role in the successful effort to stop the advance of the Axis and gain breathing space for the United Nations to win superiority in ships, planes, guns and motorized equipment.

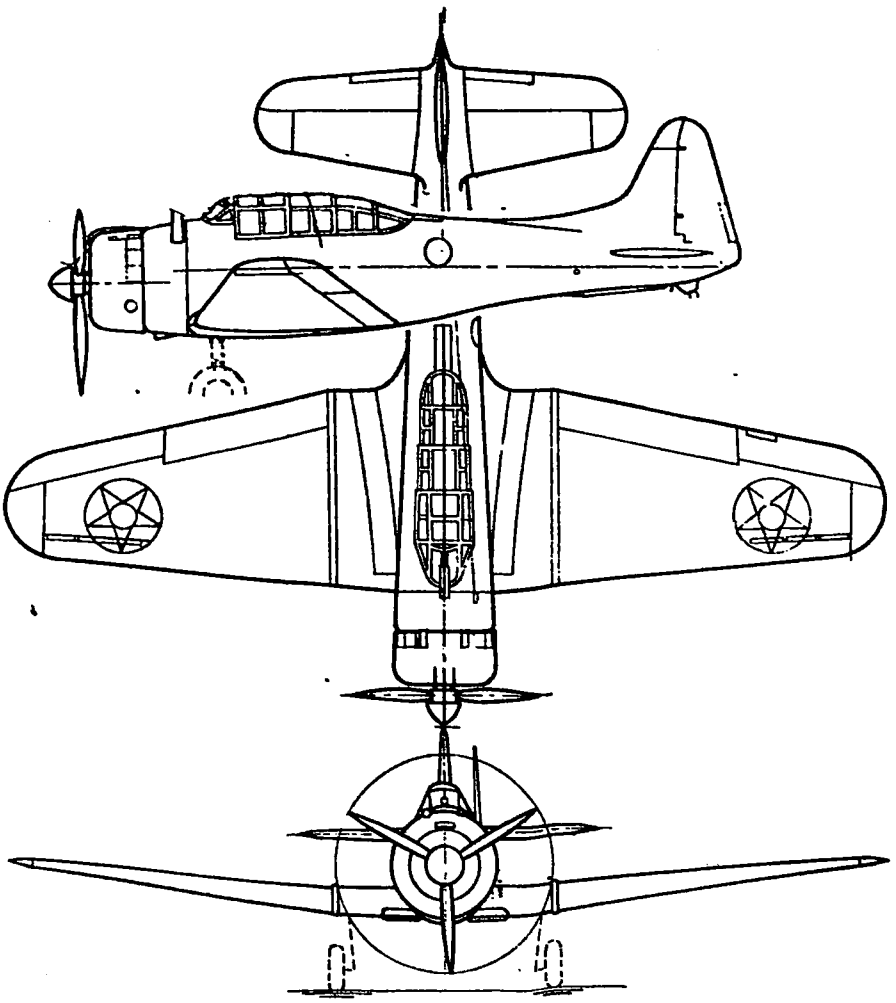
Up to and through Midway, Douglas Dauntlesses helped hold the Japanese Navy at bay in the Pacific while the Fleet recovered from the devastating effect of the sneak attack on Pearl Harbor. In a surprise raid on Salamaua and Lae on March 10, 1942, Douglas dive bombers and torpedo planes destroyed 14 Japanese naval vessels with a loss of only one plane, while on April 4, 1942, they annihilated a fleet of 12 Japanese naval vessels in Tulagi without loss.

SBDs and TBDs were the Navy's offensive weapons in the battle of the Coral Sea, where they put the entire Jap fleet to flight after sinking a carrier, Ryakaku, in five minutes, a heavy cruiser in four

minutes, and knocking out of action, and probably destroying, a second carrier.

At Midway, this same combination of Douglas carrier-based Navy planes destroyed the flight decks of four Japanese carriers, leaving them at the mercy of level-flying bombers, and also scored heavy bomb hits on two battleships, two heavy cruisers, three light cruisers and two destroyers. SBDs participated in the occupation of Guadalcanal; and, piloted by Marine or Navy fliers, they harassed the enemy daily—raiding Jap-held bases or shipping.

During the American air-naval victory of October 25, 1942, in which 50 Japanese war vessels were scattered and forced to retire, Marine Corps SBDs scored direct hits on two enemy heavy cruisers, while Navy SBDs crashed their bombs on two aircraft carriers, one



DOUGLAS SBD-3 and A-24

The SBD-3 is the Navy version and the A-24 is for the Army Air Forces.

battleship and three heavy cruisers, as well as four 10,000-ton transports which sank with some 20,000 men aboard. According to Rear Admiral J. S. McCain, chief of the Navy Bureau of Aeronautics, SBDs "have alone sunk more combattant tonnage than all other arms."

The Douglas DB-7 attack bomber saw service with the R.A.F. for more than two years before Pearl Harbor, during which time it was credited with having forced the Germans to move their airfields in occupied France and Belgium some 40 miles back from the coast, giving the British time to get their interceptor squadrons into the air against approaching German bombers.

According to Air Vice Marshal A. V. M. Dawson, commanding United Nation's air forces in Egypt, it was the Douglas Bostons that permitted the retreating British finally to make a successful stand at El Alamein, whence General Montgomery launched his victorious drive and conquered Axis-held Libya. Gen. Arnold, in his statement on performance of American aircraft in combat, called the Boston "one of the war's most striking examples of versatility and all-round efficiency", and credited two South African DB-7 squadrons with 1,500 sorties over the Libyan front between May 23 and July 9, with their first loss by enemy aircraft occurring only on July 7. Under the designation of A-20, the Douglas bomber was chosen to make the initial American raid against the European continent, which was carried out on July 4, 1942. The A-20 next went into service against the Japs in New Guinea, and later accompanied the American occupational forces when they landed in North Africa.

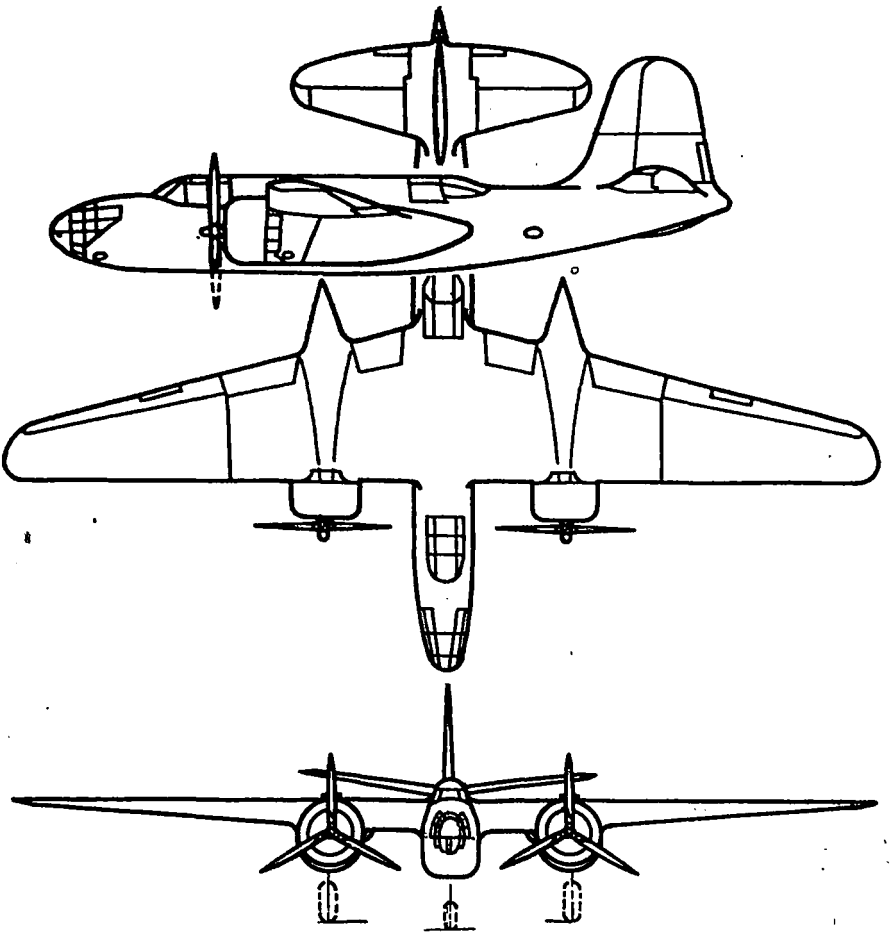
On all fronts, its task was low-level bombing and strafing of enemy troops, installations, munition dumps, oil tanks and railroad trains, at which it was eminently successful because of its tremendous speed at tree-top level and its capabilities as a fighter.

Douglas transports and cargo planes were no less important to the war effort. Accelerated production of the C-47s and C-53s permitted rapid expansion of the Air Transport Command and the Troop Carrier Command, so that before the end of 1942 cargoes of strategic materials were being rushed from the home front to all battle lines. But in addition to such essential work, these planes were doing such service as carrying paratroopers into action, thousands at a time, and rushing hundreds of wounded from isolated sectors to base hospitals for emergency operations. The outstanding paratrooper action of 1942 was that in which 44 Douglas C-47 Skytrains made a 1,500 mile non-stop flight from England to Tunis, and discharged their paratroops without accident. The Skytrains were credited with having been the sole service of supply for one important beleaguered American garrison over a period of many weeks, permitting it to win a great strategic action.

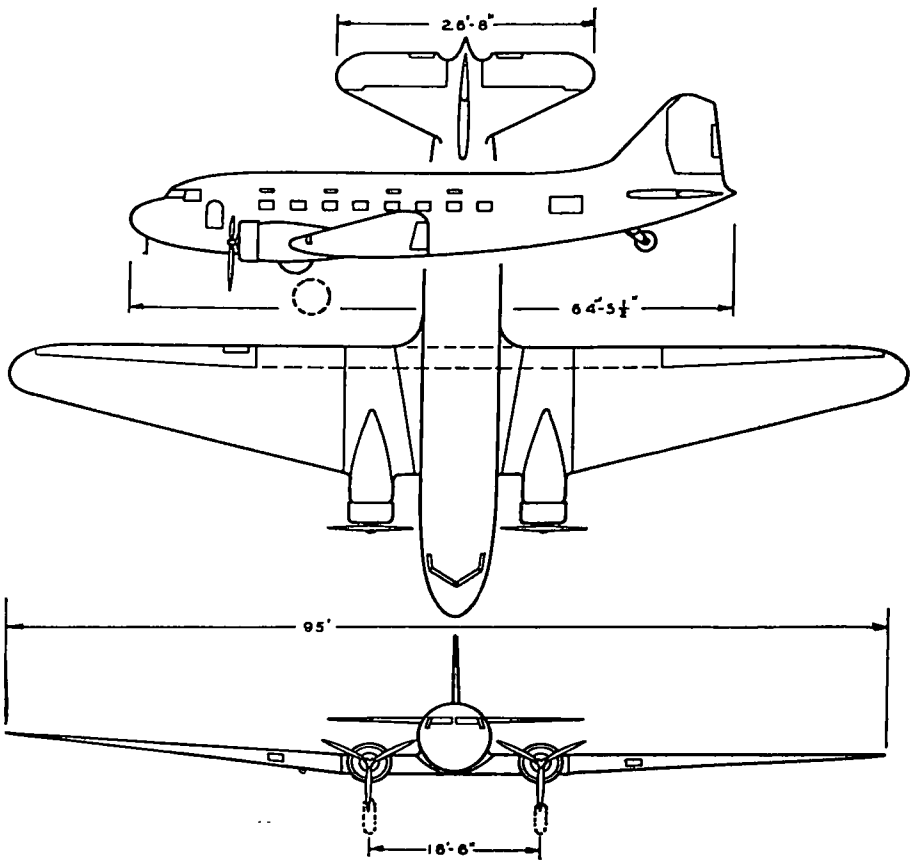
The Douglas C-54 Skymaster, which was on the assembly line at

the time of our entry into the war, was tested, proved and placed in quantity production during 1942. During 1943 one of the great new Government-built plants was to be devoted exclusively to its construction.

While Douglas production during the year was limited to the above-mentioned craft, unprecedented progress in aviation necessitated constant changes in models to permit them to retain their superiority. The A-20, Havoc, for example, went into its fifth series with perhaps as many as 1,000 improvements having been introduced since it first started from the production line. The Skymaster was improved steadily without interference in production. Both the C-47 and C-53, which as the commercial DC-3 had flown a total of nearly 300,000,000 air miles on domestic air lines, and covered a daily average of 17 times around the globe in foreign service, had numerous improvements incorporated in their design.



DOUGLAS DB-7B—BOSTON



DOUGLAS DAY-SLEEPER TRANSPORT

Available either as a 21-passenger day plane (DC-3) or a 14-place sleeper (DS-T) these planes are powered by two Pratt & Whitney Twin Wasp or Wright Cyclone engines.

To bring into effective play the full skill and ability of its present personnel, and to train and properly absorb the many thousands of men and women who joined the production army, Douglas, according to a company statement, during the year expanded and developed its technique of "human engineering." The year 1942 saw the development and introduction of advanced phases of industrial relations. During the first full year of wartime operation, Douglas pioneered the use of rest periods for shop employees during all shifts, adopted the use of industrial music both inside and outside its plants; inaugurated entertainment programs for lunch hours; started its own blood bank in cooperation with the Red Cross; launched a War Bond drive and set up a payroll savings plan for purchase by employees; expanded its material conservation program and extended training and industrial safety programs to meet the needs of new employees.

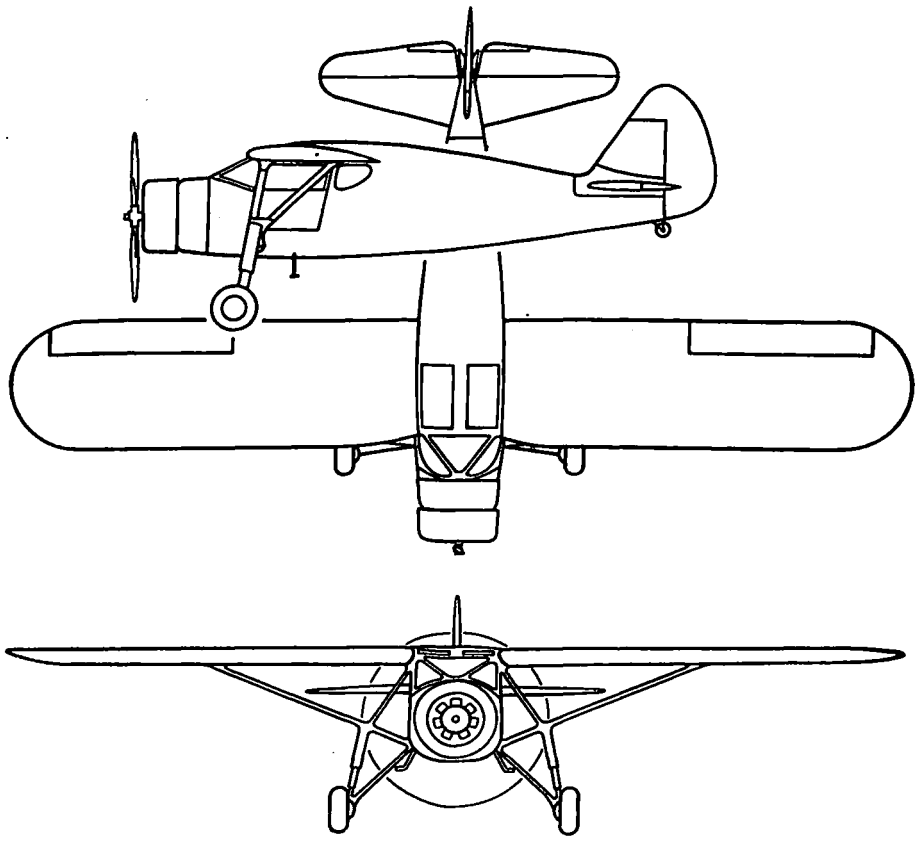
Douglas employee-management committees and their subcommittees, in which management and employees were equally represented, comprised more than 300 members in the company's California plants alone. They embarked upon a program designed both to spur production and heighten morale, and met with great success at both. Among their important projects was the expansion of the employee shop suggestion system, involving substantial cash prizes for production shortcuts. Thousands of these were received every month. Another important project was a War Bond mobilization, sponsored by these committees, which evoked such spirit and such enthusiasm in the organization that the statistics for Bond purchases by Douglas employees soared amazingly, and a number of Douglas plants were presented with Treasury flags.

Engineering and Research Corporation, Riverdale, Md., completed development work on a new model Ercoupe, 415-CA, which was practically the same as the 415-C with the exception of substitution of resinous bonded plywood for most of the sheet aluminum construction in the original model. Priority restrictions caused suspension of all Ercoupe production for the present.

Fairchild Aircraft Division of Fairchild Engine and Airplane Corporation, Hagerstown, Md., increased its personnel by 120 per cent and manufacturing space 206 per cent over 1941. Faced with the immediate and urgent need for vastly expanded facilities, Fairchild used many scattered buildings throughout the city of Hagerstown which were vacated or partially emptied by inactivity in normal business. The exhibition hall of the local fairground, several garages, warehouses, furniture factories and toy factories were representative of the types of buildings kept in operation by the Fairchild plan. Although a large addition was made to the plant situated on the Hagerstown Airport, in which wings for Martin Navy patrol bombers were manufactured, it was necessary to subcontract many of the subassemblies of the various Fairchild models. Virtually the entire facilities of a Hagerstown organ manufacturer, rendered idle during the war, were engaged in the construction of all wing surfaces for the Fairchild PT-19A and PT-26. Thus the war recession of some businesses in the city was balanced by the tremendous increase in primary trainer production.

Fairchild, in anticipating the manpower shortage, trained women to replace men called into the services. At the end of 1942, about 17 per cent of the workers in the industry were women, but at Fairchild the women employees numbered over 30 per cent of the total.

A branch factory was built in Burlington, N. C., to manufacture Fairchild's newly-designed advance twin-engine trainer. This airplane, built by the Duramold process of thin veneers molded into plywood shells for the covering sections, and with wood fuselage and wing frames, was designated the AT-14 by the Army Air Forces. It



FAIRCHILD FORWARDER

A Warner-powered utility cargo plane or personnel transport.

was powered by two Ranger inverted Vee engines of 520 h.p. each and had a stated cruising speed of about 200 m.p.h. The only aluminum used was in the engine nacelles, instrument panels, etc., and the only steel was in the landing gear, engine mounts, compression members, trusses and fittings. The first prototype of this radically new design, powered by two radial engines and designated the AT-13, was delivered in the fall of 1942, and initial test flights of the AT-14 were completed by the end of the year.

The Fairchild PT-19 was improved further by the installation of the 200 h.p. Ranger engine, cockpit enclosure and night and blind flying equipment, and designated the PT-26. It was manufactured for the Canadian air forces both at Fairchild's Hagerstown plants and in Canada by Fleet Aircraft, Ltd., under Fairchild license. Another variation of the PT-19 was designed around the Continental radial 220 h.p. engine and designated the PT-23. The PT-19 and PT-23 were started in manufacture under Fairchild license by four other aircraft manufacturers under prime contracts with the Army Air Forces.

Fairchild's commercial Model F-24, powered by a 165 h.p. Warner radial engine, was produced in quantity for the Royal Air Force and with slight revisions for our own air forces where it was designated the C-61A. It was used as a personnel and light cargo airplane, and saw service overseas.

Arrangements were completed with the Brazilian Aeronautical Commission to manufacture the PT-19 in Brazil as the standard trainer for the Brazilian Air Force. Forty-five PT-19 trainers and F-24 light cargo airplanes were flown from Hagerstown to Brazil.

A huge cargo airplane was in the mock-up stage at one of the Fairchild plants. Of radical design and construction, this new twin-engine cargo ship was designed to carry tanks, guns and troops at high speed over a 3,500 mile range.

Fleetwings, Inc., Bristol, Pa., swung into production with the first stainless-steel military airplane ever built—the basic training plane BT-12 ordered by the Army Air Forces. Trim and fast, the BT-12, with a wing span of 40 ft., and 29 ft. in length, was powered by a 450 h.p. Pratt and Whitney engine.

As for parts production, which continued to be the major portion of Fleetwings expanding activity, a number of the Army's and Navy's outstanding fighter and bomber planes rode into battle with parts, principally control surfaces of both aluminum alloy and stainless steel, manufactured in the two Fleetwings plants at Bristol. Extension of the straight-line flow mobile production system for manufacturing airplane surfaces, introduced into the aircraft industry at Fleetwings, also was accomplished in 1942.

THE FAIRCHILD PT-26

The Canadian version of the Fairchild PT-19 standard Army elementary trainer.

A giant conveyor system was installed, a system that slashed many manhours off the time previously required for applying primer coats to aircraft surfaces and drying the parts. Not only did the conveyor network save time and improve quality; it greatly relieved demand for floor space by utilizing the ceiling area, previously unused.

Extensive training programs also were sponsored. Married women were admitted to the Fleetwings sheet metal school for the first time, and enrollment was increased. A straight hourly rate was paid to students.

Women, for the first time, were added to the Engineering roster, and Fleetwings began training draftswomen at a Philadelphia vocational school. Fleetwings also intensified its training program by adding job instructor training to its program for foremen, leadmen, and other supervisors. An engineering, science and management course was started. Fleetwings also had a course for Army Air Service Command mechanics, instructing the men on how to repair and handle stainless steel aircraft structures. Additional courses in advanced layout work were held for the purpose of upgrading personnel.

The time-and-money-saving results of the Fleetwings "flying squad" of special assignments men piled up to a very impressive total. Literally scores of small, special tools were invented by the specialists —tools that brought about higher quality and faster production, including a rivet bucking yoke, used for riveting in inaccessible places, enabling one man instead of two to do the entire job faster, with rivets automatically lined up; a crimping roll, simple and light in weight, to bevel or crimp aircraft skin with one sweeping manual motion; a bearing regreaser for regreasing control-surface bearings packed with excessively heavy grease; and a pneumatic punch press for punching inspection holes in nose boxes for aluminum-alloy control surfaces—300 per cent faster than previous methods.

One of the more spectacular hydraulic valves developed at Fleetwings was a new gun-turret valve for operating a machine-gun turret, at a variable speed.

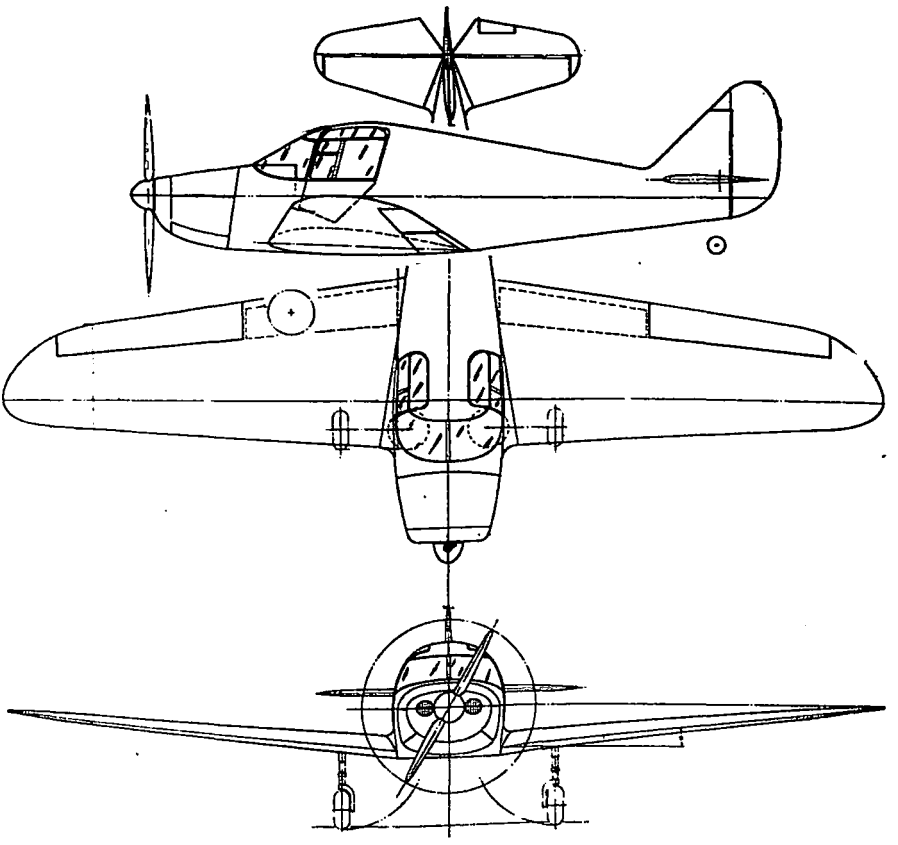
G & A Aircraft, Inc., Willow Grove, Pa., changed its name in August, 1942, from AGA Aviation Corporation, which in turn was an outgrowth of the Pitcairn Autogiro Company. Personnel was increased in excess of double the amount employed at the beginning of the year. Subcontracting commitments also resulted in the establishment of three other production centers. Designs were laid down and autogiro models produced in 1942 for the air services. More efficient and improved designs supplanted the PA-36 which was the last model about which information could be released. The company manufactured other types of aircraft, including a number of CG-4A troop carrying gliders.

General Aircraft Corporation, Astoria, N. Y., was engaged in subcontracting work and completed major assemblies of research and

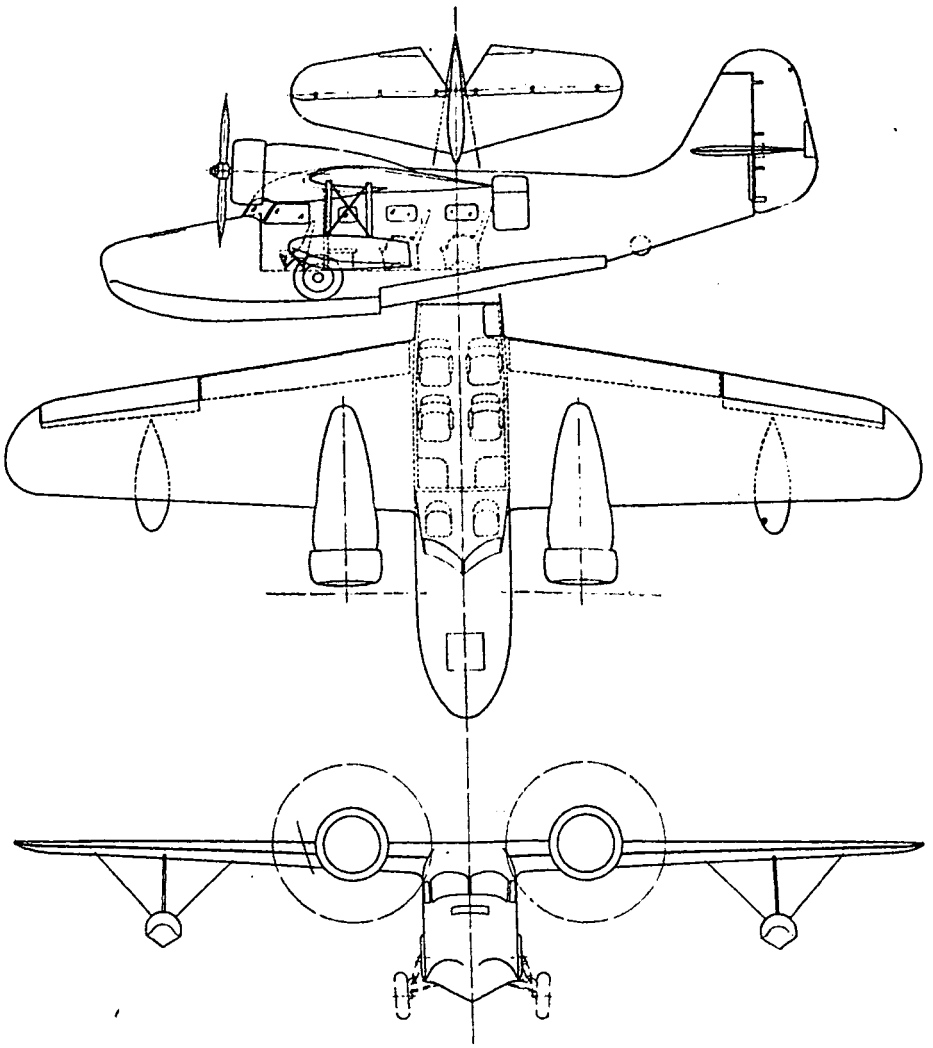
experimental projects which were related to the war effort during the first part of 1942. In February it undertook a substantial prime contract with the United States Army Air Forces for the manufacture of CG-4A cargo gliders, and has been wholly engaged in that work since that time. In April the factory and offices of the General Aircraft Corporation were moved to Astoria from Lowell, Mass., where the company had been located since its organization in May, 1940. The initial job of tooling and of readying the plant for production was completed and the first of the gliders was delivered to the Air Forces in September, 1942. A steadily increasing rate of production was maintained and a large number of gliders was completed. In view of this record of progress the company's contracts were increased substantially. Over 50 per cent of the actual manufacturing was done by subcontractors.

Globe Aircraft Corporation, Fort Worth, Tex., produced the Swift GC-1, a two-place plane with a span of 29 ft., length 18 ft. 11 in., gross weight 1,459 lbs., useful load 518 lbs., maximum speed 140 m.p.h. and cruising range 600 mi.

The Grumman Aircraft Engineering Corporation, Bethpage,



GLOBE SWIFT



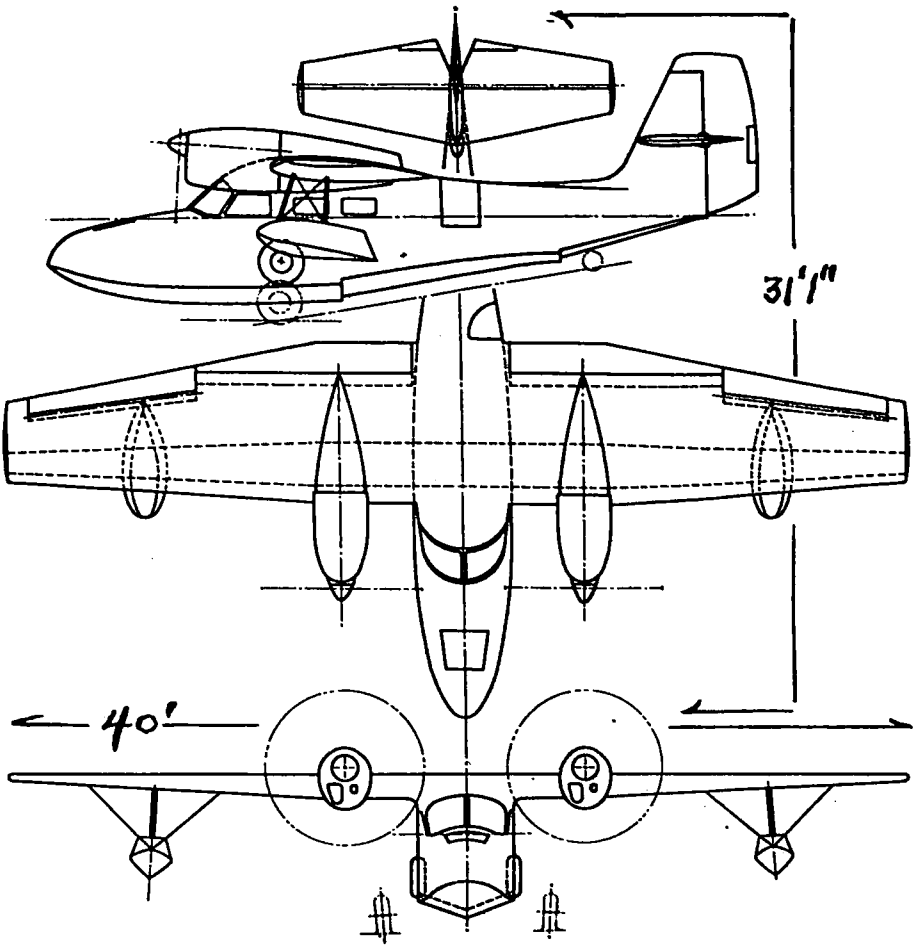
GRUMMAN GREY GOOSE

The JRF-5 and JRF-6B. An eight-place utility amphibion and navigational trainer for the Navy Air Forces and Fleet Air Arm powered by two Pratt & Whitney Wasp Junior 400 h.p. engines.

N. Y., tripled its floor space in 1942. Production in 1942 was three times greater than the total for the previous 12 years of the company's history. A dispersal plant system was established. Under this plan existing floor space in the form of idle garages and factories was leased. Into the newly acquired space, departments from the main plants were moved with less than a day's interruption, and a transportation network was established for the inter-plant flow of parts and materials. The result was increased room in the main plants for assembly work. Two main benefits of this plan were the saving of

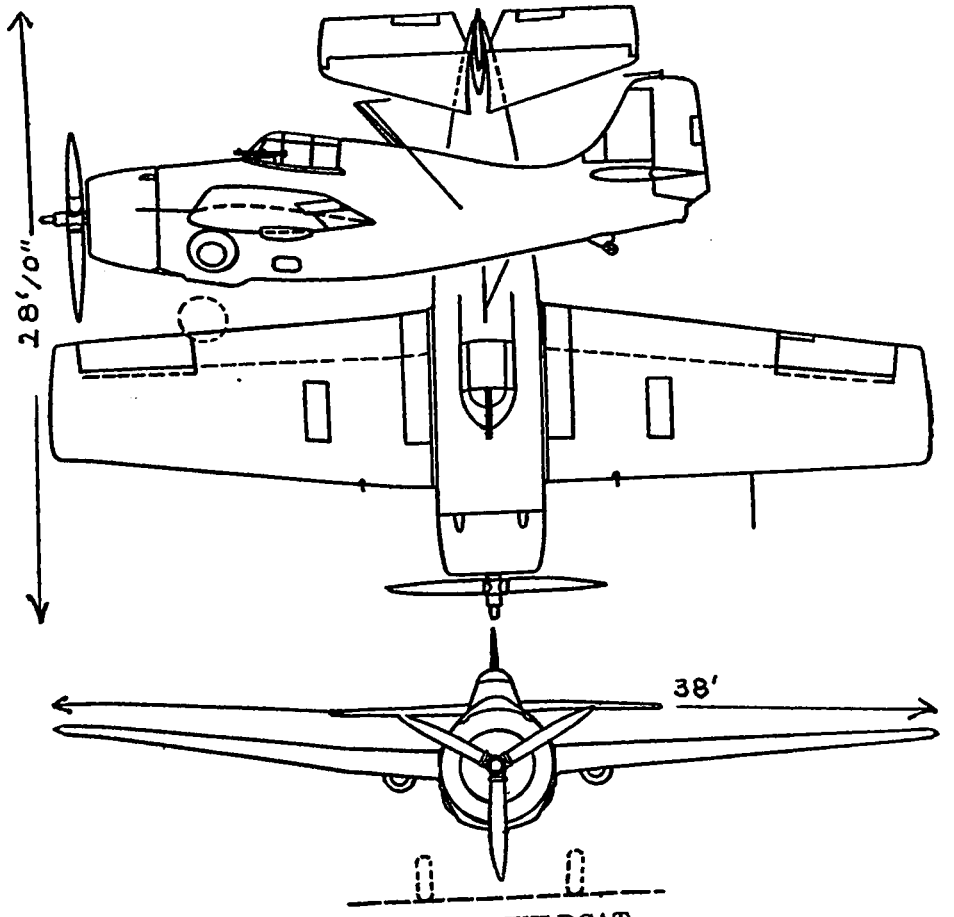
time necessary for new construction and the conservation of critical material that would have had to be used.

A new model, the Grumman Avenger, TBF-1, a torpedo-bomber, was produced early in 1942, but was not announced to the public until it had surprised the Japanese fleet in the Battle of Midway. Declared by the Navy to be responsible for a large part of the success of this battle, the Avenger increased its reputation in even more spectacular victories in other theatres of war. The Avenger carried a full size torpedo completely enclosed in the fuselage. Unusual design features included the unique Grumman folding wing. This wing folded back parallel to the fuselage, and increased by 50 per cent the number of torpedo bombers in an aircraft carrier's complement. Hailed by many experts as the "deadliest torpedo bomber in the world," the Avenger established an outstanding record of performance



THE GRUMMAN WIDGEON

A five-place amphibion for the U. S. Coast Guard and U. S. Navy.



GRUMMAN WILDCAT
A one-place fighter.

in combat. The record of one United States Naval torpedo squadron from the beginning of the Solomon Islands campaign until November 15, 1942, was 14 enemy vessels sunk with the loss of only one Avenger. It also was used with great success as a horizontal bomber and ground strafer by the U. S. Marine Corps, particularly at Guadalcanal.

Grumman production increased over 450 per cent on the Wildcat F4F-4, standard fighter of the U. S. Navy and Marine Corps, and the Martlet, British version of the same plane and the standard fighter of the British Fleet Air Arm. In war combat in Malta, North Africa, the Solomon Islands, the Gilbert Islands, Midway and Wake, the Wildcat established itself as one of the best ship board fighters in action, and repeatedly demonstrated its superiority over the enemy's latest land based fighters and bombers.

Production of utility amphibions for the armed forces continued

The J2F-5 was produced as a three-place utility amphibion and photographic plane for the U. S. Navy. The Grey Goose, JRF-5 and JRF-6B, an eight place utility amphibion and navigational trainer, was built for the U. S. Navy and for the British Fleet Air Arm. The Widgeon, J4F-1 and J4F-2, formerly a popular five-place commercial amphibion, was used by the U. S. Coast Guard and the Navy.

Higgins Aircraft, Inc., New Orleans, La., was formed in the fall of 1942 as the first outcome of long-range planning by Andrew Jackson Higgins, already successful in adapting plywood and plastic techniques to the problems of war-boat design and construction. Immediate impetus was given to the organization when the U. S. Army Air Forces awarded it a contract for the construction of 1,200 C-76 Curtiss Caravan cargo planes.

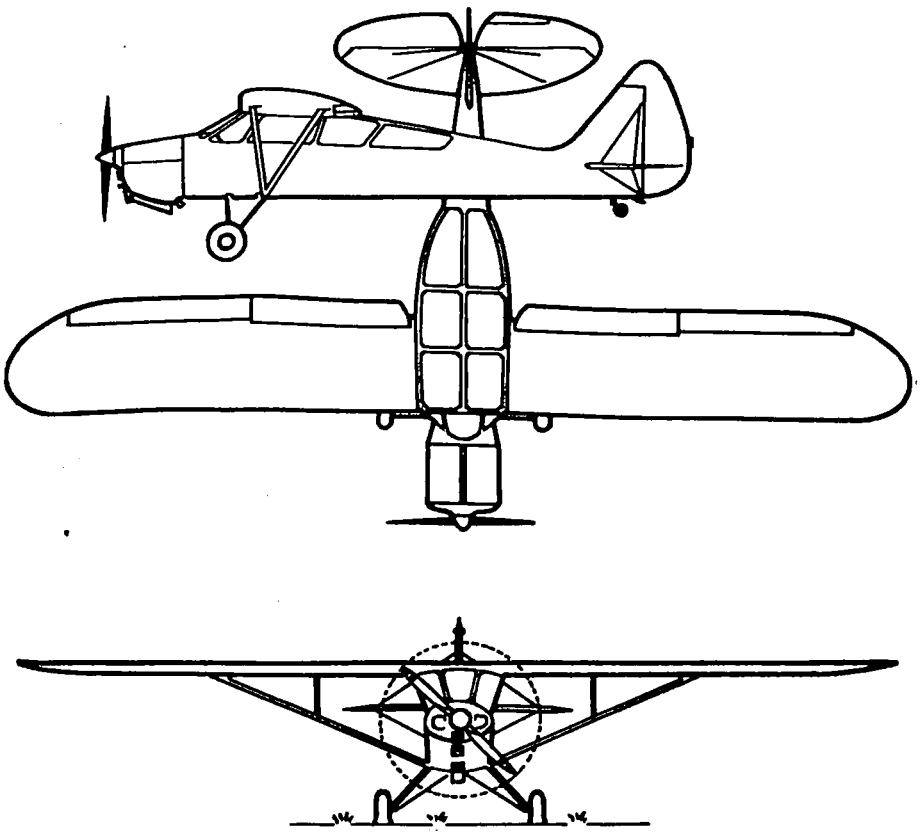
By early spring of 1943 construction of production facilities at Higgins Aircraft was well under way. The site of a new plant at New Orleans had been dredged and filled. Foundation-piling was in place, having been completed the previous year. Plant and facilities at Higgins Aircraft were to operate under the Higgins techniques, long used by Higgins in war-boat construction. A straight-line assembly was to be employed, in addition to which, almost 61 per cent of the plane sections were to be fabricated in subassemblies.

The new plant was to include facilities for manufacturing airplane parts and accessories, an engine-building plant for manufacturing aviation and marine engines, plus the features of a saw-mill, veneer mill, veneer plywood and molding plants, and wood alloy structures plant. The Higgins site also had airport facilities for both land and sea planes.

Howard Aircraft Corporation, Chicago, Ill., was building trainers under a Fairchild license.

THE GRUMMAN MARTLET I

This is the GB 36-A fighter with the R. A. F. It is powered by a 1,200 h.p. Wright Cyclone engine.



INTERSTATE LIAISON AND OBSERVATION

This Army Air Forces L-6 is powered with a Franklin 115 h.p. engine.

Interstate Aircraft and Engineering Corporation moved its executive offices from El Segundo to Los Angeles, Calif., in line with a greatly expanded production program. In addition to the aircraft precision units plant at El Segundo, Interstate began manufacturing the L-6, a liaison and observation plane for the Army Air Forces, and had acquired production facilities for a second plane of its own design for the Navy. The greatly accelerated production of precision units, including bomb shackels, machine gun and cannon chargers, and hydraulic actuating cylinders, also had forced a large increase in personnel and floor space

To speed production of the plane for the Navy, Interstate acquired through the Defense Plant Corporation, the large manufacturing plant of the Arlington Furniture Company at DeKalb, Ill., said to be the longest furniture assembly line in the world, and lending itself ideally to production of the Interstate plane. To employ the widest possible use of existing facilities, four leading representatives of "outside" industries took part in production of this airplane.

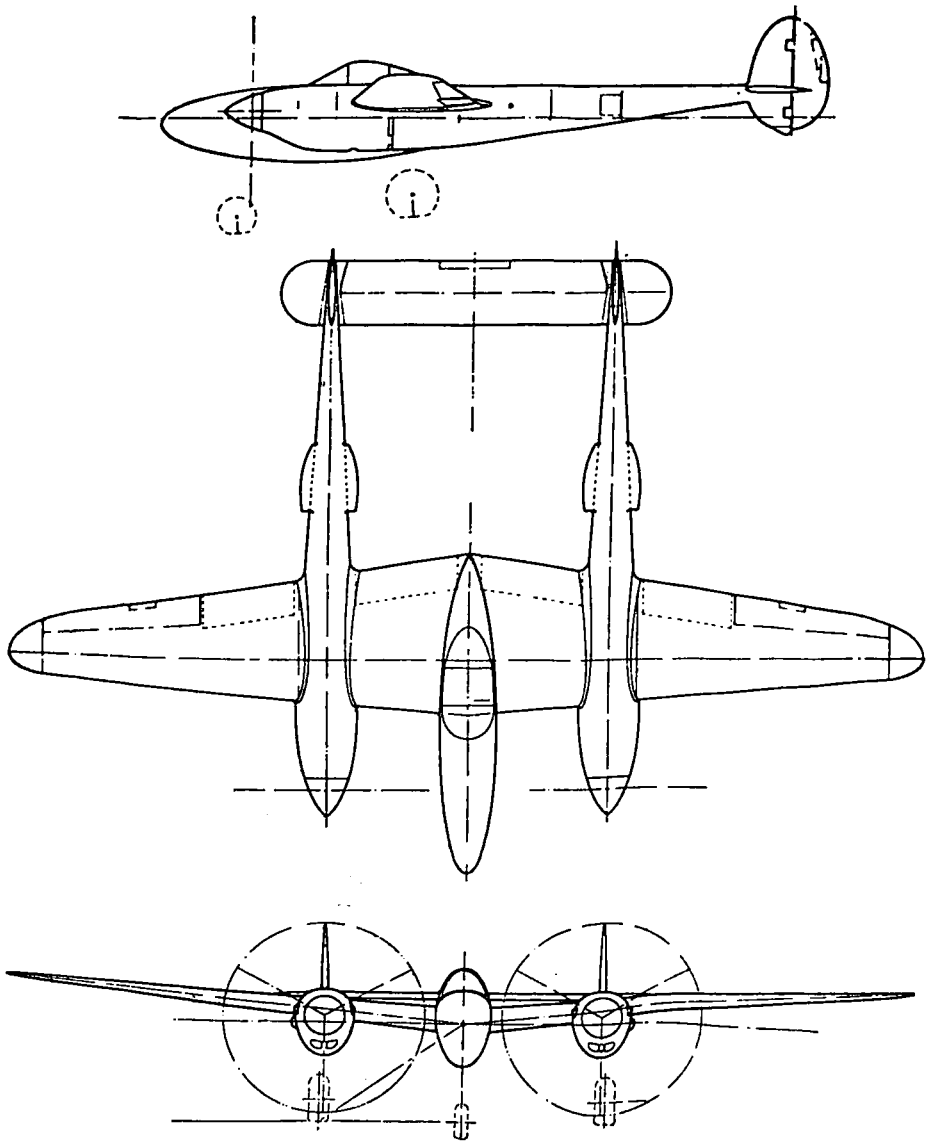
Prime contracts were assigned to the Brunswick-Balke-Collender Company, and to a group of furniture manufacturers in New York State who formed the American Aviation Corporation. Both firms worked from Interstate designs. Major subcontractors for Interstate at DeKalb were the Singer Sewing Machine Company and the Rudolph Wurlitzer Company, the latter piano and organ manufacturers. Development work on the Interstate Navy plane was carried on in the Los Angeles plant.

The Interstate Army L-6 was a high-wing, tandem type, designed for maximum visibility and to be flown under difficult take-off and landing conditions. It was powered with a 115 h.p. Franklin 4-cylinder, horizontally opposed, motor, and was equipped with a motor-driven generator and an electric starter. It had wing flaps, a steerable tail wheel and complete equipment for instrument flight. The L-6 had a maximum range of 540 mi. and a minimum of 220. The ship weighed 1,095 lbs. empty, and had a gross weight of 1,650 lbs. The observer could set up a collapsible drawing table, and because of the design of the cabin, he could see directly beneath the ship even at extremely low altitudes.

Kellett Autogiro Corporation, Philadelphia, Pa., further expanded its facilities during the year with additional plants in the Philadelphia area. Total employees and volume of shipments more than doubled. Development of autogiros and other types of rotary wing aircraft was accelerated, with activities being concentrated on types to meet specific military requirements. The Company continued to be an important supplier to other manufacturers of a number of component parts of combat aircraft.

Lockheed Aircraft Corporation, Burbank, Calif., early in 1943 flew its new Constellation transport, one of the largest and fastest of land-based aircraft. This four-engine, more than 8,000 h.p. cargo and passenger plane, designed by Lockheed engineers for Transcontinental & Western Air and later designated as the C-69 by the Army Air Forces, could fly across the United States in less than nine hours non-stop, or cross to Honolulu in about 12 hours. Its wing was an enlargement of the Lockheed Lightning P-38 fighter wing, including the Fowler flap with its maneuvering and landing positions giving the plane three sets of flying characteristics. The pressurized cabin permitted cruising at 20,000 feet, high above 90 per cent of the weather disturbances. It could fly comfortably above 35,000 feet. Three of its powerful Wright Cyclone engines would maintain a 26,000-foot altitude, and two would hold the plane at 16,500 feet.

Meanwhile Lockheed and its subsidiary, Vega Aircraft Corporation, met the war emergency by producing, in the first six months of 1942, nearly twice as many dollars worth of airplanes and parts as were delivered in the last ten years of their history. Production for the month of July, 1942, alone exceeded that for the whole year 1940,



THE LOCKHEED LIGHTNING P-38 FIGHTER

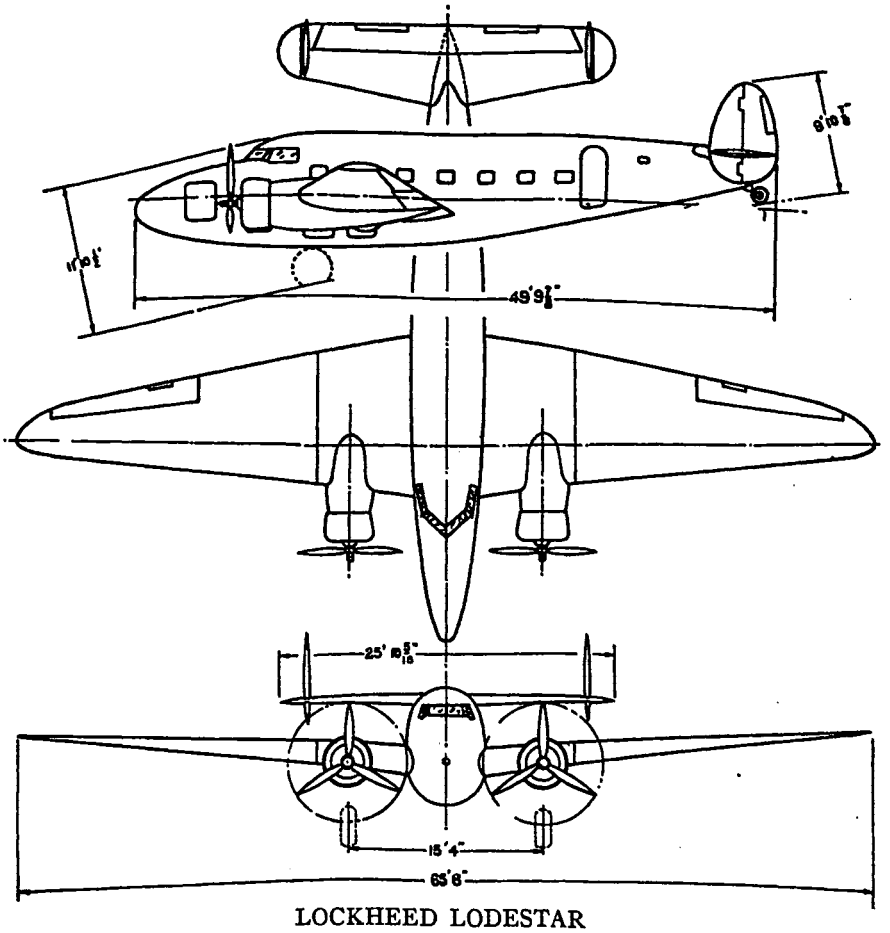
and this pace was accelerated throughout the year. Personnel problems were met, despite the loss of more than 10,000 trained men to the armed services, by the broad Lockheed educational program of job-training and up-grading applied to increasing thousands of women workers and to the physically handicapped, including the blind. Production effort during the year was concentrated upon the twin-boomed Lightning P-38 fighter, the Hudson bomber, and the Lodestar Model 18 transport in several military versions.

During the year the Lightning established itself beyond any doubt

as one of the finest all around fighting planes in the world. As an escort on bomber missions, as an interceptor of enemy aerial raids, and in ground strafing, the Lightning was proving a headache to the enemy and a source of pride and confidence to the Army Air Forces.

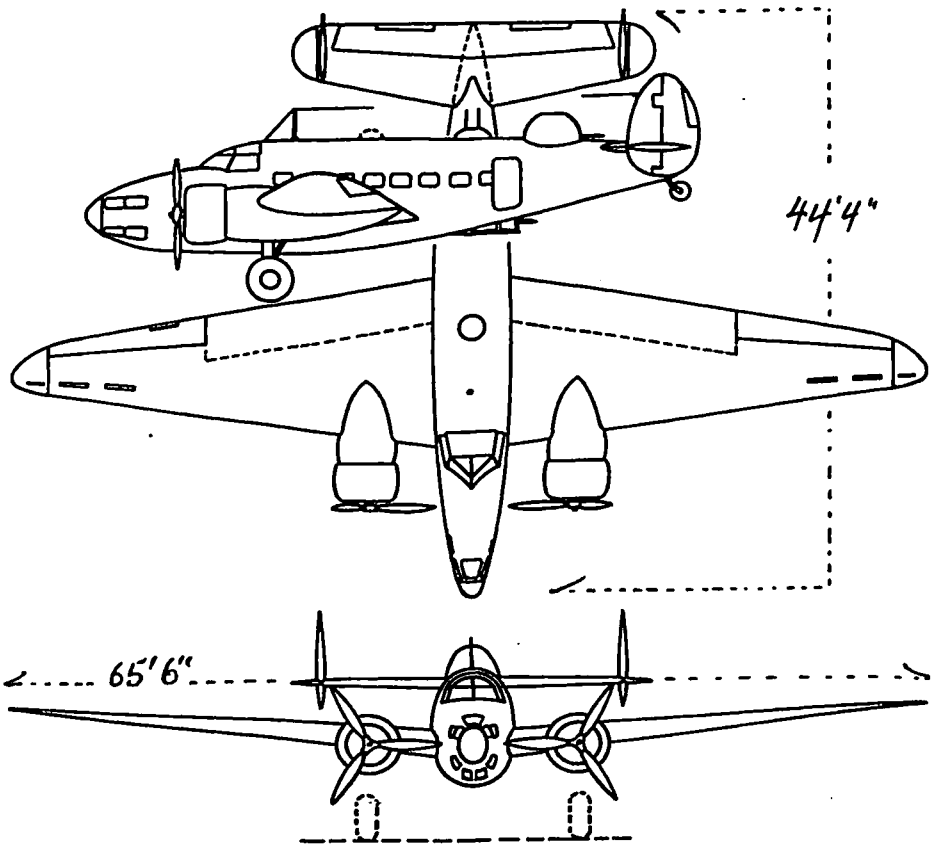
As the versatility of this twin-engine fighter-bomber was proven, its production rate was several times increased and it appeared on four major fighting fronts—the Aleutians, New Guinea, North Africa, and over Europe. Its exceptionally long range with droppable gas tanks had earned it a place on the long-range bombardment team which brought havoc deep into enemy territory with the Lightnings flying as high cover for the bombers.

Strong points of the Lightning were the enormous weight-lifting ability of its two 1,150 h.p. Allison liquid cooled engines; the efficiency of its wing, with maneuvering and landing flap to treble its range of performance; the turbo-supercharging which flew it at more than



LOCKHEED LODESTAR

This twin-engine C-60 transport carries 17 and is powered with two Wright Cyclone or two Pratt & Whitney engines.



THE LOCKHEED HUDSON BOMBER

Also in production as the AT-18, a navigational or gunnery trainer.

40,000 feet; the opposite rotation of its twin engines, which permitted speeds "in excess of 400 miles an hour" without torque effects; the concentration of all its armament in the nose, where it was effective at all ranges without dispersed cones of fire; the great weight of ammunition carried, which gave the Lightning several times as much fighting time as average fighters; the double-skinned and double-stressed ribless wing which sustained the ship even though badly riddled by shrapnel, and the great safety margin of the twin engines. Lightnings flew hundreds of miles to base with one engine shot out, outrunning and outclimbing Jap Zeroes.

These qualifications expanded the Lightning's utility, and from its original single function as a high-altitude interceptor it was pressed into service as an acrobatic dog-fighter; dive bomber, precision bomber, ground strafer, tank and submarine destroyer, photographic ship and smoke-screen layer. Constant improvements maintained its rank among the fastest and highest-flying of military aircraft. Its range was increased until it could be ferried great distances.

The sturdy Lockheed Hudson bomber, "Old Boomerang" to the R.A.F. Coastal Command for several years and fighting under both British and American colors on many fronts, continued in production in a new version in 1943. Designated as the AT-18, the airframe was equipped as a gunnery trainer for turret firing, or as a navigational trainer with standard Hudson instruments duplicated for the instruction of three student navigators seated in the cabin. Neither version was camouflaged, as no overseas training was contemplated. Both trainers were powered by two Wright Cyclone engines.

Production of Lockheed Lodestar transport and cargo airplanes continued in several versions, almost exclusively for military use, although scores of the familiar twin-tailed speedsters remained in air line service throughout the world. The Lodestar airframe, somewhat modified, also was in volume production at Vega during 1942 as the B-34 Ventura bomber.

Plant expansion continued to keep pace with the increased demands of the Services, not only in the four Lockheed plants in the Los Angeles metropolitan area, but on a wider scope. Lockheed established a major modification center in Texas to equip finished aircraft with devices required for special missions in known climates. Thus, without slowing production of the basic airplanes, all the latest in armament and instruments were added as fast as they were developed. Lockheed also established a vast new overseas operating base in addition to those already in operation, and sent its own engineering and servicing personnel to advanced Army bases to aid in training Army personnel.

Lockheed production refinements and short-cuts were manifold. One was the pioneering of plastic tooling so that three-dimensional

THE LOCKHEED HUDSON

Hundreds of these reconnaissance bombers have seen service with the R.A.F. This model, AT-18, is used by the U. S. Army Air Forces as a gunnery trainer.

contours could be "poured", hardening into tools that would sustain drop-hammer impacts of 8,000 lbs. per sq. in. under the hydropress. A rotary table more than trebled the hydropress output. The Burt welding goggle with anti-glare lenses permitted the welder to watch the tip of his arc or flame without eye-strain, improving both quantity and quality of his product. "Production illustrations" in perspective proved three times as fast as blueprints in teaching inexperienced workers to assemble structures. A rivet-standardization study reduced the number of rivet varieties in current stocks from 2,850 to 325, and the variety of washers required was reduced by 60 per cent. Standardization of spotwelding equipment made its performance consistent, and extensive research yielded results in flash-welding and in the welding and forming of substitute alloys. Stretch-forming of double-contoured parts was improved greatly, and studies of the fatigue strength of die castings greatly increased their use. Other major research projects included hydraulics and fluids, plastic bonding and fillers, the impact strength of welds, behavior of magnesium alloys, pressurization, and several projects classed as military secrets.

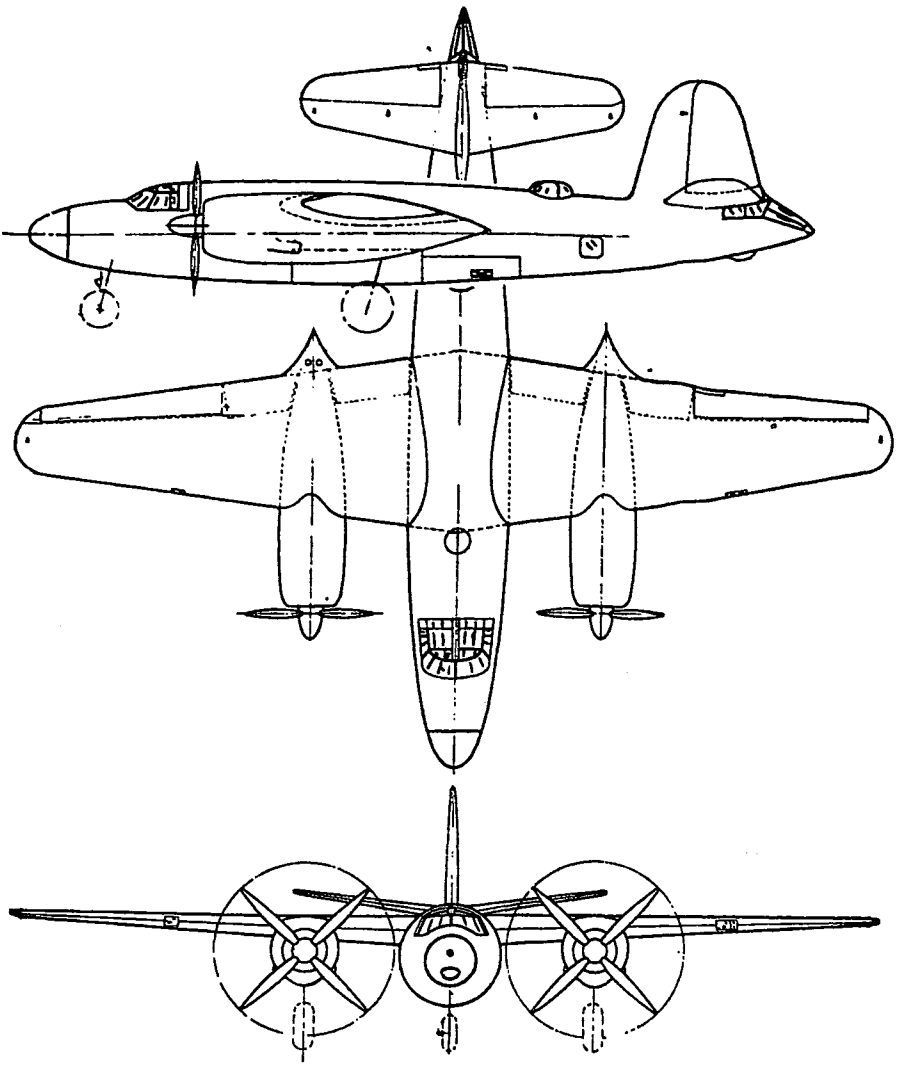
Tapping a new labor market to maintain war production in spite of the manpower shortage, Lockheed and Vega Aircraft Corporations in February began using "boypower" on the assembly lines. About 400 boys, 16 and 17 years of age, became half-time aircraft builders under a "four-and-four" plan started by Lockheed and Vega with the cooperation of the Burbank and Pasadena school systems. Each boy attended school for four weeks, then built airplanes for four weeks, so that the 400 youths alternated in filling 200 jobs along the assembly lines. The plan called for a twelve-month school year, and the boys had to keep up their scholastic grades in order to hold their factory jobs. The intention was that every boy would receive his high-school diploma, meanwhile helping to win the war and earning regular wages for his war-production work.

Luscombe Airplane Corporation, Trenton, N. J., was engaged in subcontract work for prime contractors.

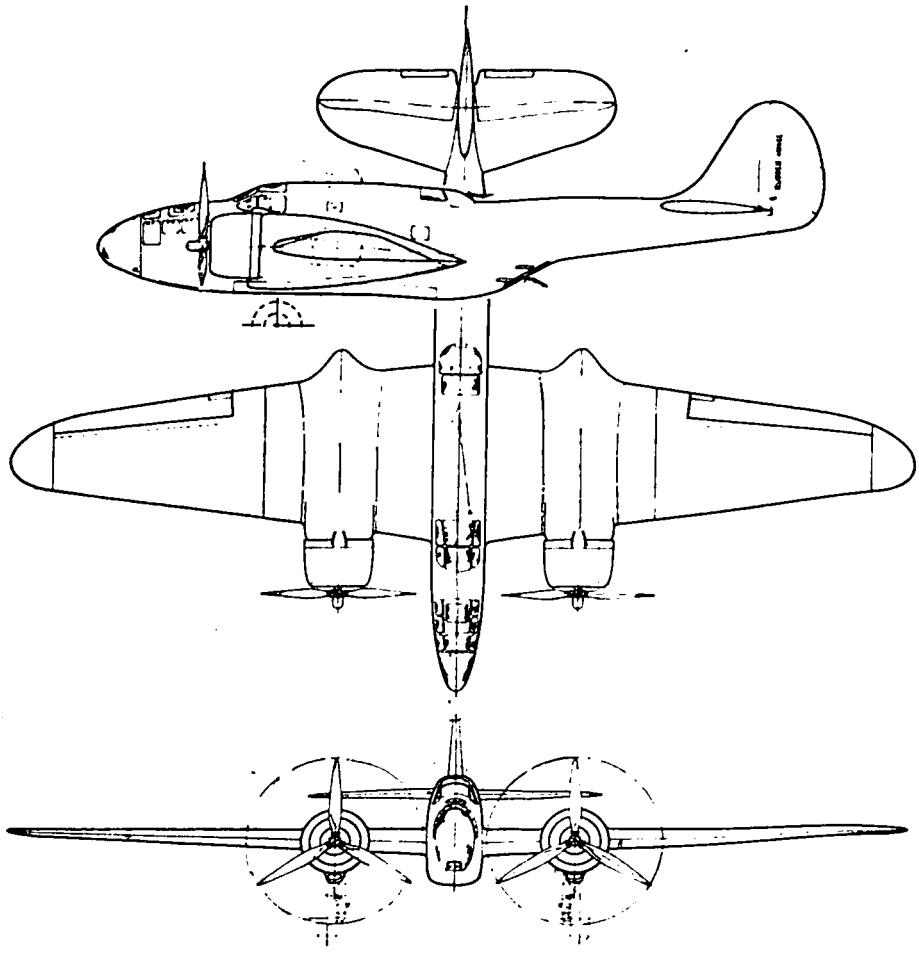
McDonnell Aircraft Corporation, St. Louis, Mo., continued to manufacture aircraft units for the Services. The company's St. Louis facilities were increased substantially with the leasing and conversion of several downtown buildings, one of which was the world's largest garage containing over 200,000 feet of production area. Personnel was doubled. The company was rushing to completion its assembly plant in Tennessee. In addition to its work on conventional aircraft structures, McDonnell pioneered in development and use of laminated paper plastic for both primary and secondary aircraft structures, including ailerons, air ducts, control tabs, doors of all types, elevators, engine baffles, engine nacelle cowlings, engine ring cowlings, fairing, fin tips, flooring, gun blast shields, seats, steps, stabilizer tips, wheel fairings, wheel wells, and wing flaps.

Of considerable interest to the industry was the extensive experimentation in vibration carried on by McDonnell under assignment from the Government. The company also conducted extensive training programs, including shop courses and courses of college level for both men and women.

The Glenn L. Martin Company, Baltimore, Md., was in production on three types of Army and Navy aircraft, including the B-26 Marauder medium Army bomber, the PBM-3 Mariner twin-engine Navy patrol bomber, which was also a cargo carrier, and the 187 Baltimore (Army A-30) bomber supplied to the British under lease-lend. Martin also had under way several other projects of importance to the war in the air and the postwar future. The huge Martin Mars,



MARTIN B-26 MARAUDER



MARTIN 187 BALTIMORE

The Glenn L. Martin Company's two-engine reconnaissance bomber used by the British R.A.F.

140,000-lb., four-engine patrol bomber for the Navy, made its first flight in July, 1942; and later was ordered changed to a cargo airplane, partly because the Navy wanted to develop larger ocean-spanning transports and also because the armament of the big plane had not advanced to a stage which would make it a particularly useful combat weapon.

The Martin B-26 Marauder was one of the deadliest bombers used by the Army Air Forces on many fronts throughout the world. It was a medium type bomber of mid-wing monoplane design. Construction was all-metal monocoque. It had a retractable tricycle landing gear. It had two Pratt & Whitney 2,000 h.p. engines, with four-blade Curtiss automatic electric propellers. With all the latest features dictated by combat experience in all war zones, the Marauder had great fire

power, power turrets, self-sealing fuel tanks and adequate protective armor. It was adapted especially for carrying torpedoes. At the Battle of Midway, the Marauders sank two Jap carriers with torpedoes, and later got two Jap destroyers in the Aleutians. In scores of bombing missions in North Africa and in the South Pacific, it fought off Jap fighter squadrons and dropped its bomb loads on the targets, proving to be not only a heavy bomb carrier but faster than the enemy pursuit ships. The Marauder was also successful on ground strafing missions, because of its heavy machine gun fire power. Thus it proved to be a triple threat against the enemy in all theaters of action—bombing, torpedoing and strafing. One of the huge Martin plants near Baltimore was devoted to Marauder production, while a Martin-operated plant at Omaha, Neb., produced it under the "Knudsen Plan," the principal sections being supplied by three automotive subcontractors and shipped to Omaha for assembly.

The Martin 187 Baltimore played an important part in the British Eighth Army's epic victory over the German Africa Corps, as one correspondent commented: "They strike in large numbers and nothing can live beneath them." As a bomber it was devastating. Its wing machine guns made it equally effective in ground strafing operations. The Baltimore was lighter than the B-26 Marauder, and was powered by two 1,600 h.p. Wright Cyclones. It carried a crew of four.

The Martin PMB-3 Mariner Navy patrol bomber weighed 24 tons, and was designed especially for long distance ocean patrol, operating from fixed bases or with the Fleet. It had a fine record in anti-sub-

MARTIN MARS IN FLIGHT

The 140,000 pound Navy flying boat is powered by four 2,000 h.p. Wright Cyclone engines.

MARTIN MARINER IN FLIGHT

One of the long-range, twin-engine PBM-3 flying boats in Navy service.

marine warfare and in rescuing survivors of sinkings at sea. The Navy also used it as an advance scout and for convoy duty because it could range far ahead and around surface vessels. It could stay away from its base for long periods of time. The Martin PMB-3 boats which were converted to Navy cargo carriers weighed 55,000 lbs., and were used for long-range flying of critical supplies.

The Martin Mars was one of the largest aircraft ever built anywhere. It was powered by four 18-cyl. 2,000 h.p. Wright Cyclone engines. Her wing was as long as a 20-story building is tall. Her hull had the cubic space of an average 15-room house. She carried seven and a half miles of wiring, 1.9 miles of conduit pipe and three million rivets. Her wing was thick enough for the mechanics to stand inside and service the engines in flight. In the opinion of Glenn L. Martin, the pioneer who conceived the Mars, she was the forerunner of even larger flying boats. He already had on his drafting boards a plane of 250,000 lbs. as compared to the 140,000 of the Mars, and he could see no engineering obstacles to flying ships of half a million pounds in weight.

The Glenn L. Martin Company also was a leading manufacturer of power operated turrets. It introduced the first of this type in 1937. In 1940 the British surprised the German pursuit pilots with these Martin turrets during bombing missions over occupied France. The turrets were used on Martin bombers and a dozen other models of combat aircraft.

Another interesting development was the Martin solution to flutter. The company's vibration group first evolved a graphical solution to the phenomenon, allowing aircraft engineers to determine theo-

retical flutter conditions of the aircraft even in the design stage. This was followed by further development of vibration pick-up apparatus which was used widely throughout the industry. Tiny two-ounce detector devices could be placed throughout the airplane and their vibration findings transmitted to an oscillograph, which made a visual record of the vibration reports, allowing a thorough check on vibration and flutter conditions, and permitting the pilot to shut down at any time that an unexpected intensity of vibration might occur.

Under the impact of the war effort the engineering department of the Glenn L. Martin Company made many contributions. One of its interesting developments was the adaptation of the mareng cell, used in self-sealing tanks, as a possible solution of the oil transport problem both in the United States and abroad. During 1942 a Pennsylvania Railroad boxcar was fitted with large mareng cells capable of carrying 13,000 gallons of gasoline or fuel oil, as against the average 8,000 gallons for a tank car. This car was tested out for many months and came through the severe operation without a fault. Early in 1943 the Government was preparing to place a large number of such cars in operation. The advantage was obvious. Shortage of steel made building tank cars impossible. The use of the mareng cells in ordinary boxcars permitted railroads to use available equipment. Moreover, there could be two-way operations of such cars, because the cells could be rolled up at the delivery point and shipped back in a small space to the oil producing centers.

The Martin training program placed thousands of men and women in both in-plant training classes and courses set up in public schools and colleges, fitting them for the myriad specialized jobs of aircraft manufacturing. Women formed 20 per cent of the productive personnel, and were employed in almost every kind of job in the plants.

Meyers Aircraft Company, Tecumseh, Mich., was building three

THE MEYERS ME-165 TRAINER
Manufactured by Meyers Aircraft Co. at Tecumseh, Mich.

types of training planes and manufacturing parts for other companies. Meyers trainers included the OTW, the OTW-145 and the Meyers Me-165. All models were used in the C.A.A. pilot training program.

North American Aviation, Inc., Inglewood, Calif., was in production on military aircraft for every fighting front in the world, and at the same time was producing a steady flow of planes for combat pilot instruction which played a major role in the accelerated training program of the United Nations. Three manufacturing units were geared to the gigantic task of supplying to the American and Allied air forces the North American B-25 Mitchell bombers, P-51 Mustang fighters and the AT-6 Texan combat trainers. North American operated three major plants, in Inglewood, Calif., Dallas, Tex., and Kansas City, Kans. Construction was begun on a giant second plant for the Dallas division of North American on March 24, 1942. An independent manufacturing unit, the plant was constructed at the request of the War Department for manufacture of heavy bombers.

Both B-25 Mitchells and P-51 Mustangs were manufactured and assembled in the parent plant in Inglewood, which long had been a major source of supply for the Allied nations. The company's newest unit, at Kansas City, assembled the B-25, with many of the subassemblies being manufactured by the Fisher Body Division of General Motors. The Dallas division's original plant was in production on the Texan trainers and also was completing arrangements to produce Mustangs in 1943.

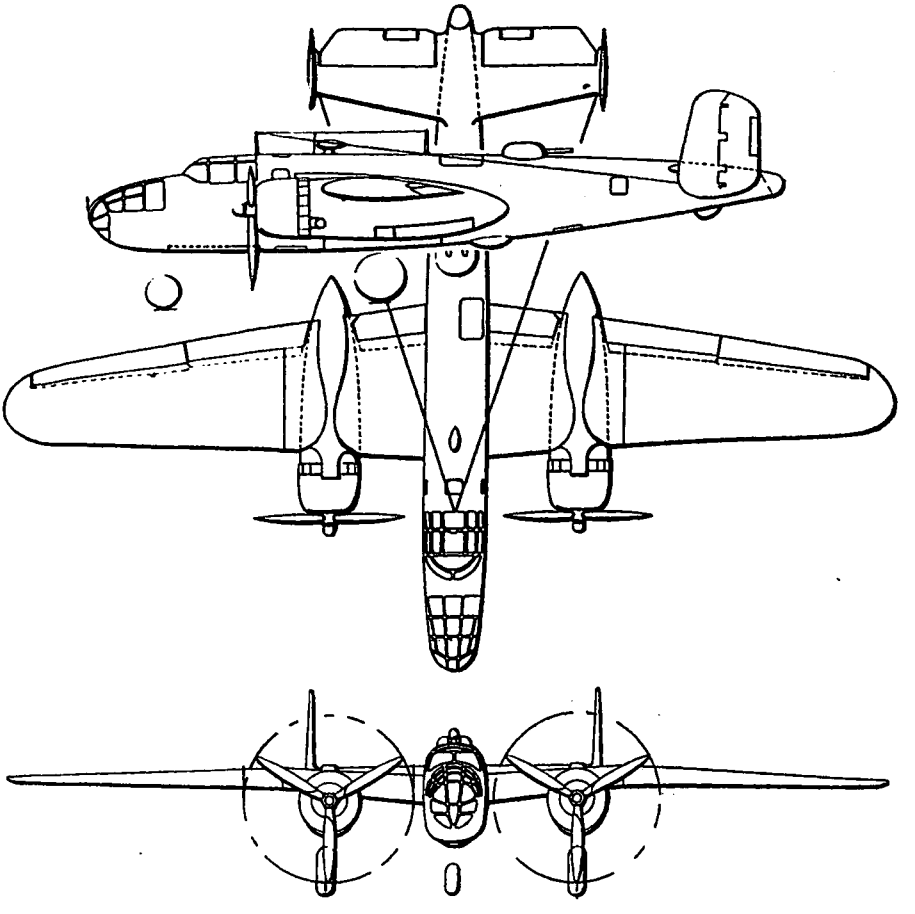
The company's excellent production record was recognized officially by presentation of the Army-Navy production E flags to the two oldest plants—Inglewood and Dallas. North American's total airplane deliveries during the 12 months ending September 30, 1942, including all types, was up 263 per cent over the prior twelve months.

Acknowledgment of the fine performance of North American airplanes by high ranking military and aviation authorities was coupled with a stirring record of combat achievements which made air history during 1942. The B-25 Mitchell bombers were in production not only for the U. S. Army Air Forces, but for the air arms of Russia, Britain, the Netherlands East Indies and China. The U. S. Navy announced early in 1943 that the Mitchells would be used in its future naval operations. The Mitchell, in quantity production many months prior to Pearl Harbor, entered service against the enemy at the start of hostilities, and became the first U. S. Army bomber to sink an Axis U-boat. A short time later, ten Mitchells and three Boeing Fortresses completed the longest round-trip bombing expedition in war history, taking off from Australia and flying to secret bases in the Philippine Islands. After a series of bombing expeditions against the Japanese in the Islands, the bombers carried safely to Australia a large number of evacuees from Lt. Gen. Jonathan Wainwright's battered Bataan forces.

The Mitchells also were selected for the most dramatic operation during our first year of war—the daring raid on Tokio and the industrial heart of Japan led by Major Gen. James H. Doolittle. General Doolittle, upon completion of the mission, said these were the planes best suited for such an operation at that time.

Engaging in an uninterrupted series of offensive operations against the enemy on all fronts throughout 1942, the Mitchells were utilized to the fullest by the United Nations. As more and more of these planes became available, their sphere of activities spread to all corners of the earth. Early in 1943, they were among the first bombers to see action on every front where the Allies faced the Axis powers.

The unheralded appearance in Europe of the new P-51 Mustang in 1942, although it had been designed and built nearly a year and a half previously at the request of the British R.A.F., caught the Nazi ground and air forces completely by surprise, and without an adequate



NORTH AMERICAN B-25 BOMBER

Known as the Mitchell, this medium bomber is powered with two Wright Cyclone twin-row engines.

defense to combat these single-engine fighters. Starting with what the British Army Cooperation Command called their "day out" in occupied Europe to rehearse invasion tactics against targets along the French coast, the Mustang operations were extended gradually until they played one of the leading roles in the Commando attack at Dieppe. Here they carried out aerial reconnaissance over an area equal to the whole Western front in World War I, pounced on enemy objectives with devastating gunfire, and formed part of the air curtain drawn across the sky above France to protect the invading troops from enemy sky raiders.

The Mustangs climaxed their first year of service when the British chose them as the first single-engine airplanes based in Britain to penetrate Germany proper. A squadron flew some 250 miles east to attack German objectives in Holland en route to Dortmund, Germany. A German military camp on the Dutch-German border was machine-gunned from tree top height, and fires were started in several lines of huts. Racing on, the Mustangs attacked a factory and a gas tank in Lathen, scoring hits on both. They sped south along the Dortmund-Ems canal, shooting up a number of barges and small ship lock-gates. On the way back to England, the Mustangs set fire to a 500-ton ship on the Zuider Zee, and caused an explosion on another vessel.

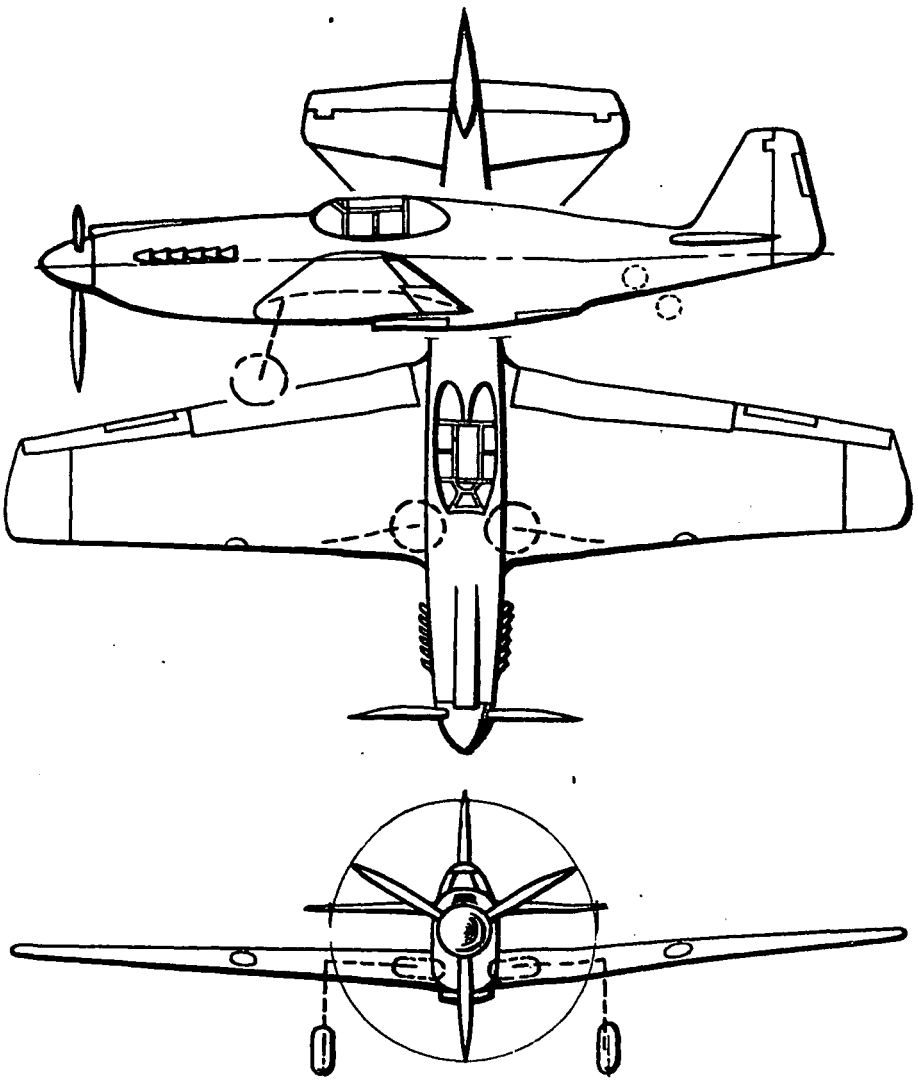
With the U. S. Army Air Forces adding these fighters to their squadrons, an announcement was made by the War Department that a new and still more effective Mustang, equipped with a Rolls-Royce Merlin engine and capable of high altitude fighting, would see service in the coming months.

A highly creditable performance record was achieved by the North American Texans, which were being used by the air forces of 24 nations for combat training. Attesting the versatility of these planes, an AT-6 was credited by the Mexican Air Force with probably sinking an Axis U-boat off Tampico, Mexico. Cadets at Craig Field in Alabama, A.A.F. Advanced Flying School, in August completed 23,000,000 miles of flying in AT-6 trainers without a single accident attributable to mechanical failure. More than 1,000 student pilots were graduated from the school up to that time, and they had used the Texans exclusively in establishing their safety record.

Earlier North American training plane designs, notably the BC-1, BT-9 and BT-14, were still in operation at many training centers throughout the United States, while the O-47 observation planes were being used for patrol duty over coastal waters.

North American was confronted in 1942 with most of the problems which faced the expanding aircraft industry during the year, centering chiefly in a lack of experienced personnel, material and equipment shortages, and frequent engineering changes. To meet the swiftly changing requirements of war, hundreds of design alterations, requiring thousands of engineering hours, were necessary. Al-

though the majority of these changes were minor, some were so far reaching that they affected not only the home plants but the service organizations in all parts of the world. However, the tooling flexibility of North American enabled the company to cope successfully with the demands for design change without delaying seriously the delivery of airplanes to the fighting fronts. Increase in aircraft production volume during 1942 permitted the adoption of more highly specialized production facilities and methods in North American's three plants. Conveyor systems were installed extensively to speed the flow of sub-



NORTH AMERICAN MUSTANG
This single-seat fighter has an Allison engine.

NORTH AMERICAN TRAINERS FOR U. S. NAVY

Texans in final assembly at the Dallas plant of North American Aviation.

assemblies as they traveled to the final assembly departments, and of major units on the final assembly lines.

The labor supply problem became acute as thousands of employees entered service. The situation was aggravated further at North American by the necessity for steady personnel expansion to meet stepped-up production schedules. Because the skilled labor reservoir was nearly exhausted, replacements necessarily were made from among persons who were relatively unskilled in aviation crafts. Women were hired in unprecedented numbers, and at the beginning of 1943 they constituted nearly half of the total personnel in the three plants. Scores of handicapped men and women also were employed as small parts assemblers, sheet metal workers and machinists.

Despite these problems, North American was able to maintain its usual high standard of workmanship because of a well-trained supervisory nucleus and expansion of its in-plant training program. The company utilized public school facilities and established its own training centers to provide men and women with the opportunity to secure fundamental experience in handling basic tools for specific basic jobs. Employees received regular wages while training, and worked on actual production parts and assemblies in later training phases.

Despite the expansion of personnel and more man-hours of work, the accident-frequency record at North American during 1942 was lower than prior to the war. The employment of thousands of men and women, the majority unfamiliar with factory work, created new safety hazards which were offset effectively by a well-integrated safety program. North American's Inglewood plant was awarded a safety trophy by the California Federation of Business and Professional Women's Clubs for having the lowest accident-frequency rate

of all the aircraft plants in California during the first six months of 1942.

A material conservation program was adopted at all plants to conserve, properly segregate and salvage materials. North American effectively reduced waste and spoilage, not only of materials, but also of machinery and equipment. Rejected parts and inactive materials were directed into other manufacturing channels, while materials which could be re-used in aircraft production were segregated and salvaged for use in the plants.

The company's employee suggestion plan proved highly successful during its sixth year of operation, providing all employees with opportunity and incentive to submit production improvement ideas to the management with assurance of prompt action. Many significant contributions were made by employees of North American, for which they received tens of thousands of dollars worth of war bonds. In addition to the awards made normally, North American conducted a special organization-wide contest over a limited period, awarding employees a total of $10,000 in war bonds for suggestions useful in increasing production, conserving materials or improving general manufacturing efficiency.

North American's field service department, a unit within the engineering organization which coordinated operational and maintenance information between the home plant and the pilots and mechanics operating the company's products, broadened its activities to a degree consistent with the expansion of American and British war operations. Field service representatives, thoroughly specialized and thoroughly trained, were assigned to posts in North Africa, Alaska, London, Australia, New Guinea, China and India, as well as air bases throughout the United States.

Capable of producing a 327 m.p.h. air speed, a new wind tunnel, vital to aeronautical research projects at North American, was being completed at the Inglewood plant. North American engineers also constructed a new "cold chamber" in the Inglewood research laboratory in which the temperature could reach 98° below zero from +67° F in 205 minutes. The cold room's temperature also could be raised to +180° F in 22 minutes without damage to equipment. The experimental chamber enabled engineers to study the operation of equipment under various temperature conditions.

Northrop Aircraft, Inc., Hawthorne, Calif., was in its fourth year as a manufacturing organization. The company's first production model was the N-3 Patrol Bomber, the last of which was delivered to the Royal Norwegian Naval Air Force; and early in 1943, saw service in Iceland. Northrop Aircraft was in volume production on A-31 dive bombers under license from Vultee Aircraft, and also produced under sub-contract nacelles and cowling for Boeing Flying Fortresses, as well as empennages for Consolidated Aircraft.

NORTHROP N-3PB PATROL BOMBER

It is powered by a Wright Cyclone engine and equipped with Edo floats. These planes were in service in Iceland.

The Northwestern Aeronautical Corporation, Minneapolis, Minn., with Harry A. Shaffer as president and general manager, was organized for production of CG-4A gliders. The company also operated two flight schools—Aero-Ways at Cleveland, O., and Hood Aircraft at Northampton, Mass.

Piper Aircraft Corporation, Lock Haven, Pa., soon after Pearl Harbor, sold the U. S. Navy all the standard trainers that it had in stock, while the Army took the other models, including Cruisers and Coupes. The Piper basic trainer was produced for the Army. In August, 1942, Piper developed a new Cruiser model with a 100 h.p. Lycoming engine. It was readily convertible into an ambulance plane, and the Navy ordered a number for use at its training centers. Piper also produced a 3-place training glider. Delay in receiving adequate supplies of materials and loss of important skilled personnel to the Services were among the more important problems encountered in filling production requirements.

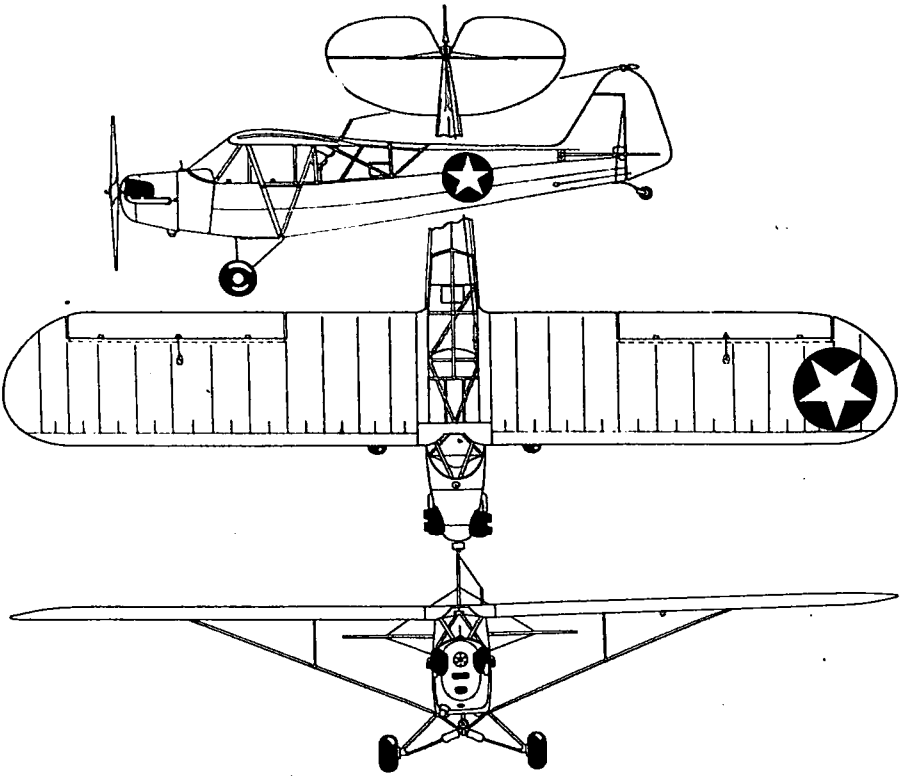
Republic Aviation Corporation, Farmingdale, N. Y., increased production of the super-powered P-47 Thunderbolt Army fighter. Additional production was provided by the establishment of a huge manufacturing unit in Indiana. From these two sources Army Air Forces pilots were receiving an ever increasing quantity of Thunderbolts.

Weighing approximately 13,500 lbs., the Thunderbolt was heavily armored and armed, carrying eight .50 cal. machine guns. It was the

only fighter type aircraft using the Curtiss four-blade propeller. A one-place machine, the P-47 is a single-engine, high-altitude fighter powered by a 2,000 h.p. Pratt and Whitney double-row Wasp, with a turbo-supercharger installation which gave it a 40,000 ft. ceiling. Designed by Alexander Kartveli, vice-president and chief engineer of Republic Aviation, who also designed the P-43 Lancer and other Republic models, the Thunderbolt was in the 400-plus m.p.h. class. While being flown by Army Air Forces personnel at an East Coast air base late in November, 1942, it established a new dive record of 725 m.p.h.

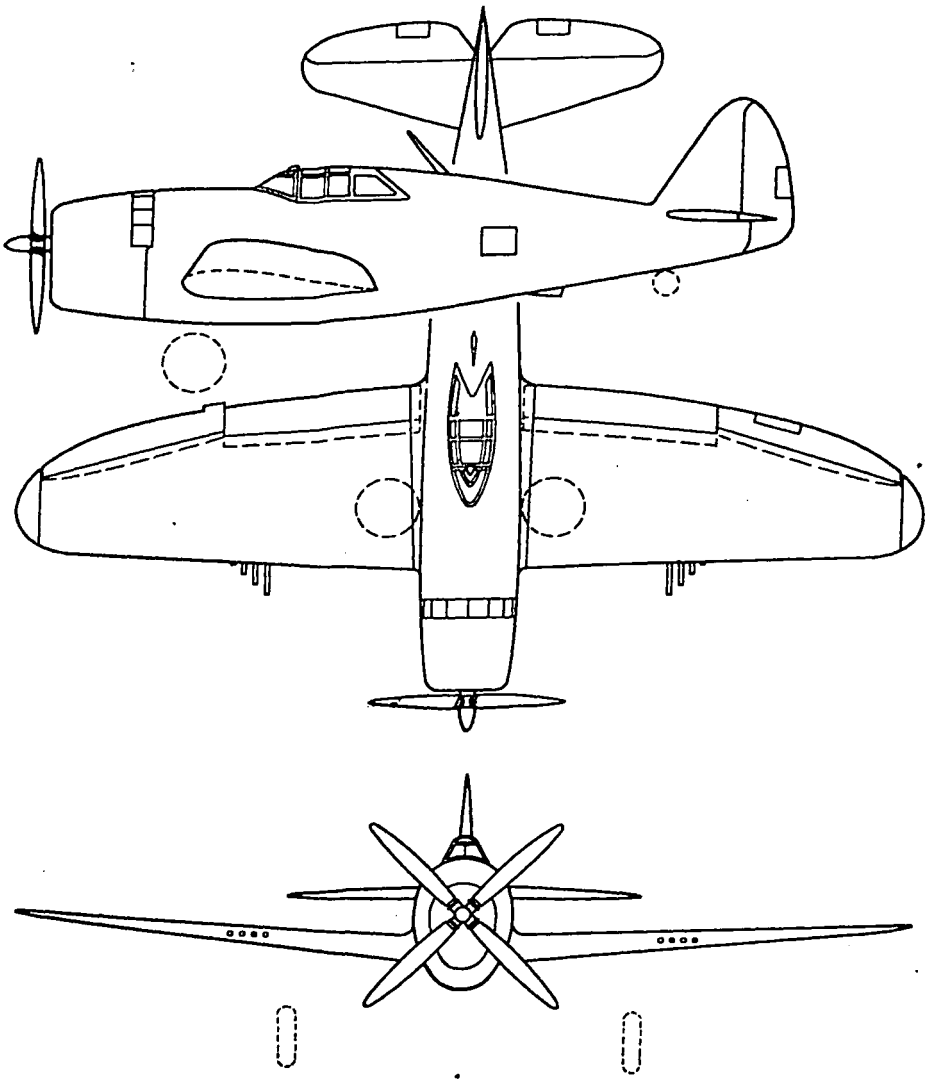
The Thunderbolt's wing span was 40 ft. 9 5/16 in.; height 12 ft. 4 11/16 in.; length 35 ft. 5 3/16 in. In addition to being a high altitude fighter, the Thunderbolt also had a long range.

One of the outstanding feats in the company's history was the rapidity with which its Indiana division was created. Building in what had been cornfields and pastures, the Republic organization erected, tooled and set into production within the short space of five months one of the largest aircraft plants to be found in the Midwest. The completion of the Indiana division in such a short space of time per-



PIPER ARMY LIAISON

A two-place plane used also for primary training.



REPUBLIC THUNDERBOLT

A high altitude fighter powered with a Pratt & Whitney Double Row Wasp engine rated at 2,000 h.p.

mitted the company to beat by months the schedule set by the Army Air Forces for the delivery of the first plane from this unit.

In addition to the company's expansion in Indiana, new facilities were added to the Farmingdale plant. Employment was expanded several times. During 1942, for the first time in the company's history, women were employed in the production of the P-47 Thunderbolts. Company officials estimated that ultimately 60 per cent of the entire production personnel would be women.

Ryan Aeronautical Company, San Diego, Calif., multiplied pro-

duction several times over, and early in 1943 was acquiring new factory buildings and additional office and engineering space. Ryan manufacturing activities, which in recent years had been concentrated on production of low-wing primary training monoplanes for the U. S. Army Air Forces, U. S. Navy and friendly foreign governments, expanded into new fields. Contracts were signed with the Navy for mass production of the SOR-1 scout observation plane, a ship- or land-based aircraft intended for long-range scouting missions, a basic type developed by Curtiss-Wright. It had an exceptionally long cruising range and could maneuver and land at low speeds, even though much faster than older airplanes previously carried on naval ships for similar duties. The SOR-1 was a midwing monoplane, powered with a Ranger inverted V-type in-line 12-cyl. aircooled engine. The fuselage was all metal, of semi-monocoque design, with a two-place tandem cockpit arrangement. The metal wings and tail units were of cantilever design. For catapult operation and water landings the SOR-1 was equipped with one main float and two wing-tip floats, and for operation from land bases, it used the conventional landing gear.

In December the Navy instructed Ryan to taper off production of the SOR-1 and design an entirely new combat airplane. During the transition period, Ryan was assigned to subcontracting work on major components of important military aircraft for several prime contractors.

Ryan also completed experimental models of a new Army plywood military trainer, the PT-25. This was a plastic-bonded plywood ship of advanced design believed to be the nearest approach yet reached

RYAN TRAINERS

A corner of the Ryan Aeronautical Company's plant at San Diego, Calif., showing construction of Ryan trainers.

to the complete elimination of strategic materials in a military airplane. Aluminum alloys and all strategic materials were excluded from the new PT-25, except for the engine cowling which represented less than 2 per cent of the total weight of the plane. No forgings, castings, or extrusions were used, nor were critical steels required for any of the fittings or structural parts. The plane was powered by a 185 h.p. Lycoming, 6-cyl. horizontally opposed air-cooled engine. Manufacture of this plywood ship required little special equipment because cold-setting urea formaldehyde glues, which eliminated all tricky handling, were used. The only molded plywood section was the leading edge of the outer wing panel. Large-size, flat plywood sheets were employed for all other parts of the plane, and since all shaping of the fuselage and other units was done over large radii, no complex forms were needed for fabrication. Metal fittings, where necessary, were simple welded sheet steel and steel tubing. The Ryan company now was conducting research work which later would enable it to convert most of the secondary structures to plastic materials. Studies were also under way toward the eventual adoption of plastics for primary structures.

Ryan continued to make a specialty of building exhaust systems for other aircraft companies. Ryon manifolds were standard equipment on many outstanding military planes.

Ryan continued to produce PT-22 primary training planes for the Army. Many of the commercial flying schools which gave primary training under Air Forces contract were equipped with Ryan PT-22 planes. In addition, a seaplane model of the trainer was developed. Designated ST-3S, this seaplane trainer differed from the Army latest Ryan trainer only in the substitution of twin floats for the conventional land-plane landing gear. It was powered by a 160 h.p. Kinner radial engine.

The St. Louis Aircraft Corporation, St. Louis, Mo., erected new factory buildings and installed additional facilities, thereby greatly increasing its airplane production capacity. This expansion program included installation of new machinery, tools and other technical equipment. New buildings provided facilities for factory supervisory personnel and all production departments. Training classes were organized and expanded to provide the necessary male and female workers. Manufacturing activities were centered on the production of PT-23SL primary training planes for the U. S. Army Air Forces. This two-place open cockpit primary trainer powered with a Continental 220 h.p. engine, had a span of 36 ft., an overall length of 25 ft. 11 in., and an overall height of 7 ft. 6 in. St. Louis also produced airplane parts for other prime contractors and collaborated with the Army Air Forces on restricted engineering projects.

Sikorsky Aircraft Division of United Aircraft Corporation, Stratford, Conn., reported important advances in the development of the

Sikorsky helicopter. In addition to the V-S 300 experimental helicopter, a larger two passenger model was under development for the U. S. Army. The first of these helicopters was flown successfully from Stratford, Conn., to Wright Field at Dayton, O., a distance of 761 miles. First flown in 1939, the craft appeared in 1943 to embody all the necessary fundamental qualities of controllability and stability. The V-S 300 had no fixed surfaces. The entire lift was secured from the single, three-blade, power-driven main rotor, which was 28 ft. in diameter, and turned at about 260 r.p.m. in normal flight. The engine was a 90-100 h.p. Franklin aircooled, Model 4AC-199. Longitudinal and lateral control were secured by cyclical change of pitch of the main rotor blades. This inclination could be directed toward any desired point throughout the 360 degrees of the disc. Momentary tilting of the disc provided lateral and longitudinal control. Prolonged tilting of the disc provided horizontal travel of the ship in the direction of the tilt.

Increase or decrease in lift of the main rotor, to control the rate of climb or descent of the aircraft, was secured by another control lever in the pilot's cockpit by action of which the pitch of all three main rotor blades was altered simultaneously. The engine throttle was mechanically synchronized with the pitch control, so that an increase in pitch would result in an increase in throttle opening. This resulted in maintaining a substantially constant engine and rotor speed throughout the normal range of pitch travel.

The torque of the main lifting rotor was compensated by an auxiliary tail propeller turning in a vertical plane at the tail of the fuselage. This rotor had a 7 ft. 8 in. diameter and turned at approximately

SIKORSKY HELICOPTER

The VS-300 experimental helicopter simplified to include but one auxiliary control rotor and one main lifting rotor. Igor Sikorsky is at the controls.

1,300 r.p.m. in normal flight. The pitch of the blades of this rotor was controlled by the conventional rudder pedals in the pilot's cockpit. A free-wheeling unit between the engine and the transmission shaft made it possible in case of engine failure for the main rotor to autorotate and to continue to drive the tail rotor, thus providing a controlled glide.

The craft had been mounted alternately on wheels and on rubber pontoons. With the latter installation it was found practical to operate from either land or water, and also from mud and marshes. No wheels were required except for handling on the ground.

An expansion program, involving construction valued at millions of dollars was carried on at Stratford, and was still under way in 1943. Among the new structures were an airport hangar, an engineering and experimental building, an office building and assembly bay, a boiler plant, a tool engineering building and a first aid station.

Southern Aircraft Corporation, Dallas, Tex., devoted expanded manufacturing facilities to parts for prime contractors, including Consolidated, Grumman, Martin and Vultee. Facilities and personnel were increased in order to meet schedules, and floor space was increased fourfold, as was the personnel of which 35 per cent were women at the beginning of 1943.

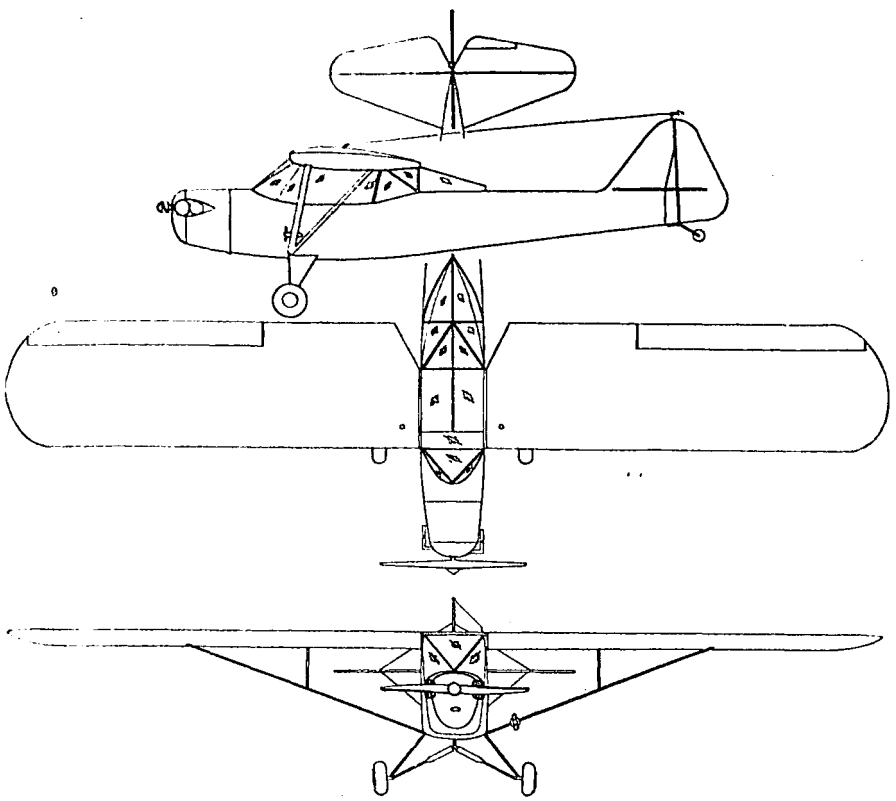
Spartan Aircraft Company, Tulsa, Okla., was devoting expanded manufacturing facilities to subcontract work on military planes.

Swallow Airplane Company, Wichita, Kans., was doing subcontract work for aircraft manufacturers.

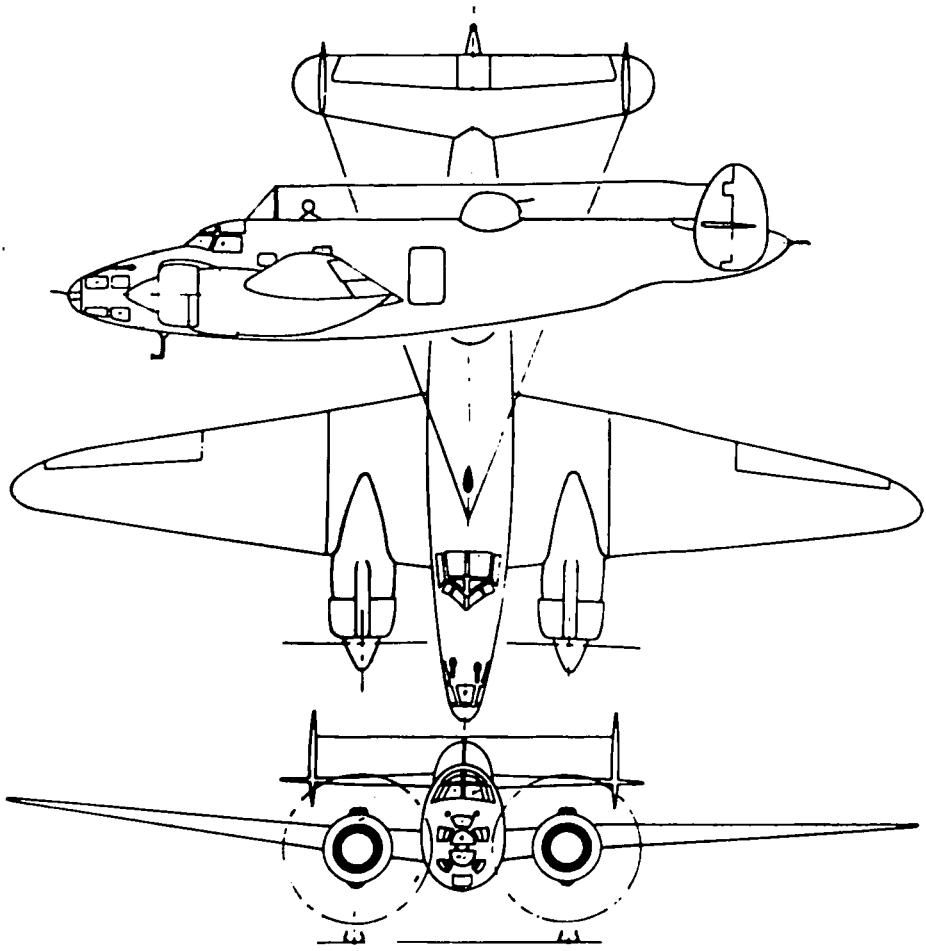
Taylorcraft Aviation Corporation, Alliance, O., was in full-out production of military aircraft, with renewed orders for L-2 "grasshopper" liaison planes. Personnel was doubled, and 38 per cent of the total were women. Powered by the 65 h.p. 4-cyl. opposed, air-cooled Continental engine, the L-2 was used primarily by the Field Artillery to replace the observation balloon of World War I. Flying low over the ground batteries, these "grasshopper" planes proved highly advantageous in spotting enemy positions and directing artillery fire. They also were used for other liaison and short-range reconnaissance work. The L-2 was adapted from the commercial Taylorcraft Model D tandem trainer, being a high-wing, strut-braced, single-engine monoplane, of tubular steel, fabric-covered construction. Alterations from the commercial model were made to fit military requirements. Increased vision from the rear seat was obtained by removal of the wood fairing which formed the streamlined back of the Model D, thereby eliminating any obstruction of view from the cabin. This resulted in a more or less flat upper deck. A "blister" of transparent cellulose acetate was then installed to enclose the cabin at the top and rear, extending from the cabin roof at the trailing edges of the wings and terminating in a tapering effect on the upper fuselage deck nearly midway to the tail. This arrangement afforded an excep-

tionally wide range of vision for the observer who sat in a swivel seat in the rear of the cabin. Added vision was accomplished by eliminating the corners of the butt ends of the wings at the trailing edges. The entire cabin roof was transparent and the window area included both sides of the cabin. The ships were equipped with two-way radio, including batteries and wind-driven generators. A few of these ships were painted in aluminum and numbered, to be used as trainers for Field Artillery personnel. The great majority, however, were painted in regulation Army camouflage color and were used to great tactical advantage in artillery operations on world battle fronts.

The Taylorcraft company in the spring of 1942 received a contract for a substantial number of TG-6 three-place training gliders for the Army Air Forces glider pilot training program. Several additional gliders were delivered to the U. S. Navy, the naval designation being XLNT-1. Here again the Taylorcraft model D commercial tandem trainer was used as a basis in the design and construction of the TG-6 glider. In place of the engine, a tubular steel "boom" was added as a nose section, including an extra pilot's seat, instrument panel, and an extra set of controls.



TAYLORCRAFT ARMY GRASSHOPPER L-2



VEGA VENTURA BOMBER

This Army Air Forces bomber has two Pratt & Whitney engines and carries a crew of four. As a combat patrol plane for the Navy it is the PV-1.

Timm Aircraft Corporation, Los Angeles, Calif., continued to expand during 1942 with the completion of its Saticoy plant and the opening of its Alameda plant. The Saticoy Plant, built upon 54 acres of company-owned land near Timm's Woodley Plant, where subassemblies for other aircraft manufacturers were produced, was devoted to the construction of Timm Aeromold N2T-1 trainers for the U. S. Navy. It was a 2-place, cantilever low-wing, military type monoplane, with fuselage, wings and control surfaces built entirely of plastic-bonded-plywood by the Timm Aeromold Process. Its length was 24 ft. 6⅝ in., wing span 36 ft., height 7 ft. 7¼ in. At Timm's Alameda Plant, the Army's new 15-place transport gliders CG4A were produced. Some 12 associate producers made the component parts for the gliders. The transport glider had a welded steel tube

fuselage, built in three sections and covered with fabric to facilitate production. Its plastic plywood wing was strut-braced, high-lift, and assembled from four separate panels. The fuselage was nearly 10 ft. wide with full head room. Pilot and co-pilot were seated in the nose. It could accommodate 15 fully armed troops, their equivalent weight in ammunition or an Army jeep.

Vega Aircraft Corporation, Burbank, Calif., wholly owned by Lockheed, was one of the youngest firms in the aviation field and one of the most active. The company's fifth birthday, late in 1942, was celebrated by the award of an Army-Navy E for excellence in war production, achieved less than two years after Vega occupied its new main plant at Burbank, Calif. Early in 1943 Vega was concentrating upon the production of two ships: the PV-1 for the Navy was an adaptation of the Vega Ventura bomber, and the Boeing B-17 Flying Fortress, built at the request of the Army Air Forces under the Boeing-Vega-Douglas bomber pool. This activity followed the completion of several contracts for the original Ventura bomber, designated as the B-34 or Model 37, and already in service with American and British forces on several fronts.

The PV-1 was the Navy's first land-based twin-engine combat patrol plane with adequate range, plus offensive and defensive armament. It generally was equipped to carry depth charges or a standard

VEGA VENTURA COMES HOME

With seven feet of wing torn off during an R.A.F. strafing raid over the Continent, this bomber brought its crew back to England.

VEGA PV-1 PATROL BOMBER

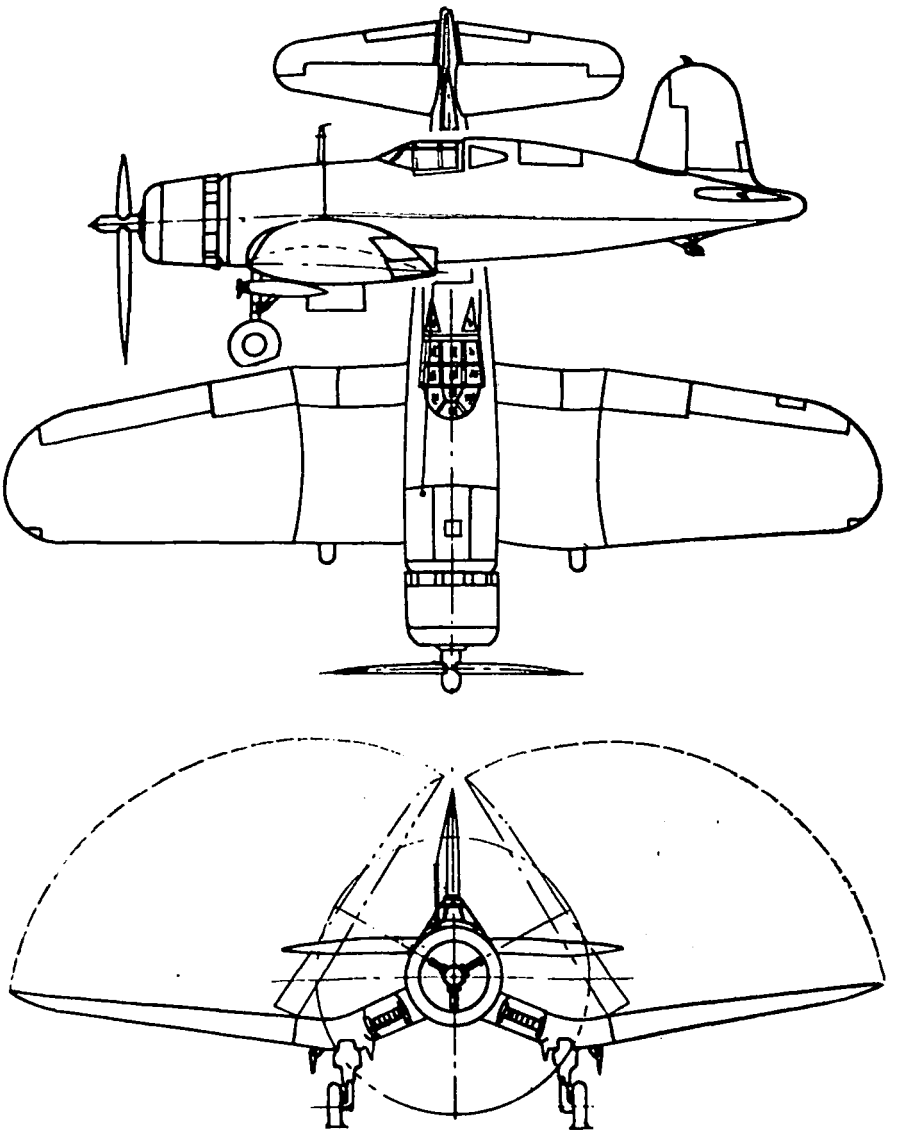
Developed as a heavily armed twin-engine patrol for the U. S. Navy, it could carry depth bombs or a torpedo. It is powered by Pratt & Whitney engines.

torpedo in its enlarged bomb bay, and was heavily armed by machine guns protecting all vital points, as well as in the nose for strafing or attack purposes. It carried more radio equipment than any other plane then built by Vega or Lockheed, and could land at less than 80 m.p.h. It was described as "fiercer, farther and faster" than the Lockheed Hudson which it resembled. Droppable gas tanks and fuselage tanks gave the PV-1 unusually long range for submarine patrol and seeking out enemy shipping. Powered by two Pratt and Whitney engines, the ship had a wing span of 65 ft. 6 in. and normally carried a crew of four.

A spectacular feature of Vega's short history was its eleventh-hour change of program to build the Fortresses under the Boeing-Vega-Douglas bomber pool—while at the same time completing its main factory, and turning out Ventura twin-engine bombers at a rapidly accelerating rate. This triple program was carried forward so effectively, despite the difficulties of training inexperienced personnel, that the B-17's came through six months ahead of the Army schedule, while the Venturas, produced "on momentum," were 25 per cent in advance of their own timetable. Vega achieved this miracle of production by reducing its airframes to the maximum number of small sub-assemblies; completing them, and building them into major sub-assemblies which were united finally to form the airplane. There was a maximum of bench-work, and a minimum of work on the partly finished ship which was difficult of access. Reducing this difficulty still further, Vega employed a "double-deck" system of assembly in which the ships moved past two-story platforms, permitting workers to reach the job on both levels at once. This was increased to a three-story platform for the fabrication of B-17 wings. The kit system, in which all parts needed for a certain operation were handed to the assembler together, also speeded production. So did the principle of short-cycle operations, which permitted the unskilled worker to become proficient quickly at one small phase of the big job. An electro-

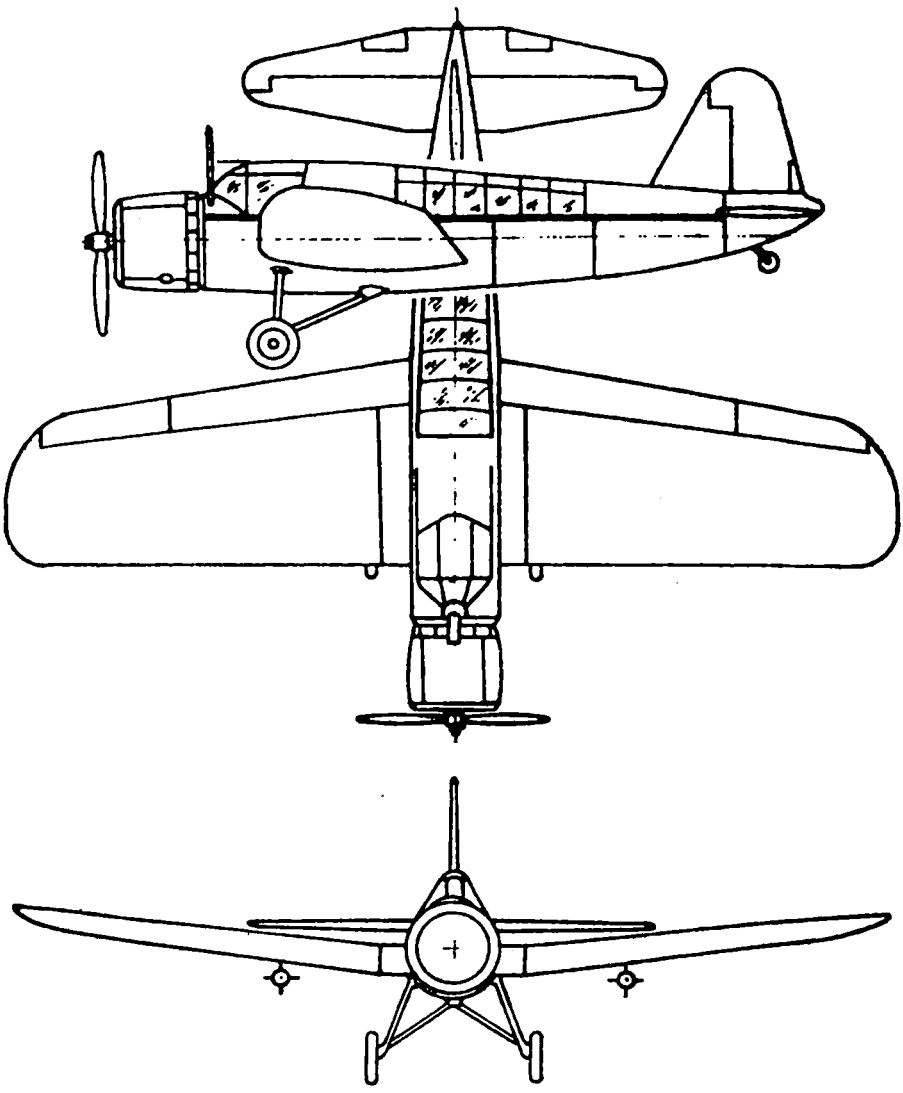
lytic template process saved 50,000 man hours in production of the B-17 alone. The use of plastics for jigs cut a six-months tooling program in half. Men who worked the clock twice around in emergencies pushed production forward by 30 days or more on deliveries.

Vought-Sikorsky Aircraft Division of United Aircraft Corporation, Stratford, Conn., rushed to completion hundreds of OS2U3 Kingfisher observation scout planes for the U. S. Navy and placed in



CHANCE VOUGHT CORSAIR

This single-seat carrier-based Navy fighter is powered with a Pratt & Whitney double Wasp engine rated at 2,000 h.p.



CHANCE VOUGHT KINGFISHER

The OS2U-3, an observation scout, has a Pratt & Whitney Wasp Junior engine.

quantity production the F4U-1 Corsair, a new shipboard fighter. Three V-S 44A flying boats were completed for American Export Airlines for regular service across the North Atlantic, and development of the V-S 300 helicopter, direct-lift aircraft was continued.

On January 15, 1943, manufacturing was divided into two separate divisions—Chance Vought Aircraft Division and Sikorsky Aircraft Division. This was a return to the status of 1939 before the two divisions were consolidated. This new arrangement permitted Chance Vought Division to concentrate on development and produc-

tion of combat aircraft while the Sikorsky Aircraft Division carried on the development of the helicopter for military and commercial purposes.

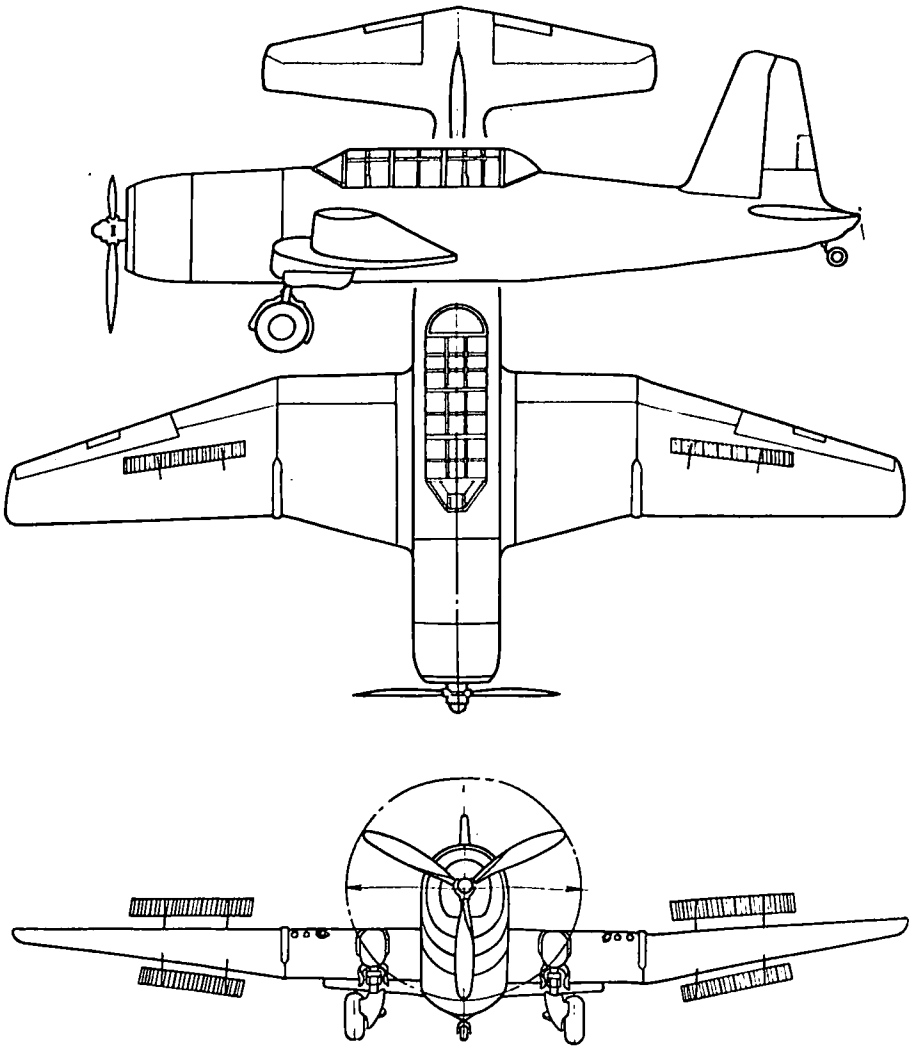
The F4U-1 Corsair, to which the full facilities of Chance Vought Aircraft Division were devoted, was a single-seat, carrier-based fighter, one of the fastest and highest performing naval fighters in the world. It had an inverted gull-wing of single-spar all-metal construction. Use of the gull-wing provided maximum aerodynamic efficiency and at the same time made it possible to employ a large diameter propeller with a comparatively light, short landing gear which readily folded aft into the wing. The wing covering was flush-riveted metal skin on the leading edge and fabric on the trailing edge. The fuselage was of monocoque design and had the skin attached by spot-welding. The tail wheel and arresting gear were retracted into the tail cone. All movable control surfaces were fabric-covered. The Corsair was powered by a 2,000 h.p. Pratt and Whitney Double Wasp engine and equipped with a three-blade Hamilton Standard Hydromatic propeller.

The OS2U-3 Kingfisher was similar to its predecessors, OS2U-1 and OS2U-2, and designed to be an observation-scout operating from a battleship or cruiser as a seaplane. It could be converted to a landplane for shore-base duty. The two-place monoplane had a fuselage of monocoque construction with a midwing of single and cantilever type spar. The wing and fuselage employed spotwelding for attachment of the skin. All control surfaces were fabric covered. The engine was a Pratt and Whitney Wasp Junior. The propeller was a two-blade, constant speed, controllable pitch Hamilton Standard. Corsairs also were being built under license by Brewster Aeronautical Corporation and Goodyear Aeronautical Corporation.

Vultee Aircraft, Inc., with headquarters at Vultee Field, Downey, Calif., greatly increased its production facilities in 1942, announced important gains in technical progress and put new plane models into production. At the close of 1941 Vultee acquired 34 per cent of the common stock of Consolidated Aircraft Corporation, and the two companies operated under a closely associated management, with Tom M. Girdler chairman of the board of both companies.

Vultee was the first plane manufacturer to mechanize its assembly lines completely and put its operations on a mass production basis. The example was influential, and the production methods originated in the aircraft industry by Vultee were adopted by other manufacturers, including its associated company, Consolidated Aircraft Corporation. During 1942 it was demonstrated at Consolidated that heavy Liberator bombers, C-87 transport ships and flying boats for the Navy likewise could be built with mass production techniques, using mechanized assembly lines.

Gen. Henry H. Arnold at the end of June, 1942, congratulated Vultee when its four thousandth Valiant trainer moved off the



VULTEE A-35 VENGEANCE DIVE BOMBER
It is powered by a Wright Cyclone 1,600 h.p. engine.

assembly line. In September Vultee employees were awarded the Army-Navy E for their part in speeding the war effort. In July, Vultee purchased all the stock of Intercontinent Aircraft Corporation, parts manufacturers at Miami, Fla. Late in the summer Vultee established at Louisville, Ky., a modification center where Vultee planes were changed and camouflaged to suit the particular climate and combat conditions under which they would operate. In October, Vultee received approval from the Defense Plant Corporation for a $350,000 expansion at Vultee Field, representing addition of machinery and equipment. In December, it was announced that Vultee soon would start production of torpedo bombers for the Navy in a new Vultee

plant at Allentown, Pa. The cost of facilities, considerably reduced through acquisition of one of the Mack motor bus plants at Allentown, was $11,000,000, while the contract for planes was over $100,000,000.

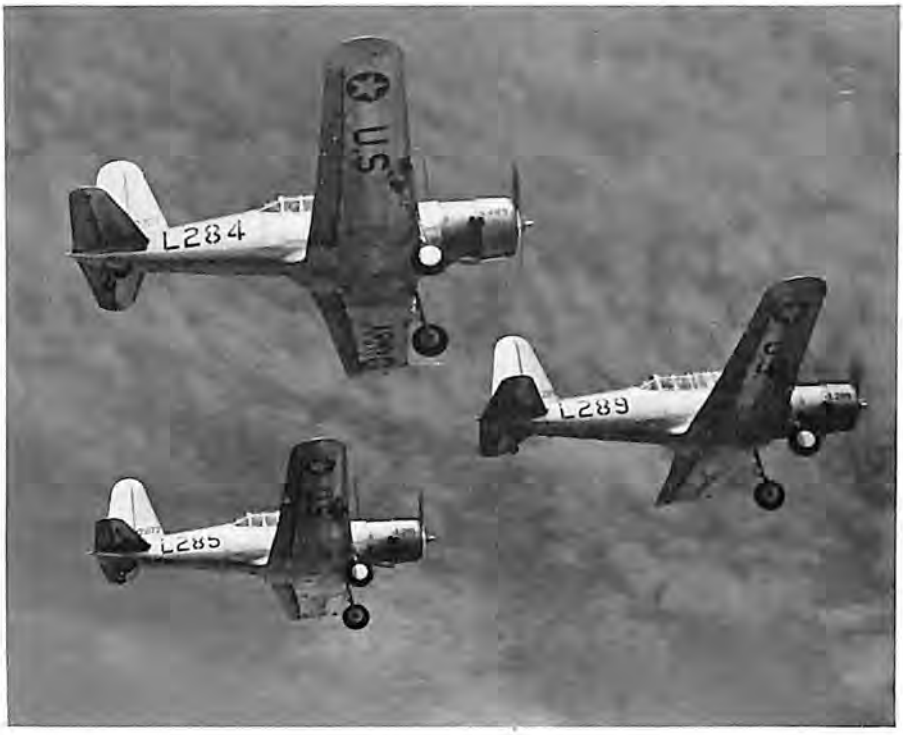
Plant improvement included the installation by the Vultee Field Division of many additional conveyors. Vultee's Stinson Division at Wayne, Mich., also installed conveyors to speed production of the Sentinel liaison plane and the Reliant navigational trainer. Powered final assembly lines were completed by the Nashville Division.

Vultee engineers developed a radio test flight recorder, a radio operated mechanism which instantly transmitted from an experimental airplane to laboratory crews below a complete picture of the strains and flutters, characteristics, performance and reactions of the plane. These occur too rapidly, in today's high performance aircraft, for a test pilot's eyes and hands to notice and record. The automatic flight recorder permitted technicians on the ground actually to know more about the new airplane's condition in test flight than did the pilot at the controls.

To help eliminate bottlenecks caused by scarcity of aluminum and other materials, the Vultee Field Division converted the design of its basic trainer to permit use of non-critical materials. The Vultee trainer at the beginning of 1943 was 70 per cent wood and plastics, saving enough aluminum to build 400 more Vengeance dive bombers annually. The company was further prepared, as a result of research, to recommend the production of airplanes made largely of low carbon steel, as soon as that material was made available. A new process of combining thin sheet steel with what is called "expanded metal" was developed, providing sheets of greater rigidity and strength in relation to weight. An alternate method of using sheets of slightly heavier gauge, without reinforcing, also was tested successfully. Electric spot welding, which was difficult to adopt for use on aluminum, could be used to speed up assembly of parts formed of low carbon sheet steel.

The Vultee Field Division at Downey devoted the major part of its work in 1942 to mass production of Valiant basic trainers for the Army and Navy. In addition, it was making parts for the Consolidated Liberator bomber and parts for Lockheed and Douglas. The Nashville Division concentrated on production of the Vengeance dive bomber. The Stinson Division produced Sentinel liaison planes and Reliant navigational trainers, two new airplanes brought out in November, 1942. The Intercontinent plant in Miami was producing parts for Vultee planes, including sections for the Vengeance dive bomber. As 1942 production continued to expand in these various plants, Vultee's training program for workers was intensified.

The Vultee 74 Valiant Basic Trainer had Army Air Forces designations BT-13, BT-13A and BT-15; U. S. Navy designation SN-V1. The Valiant was a two-seat, low-wing, cantilever monoplane with a wide center section; wing span, 42 ft., length, 28 ft. 10 in., height, 12



VULTEE VALIANTS

Basic trainers with the Army Air Forces.

ft. 4 in., gross weight, 4,360 lbs. The BT-13A was powered with a Pratt and Whitney Wasp Junior 450 h.p. engine, having a maximum speed of 180 m.p.h.; cruising speed of 168 m.p.h. and ceiling of 21,000 feet. The SN-V1 was powered with a Wright R-975 E-3 engine, having a maximum speed of 180 m.p.h., cruising speed of 168 m.p.h. and ceiling of 21,000 feet.

The Vultee Vengeance Dive Bomber had model numbers A-31 and A-35. The A-31 originally was built for the British, later diverted to the A.A.F. The A-35 was the latest in the Vultee Vengeance series at the beginning of 1943. It was a powerful and fast dive bomber with a bomb-load capacity of 2,000 lbs. and an unusually long range, permitting it to penetrate deeply into enemy territory. It was equipped with newly-perfected dive brakes and a highly efficient rudder control. The brakes were hydraulically controlled, and when open during the plane's death-dealing, almost vertical dive, served to guarantee the pilot complete control while giving him a high degree of accuracy in aiming bombs. The Vengeance was a two-seat, midwing cantilever monoplane of all-metal construction with a wing span of 48 ft., length 40 ft., a height of 14 ft. 6 in. It was powered by a 1,600 h.p. Wright Double Cyclone aircooled radial engine.

The Stinson Sentinel L-5 called "Flying Jeep" was a liaison plane designed to be the "eyes upstairs" of the artillery, cavalry, tank corps and infantry. Like its counterpart the Army "Jeep", this new plane was engineered to go wherever ground troops could go, to get in or out of a cow pasture, to set itself down on a highway. The Sentinel carried a pilot and an observer, and had radio equipment for communication with ground units as well as with other planes. It hovered at exceptionally low altitudes while directing artillery fire or the movement of tanks. It required little gasoline and demanded small service work—important factors on battlefronts with supplies and service problems. Its wing span was 34 ft., length 24 ft., weight 2,100 lbs. It was powered by a 190 h.p. Lycoming horizontally-opposed engine.

The Stinson Reliant Trainer AT-19 was built under the direction of the Army Air Forces for assignment to the British under lend-lease for teaching Navy fliers, operating from aircraft carriers, how to navigate. It was a high, gull-wing monoplane with a seating capac-

WACO UPF-7 TRAINERS

A week's production of trainers sold to flying schools under the C.P.T. program, outside the factory of the Waco Aircraft Company, Troy, O.

ity of four. It possessed a high degree of stability, and was powered by a 290 h.p. Lycoming radial engine.

The Waco Aircraft Company, Troy, O., continued in production on two models designed for use in the Civilian Pilot Training Program, and also expanded its wartime activities to include the creation of nine and 15-place gliders for the Army, development of an all-wood, twin-engine cargo plane; and the manufacture of parts for other prime contractors.

Waco UPF-7 trainers for C.P.T.P. operators were produced in quantity until late in 1942 and a considerable number of the Waco VKS-7F—a cabin trainer especially designed to meet the requirements of the cross-country C.P.T.P. contracts—were turned out. The latter ship was an improved version of the Model S known as the Waco Standard.

Early in 1942, the 15-seat Waco glider was placed on the production lines of 15 other aircraft manufacturers under direct contract to the Army Air Forces and under the guidance of Waco engineers. This model also was built in Waco's own factory.

Waco's stepped-up war activity was reflected in employment rolls which reached a new high and in the completion of a second factory addition which added substantially to the manufacturing floorspace available. Despite the mounting demand for new production, Waco took precautions to assure the continued participation of its trainers in the C.P.T.P. by earmarking a portion of its facilities for replacement parts and by increasing service personnel. The Waco twin-engine cargo plane was scheduled for production in 1943.

Manufacturers of Aircraft Engines

Aircooled Motors Corporation, Syracuse, N. Y., was engaged throughout most of 1942 in development work and production of new Franklin warplane engines for the Army and Navy. The engines were of the horizontally opposed, aircooled type. In production for light training planes and for C.A.P. use were these Franklin engines: The Franklin 6AC-298-F_3 was a split crankcase, six cyl. horizontally opposed, overhead valve, direct drive, aircooled engine rated 130 h.p. at 2,550 r.p.m., bore 4¼ in., stroke 3½ in., compression ratio 7 to 1, piston displacement 298 cu. in. The Franklin 6ACG-298-H_3 was a geared version of the 6AC-298-F_3, rated 165 h.p. at 3,500 r.p.m. engine speed, and 2,200 r.p.m. propeller speed. The Franklin 4AC-176-F_3 was a split crankcase, 4-cyl. horizontally opposed, overhead valve, direct drive, rated 80 h.p. at 2,500 r.p.m., bore 4 in., stroke 3½ in., compression ratio 7 to 1, with 176 cu. in. piston displacement. The Franklin 4AC-199-E_3 was similar, with 4¼ in. bore, 3½ in. stroke, 199 cu. in. piston displacement and 90 h.p. at 2,500 r.p.m. The Franklin 4ACG-199-H_3 was a geared version of the 4AC-199-E_3. It was rated at 113 h.p., at 3,500 r.p.m. engine speed, and 2,200 r.p.m.

propeller speed. The Franklin 6AC-264-F$_3$ had 120 h.p. at 2,600 r.p.m.

Allison Division, General Motors Corporation, Indianapolis, Ind., was delivering in high quantity America's only native-designed liquid cooled aircraft engine to reach mass production. The high production goal for this engine originally set by the Army Air Forces had been reached at the time of Pearl Harbor. At the beginning of 1943, Allison was producing engines for fighter planes at a rate which represented a 14-to-1 expansion over that of February, 1940, when quantity production of the engine was first undertaken. In terms of horsepower Allison was producing in one day 70 per cent of its monthly output of 1940. In that three-year period there had been a 12-to-1 increase in payroll, with 25 per cent of the productive employees women. Plant floor space had increased 663 per cent.

Allison had in regular production four models: the F-17, the F-20, E-19-R and the E-19-L. All change-overs to these new and different models were made without plant shut-down which usually occurs when such change-overs are undertaken, and in spite of the fact that the newer models required many new parts. The high production record attained by Allison was in a measure due to parts production of the Allison engine by other divisions of General Motors, the Cadillac and Delco-Remy Divisions making the major contribution. Cadillac, with its precision background, made 250 Allison parts, including crankshafts, connecting rods and gear reduction assemblies. Delco-Remy supplied aluminum and magnesium castings, in addition to 75 different machined parts. Other General Motors divisions subcontracting Allison parts were Chevrolet, New Departure, Hyatt Bearing, Delco Products, Packard Electric, A.C. Spark Plug, Antioch Foundry, Harrison and Inland.

The 7,000 parts in the Allison engine, however, comprised only 700 "piece parts" or separate production problems as against 2,300 "piece parts" in the most widely known European rival engine. For example, "piece parts" in one small subassembly were reduced from 39 to 3 by simply casting the part whole rather than bolting it together. This simplification of manufacture, an Allison practice from its inception, accounted in high measure for the 1942 production record.

In the fall of 1942, construction was completed on a new plant for the Allison Division, bringing to a total of six factories in the Indianapolis area housing Allison activities. Of the total plant floor space in these six factories 62,800 square feet were devoted to classrooms and other educational facilities for training Army mechanics and others whose responsibility it was to service and maintain Allison engines on all of the principal war fronts of the world. More than 20,000 men had been trained for this maintenance service.

In its period of record performance to meet the nation's war needs Allison did not neglect engineering development. By early in 1942 the

ALLISON ENGINE INSPECTION

Here women are inspecting main and connecting rod bearings.

laboratory floor space devoted by Allison to experimental engineering and development had been increased approximately three-fold over that of 1940. The number of technicians was quadrupled. One of the outstanding engineering achievements in this period was increase in horsepower output per pound of engine weight. In 1940 this weight ratio was 1.22 pounds per horsepower. In 1942 it was reduced to less than one pound per horsepower.

As the war in the air became intensified in 1943, war communiques from various fronts around the world made clear the wisdom of the Air Forces decision, made long before the start of World War II, to develop, along with sources for other types, an American source for liquid cooled aircraft engines. According to the communiques, the Allison engine was performing up to, and in some instances beyond, highest expectations, in the Lockheed Lightning, the Bell Airacobra, the Curtiss Kittyhawk and Tomahawk and the North American Mustang.

Commonwealth Aircraft, Inc., Kansas City, Kans., formerly Rearwin Aircraft & Engines, Inc., produced three models. The Ken-Royce Model 5E was a direct drive aircooled engine with C.A.A. rating of 70 h.p. at 1,950 r.p.m. The Ken-Royce Model 5G had a rating of 90 h.p. at 2,250 r.p.m. Ken-Royce Model 7G had a rating of 120 h.p. at 2,225 r.p.m.

Continental Motors Corporation, Muskegon, Mich., reported a

fourfold production increase in 1942, its Detroit plant winning the Army-Navy E. Another plant was completed in Michigan to produce high output aircooled and liquid cooled aircraft engines.

The Guiberson Diesel Engine Company of Dallas, Tex., increased production of two sizes of Diesel engines during 1942 and expanded its comprehensive research development program. The Guiberson A-1020 aircooled Diesel for aircraft, developing 310 h.p. at 2,150 r.p.m. with a dry weight of 2.1 lbs. per h.p. and with a displacement of 1,021 cu. in., received extensive testing on several types of American airplanes after it received an approved type certificate in 1940. During 1942 Guiberson produced the T-1020 radial Diesel as a power plant for large numbers of U. S. Armored Force light tanks. This engine, of which the aircraft type is a modified version, was credited with outstanding performance during the elaborate desert maneuvers in California, which prepared the U. S. Armored Force for the invasion of North Africa. Guiberson-powered tanks were used by U. S. Marines in the Solomons campaign.

At the Dallas plant, a new and elaborately equipped single-cylinder test laboratory was installed, and the Company enlarged its research staff to intensify its long-range development program.

The Guiberson Aircraft and Heater Division, during 1942, en-

MODERN EATING FACILITIES FOR EMPLOYEES

The main dining room at the plant of the Jacobs Aircraft Engine Co., Pottstown, Pa.

FOR LYCOMING AIRCRAFT ENGINES

Crankshafts for Lycoming's 300 h.p. engine on a roller-conveyor line. Every pair means power for a twin-engine Army advanced training plane.

larged its facilities to serve the aircraft industry's greatly expanded Southwestern plants, producing highly specialized parts on a subcontracting basis for Consolidated, North American, Lockheed, Globe and others. The Guiberson shops, equipped with specially designed machine tools, possessed complete facilities for drop hammer sheet metal forming, stainless steel exhaust manifold manufacture, aluminum alloy fabrication and heat treating, parkerizing and cadmium plating. It produced a wide variety of aircraft parts, but was concentrating on specialty work of a custom-made nature, since the plant's engineering and manufacturing facilities were designed to provide specialized service for the aircraft industry.

Jacobs Aircraft Engine Company, Pottstown, Pa., continued large scale production of its L-4 and L-6 series engines. The military demand for these engines for twin engine advanced trainers and light personnel transports made necessary still further expansion of the company's plant which had been trebled in area in 1940 and 1941. In addition, during 1942, the company constructed a large new plant for the production of Pratt & Whitney engines under license for the Services.

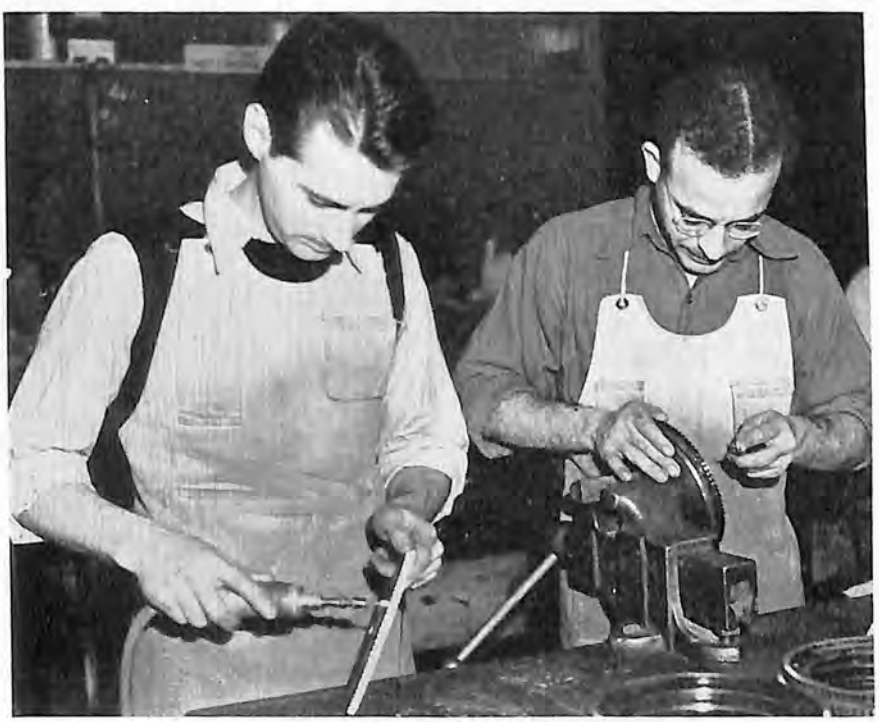
Jacobs engines powered the majority of the twin-engine advanced trainers for bomber-pilot training in both the United States and Canada. These trainers included the AT-17 Bobcat, the Cessna Crane, and the Avro Anson, of English design, built in Canada. In addition, the Cessna C-78 personnel transport powered by two Jacobs model L-4MBB engines was adopted by the Army as a standard officer's

transport plane, and early in 1943 was in service throughout this country, and in the various theatres of war. They were fast, economical and could land in and take off from small or rough fields. The C-78 made an extremely efficient officer's transport.

A number of further innovations in production efficiencies were introduced in the Jacobs plants during the year, and minor refinements were made in the company's production engines, although these well tried models remained basically unchanged.

Kinner Motors, Inc., Glendale, Calif., was producing seven models of aircraft engines. All were 5-cyl. radial, static, aircooled, 4-cycle engines, rated by the U. S. Civil Aeronautics Authority as follows: The K-5 at 100 h.p. at 1,810 r.p.m., the B-5 and B-54 at 125 h.p. at 1,925 r.p.m., the R-5 series 2, R-55 and R-56 at 160 h.p. at 1,850 r.p.m., and the R-53 at 175 h.p. at 2,100 r.p.m.

The Lycoming Division of The Aviation Corporation, Williamsport, Pa., was in full-out production on engines for a growing number of war training planes from 50 to 300 h.p. Latest of the Lycoming developments was a flat, 6-cyl. geared engine, the GO-435. It was horizontally opposed and developed 220 h.p. with reduction gearing at a crankshaft speed of 3,000 r.p.m. with propeller at 1,925 r.p.m.



BARBERS WORK FOR LYCOMING

To remove tiny burrs from crankshafts, the Lycoming Division of Aviation Corporation employed barbers for their fine touch with small power polishers.

Pratt & Whitney Aircraft Division of United Aircraft Corporation, East Hartford, Conn., kept well ahead of schedules in producing important engines for all types of American planes from advanced trainers to fighters and bombers. It also increased war engine output tremendously by assisting six licensee manufacturers to get into production. At East Hartford production was raised by the establishment of five satellite parts plants in neighboring communities. This expansion was piled on top of the large expansions of 1940 and 1941 which had multiplied floor area many times. The 1942 program added approximately 100 per cent in floor space and almost 50 per cent in personnel.

Planned in advance, the Pratt & Whitney subcontracting system absorbed the expanded demands upon it without interruption. As a result of planning, careful development and constant liaison, the flow of purchased parts and accessories from vendors in 29 States kept pace with the swelling tide of production in the main plant. Suppliers of raw and semi-finished materials also had been prepared for the demands of the war program through the same careful planning. Of the five satellite plants, three were newly constructed, one was a former textile mill and the fifth a remodeled automobile service building.

Entire departments were moved from East Hartford into these branch plants—each move being accomplished without the loss of an hour in production time or delay in assembly of a single engine.

The year saw five licensees swing into production on various models of Pratt & Whitney Wasp engines—Ford at Detroit, Buick at Chicago, Chevrolet at Tonowanda, N. Y., Nash-Kelvinator at Kenosha, Wis., Jacobs at Pottstown, Pa. A sixth licensee, Continental, was to start early in 1943 at Muskegon, Mich. Pratt & Whitney Aircraft passed on to all these concerns the "know-how" based on years of design, research, development and experience, in the shortest possible time, and then cooperated so that no bottle necks should hold up production. To communicate the "know-how," Pratt & Whitney Aircraft at the end of 1942 had given its licensees in training and manpower assistance the equivalent of 41,666 man days.

Added to the expansion of its own facilities and assistance given to its licensees, Pratt & Whitney Aircraft, at the request of the U. S. Navy, started another vast project at Kansas City, Mo. There it was building a plant to equal in size the expanded East Hartford unit. Ground was broken July 4, 1942, and Double Wasps in quantity were to be produced there in 1943.

In East Hartford the division produced 31 variations of 12 models of four basic types of engines ranging from 450 to 2,000 h.p. These included the 9-cyl. Wasp, Jr. and Wasp, the 14-cyl. Twin Wasp, and the 18-cyl. Double Wasp engines. At the same time sufficient flexibility of production was maintained to enable quick concentration on types required by the Services under the changing strategy of war.

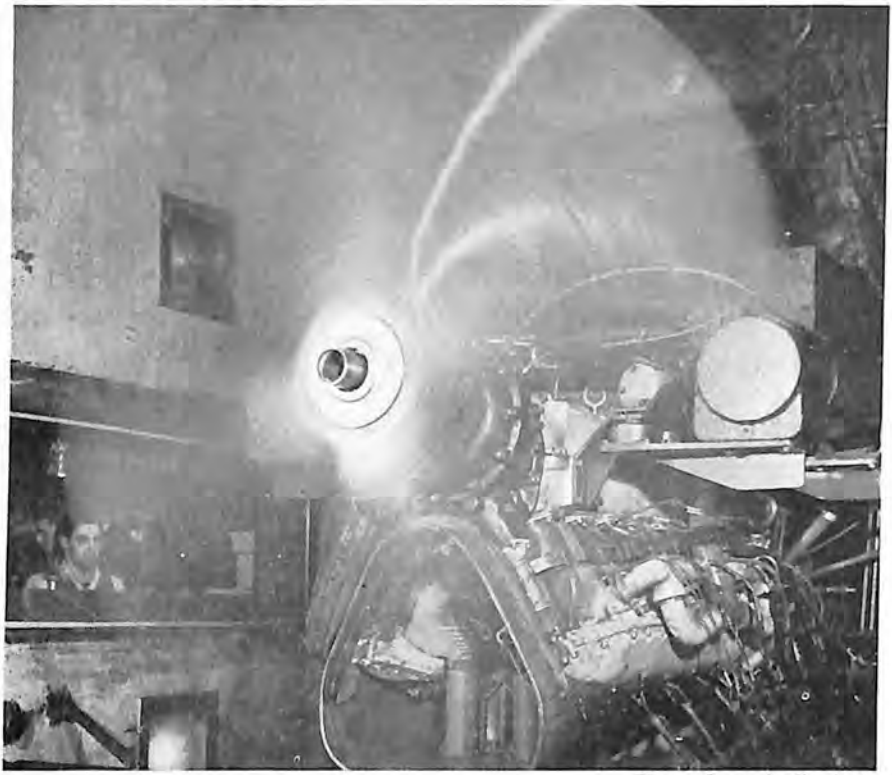
Meanwhile, intensive experimental development was carried on by Pratt & Whitney, both in refinement and improvement of existing models and development of new types.

Ranger Aircraft Engines Division of Fairchild Engine and Airplane Corporation, Farmingdale, N. Y., increased production over 190 per cent while carrying out extensive plant expansion and revision of production processes during our first year of war. Engines delivered by Ranger were the 6- and 12-cyl. inline, inverted, aircooled type and were for installation in the U. S. Army Air Forces primary trainer PT-19 built by Fairchild; the Royal Canadian Air Force Cornell trainer; the Grumman twin-engine Widgeon amphibion (6-cyl. installations), and the U. S. Navy scout-observation plane SO_3C; and the new twin-engine, plastic-bonded wood bomber crew trainer AT-14 built by Fairchild; (12-cyl. installations). Production was accomplished despite shortage of materials, a dwindling labor market and overdue machine tool deliveries.

On April 27, ground was broken on a new construction project at Farmingdale, which by November of 1942 made available an additional area of 212,424 sq. ft. for Ranger engine production and assembly. A second plant also was leased and placed in operation in July of last year. This unit was acquired to house small parts machine shop and materials supply departments and to feed the Farmingdale

PRATT & WHITNEY ENGINE PACKAGES

The huge aircraft engines are sealed in a Pliofilm jacket before being crated. It guards against moisture.



Hans Groenhoff photo

RANGER ENGINE ON TEST STAND

plant with finished small parts and subassemblies. This addition of 333,857 sq. ft. brought the combined area of both plants to 724,210 sq. ft. at the beginning of 1943.

Subcontracting was helping Ranger meet schedules. Next to adequate sources of vendor-supplied material came the essential refinement of production process to accelerate output and simplify machine-shop procedure to permit hiring machine-tool operators (with insufficient experience) to operate multiple purpose machines.

Production short cuts included installation of automatic burnishing machines capable of polishing a crankshaft in five minutes where hand operations required four manhours; development of machine-operated stud drivers, which permitted one man to do the work of six; utilization of previously discarded machine tools to perform single, simple operations and reduction of complicated setups on multiple purpose machines by designing of permanent quick-change fixtures.

Women were employed on productive jobs at Ranger in July, 1942. The earliest application was for routinized operations such as

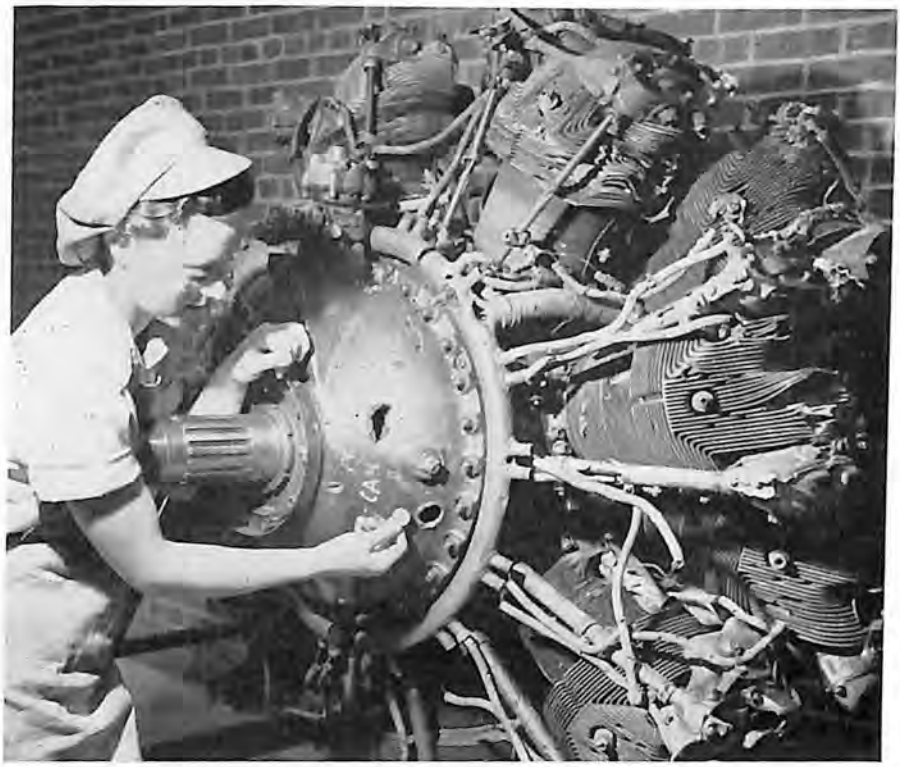
punch presses, bench inspection, burring, and simple machine tools. By September, however, women with as little as four weeks of training in machine-shop work were operating lathes, drill presses, and other machines requiring definite skill. At Farmingdale, 20 women first were trained and placed on the job as engine testers and inspectors during October. This was most outstanding because of their satisfactory execution of work previously done by graduate engineers only.

The Warner Aircraft Corporation, Detroit, Mich., continued production of the Scarab and Super-Scarab Series 50 engines, rated at 125 and 145 h.p. respectively. The Super-Scarab Model 165 engines were produced in quantities for the Army Air Forces, for installation in the C-61 airplanes manufactured by Fairchild. The Super Scarab Model 165 was a 7-cyl. aircooled engine, rated at 165 h.p., with a take-off rating of 175 h.p. with a controllable pitch propeller. In addition to the manufacture of aircraft engines, Warner manufactured hydraulic brake control units for various manufacturers of military aircraft. Due to increased production on engines and hydraulic brake control units, additional plant area was provided, with 30 per cent to the Detroit plant and opening a new plant at Grand Rapids, Mich.

...Wright Aeronautical Corporation, Paterson, N. J., continued its tremendous expansion program. A giant plant was erected in New Jersey, using the recently developed "Warspeed" technique whereby the concrete roof and supporting columns were poured over mobile wooden forms which, after the concrete had set, were moved on suitable tracks into position for pouring the adjacent sections. After completion of the roofing, the walls and floors were built of brick and concrete. The plant was designed entirely without windows, and with light-proof ventilation. Ground was broken in the Spring; by late Fall engines were being produced. Extensive additions were made to other Paterson plants, the Ohio plant was more than doubled in extent, and two new foundries were erected.

Large numbers of women were given employment in all branches of manufacturing, including foundry and machine shop, as well as in engineering, clerical and laboratory work. Preparations were made for training and employing 20,000 women workers in 1943.

The Wright Whirlwind remained in production in both the 7-cyl. model rated at 235 to 350 h.p., and in the 9-cyl. models of 365 to 450 h.p. The former was used principally in primary training planes. The 9-cyl. model was produced in considerable numbers, the bulk of the output being manufactured under license by Continental Motors Corporation for use in the M-3 tanks. Widespread use of this Whirlwind 9 also was made in Vultee BT-15 and North American BT-9 basic trainers, Curtiss SNC-1 scout trainers, North American NA-64 Yale trainers, Stinson Reliant observation planes, and Goodyear Navy patrol airships.



SHELL-TORN WRIGHT CYCLONE

Though riddled by bullets and shellfire, and with the other engine of the Douglas Boston bomber shot off in a daylight raid over France, and bombardier and gunners killed at their posts, this Cyclone brought the ship back to England.

The Wright Cyclone 9, which was rated at 525 h.p. when it was first built in 1927, continued in production in the 1,100 and 1,200 h.p. models. Both featured a two-piece forged steel crankcase. This engine was the standard power plant for the Boeing B-17 Flying Fortress. Its rating of 1,200 h.p. was the highest ever accorded to a 9-cyl. radial aircooled engine. The Cyclone 9 powered a score of American warplane models. The output of these engines was increased sharply through the contributions of the Studebaker Corporation which undertook quantity production under a licensing arrangement.

An outstanding development by Wright Aeronautical was a forged aluminum cylinder head to replace the cast heads formerly in use. This new head was substantially stronger than the cast head, its improved cooling characteristics and greater volumetric efficiency made possible an increase in power output of approximately 15 per cent. This power increase, coupled with the somewhat lighter forged head had the effect of reducing the weight of the entire engine to below

one pound per horsepower, making it the first high power engine to possess so low a weight-horsepower ratio. First applied to the Cyclone 9, it was planned to extend its use to other engines when conditions permitted. Revolutionary new machining processes were evolved for the manufacture of the head.

Production of the Wright Cyclone 14 was increased still further to meet the growing demands of the Services. Introduced in 1936, this engine had scored outstanding successes by powering the Boeing 314 Clipper ships of Pan American airways, and had proven itself capable of withstanding the tremendous strains imposed by long hours of continuous running. Both the 1,600 h.p. model with an aluminum alloy crankcase, and the 1,700 h.p. model with a forged steel crankcase were in production. These engines powered 17 types of warplanes.

Limited production was maintained on the Wright Cyclone 18, the world's largest aircooled radial, used on the Douglas B-19, Lockheed Constellation and the Martin Mars.

Continuing its development and materials conservation program, Wright introduced the use of plastics as a substitute for aluminum in push rod housings and cylinder baffles, and made innovations in manufacturing equipment. All plants were completely conveyorized to reduce handling time and eliminate storage of parts in process.

All Wright Cyclones were equipped with the Wright dynamic damper which, in most models, was applied to both the front and rear crankcheeks. Aluminum cylinder heads were screwed and shrunk on to the nitralloy cylinder barrels, full pressure valve rocker lubrication was provided and provision was made for hydraulic controls for either constant speed or variable pitch propellers. The Wright torque indicator was made available on all 9, 14, and 18-cyl. models and was supplied in built-in form in the lower portion of the nose section. Cap screws were employed for cylinder hold-down purposes on steel crankcases in place of the studs used on earlier models, thus facilitating disassembly and permitting magnetic inspection of the screws as well as of the entire crankcase at every major overhaul. Hollow exhaust valves were partially filled with a sodium-mercury eutectoid, replacing the solid metallic sodium used in earlier models. Pure silver replaced the lead bronze for connecting rod bearings.

Wright engines were employed extensively in the passenger planes of leading American and foreign air lines.

Manufacturers of Accessories

Adel Precision Products Corporation, Burbank, Calif., added a number of new products to its line of aircraft equipment, among them the stacking midget four-way hydraulic selector valve, designed to do the work of a multiple type valve, save space, increase efficiency and simplify servicing and installation. Several high capacity valves

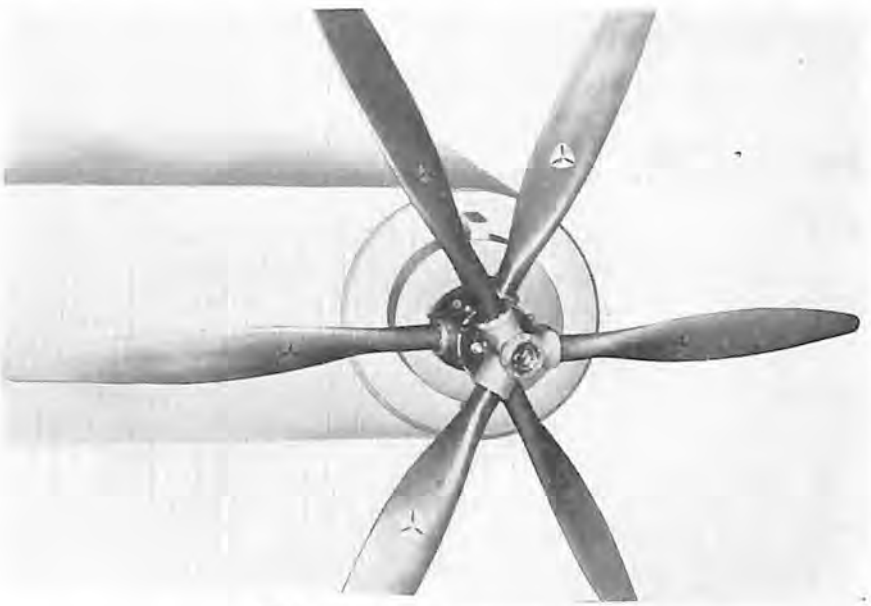
ADEL'S STACKING MIDGET

A new four-way hydraulic selector valve designed to do the work of a multiple type valve, save space, increase efficiency and simplify servicing and installation.

could be clamped together and installed in closely confined areas such as the cockpit control panel. Parts were interchangeable, and sections could be serviced without disturbing the complete assembly and without disconnecting associated lines and fittings. Plastic line support blocks with a thin Adelite cushion were offered to replace the former solid synthetic rubber block with a saving of 88 to 94 per cent in rubber. A noiseless relief valve also was developed. The Huntington Division of Adel started production on an improved hose clamp, "Sta-loc", made of stainless steel. With one simple adjustment it could be snapped on without tools or special skill. There were no screws or bolts; an even, all-around pressure was exerted, and the clamp could be used repeatedly. To reach production goals, the personnel problem was met by a company-operated training school where unskilled people became expert shop workers for specialized operations in a few weeks of intensified training. A group of nationally known engineers and executives joined the Adel staff, and helped speed the engineering and production machinery. Physical plant equipment was added to meet production expansion, which was aided also by the output of about 200 subcontractors. With new engineering offices in Detroit, Mich., and Dallas, Tex., the company had four engineering offices in the United States and one in Canada to assure competent and ample consulting service. The company offered 100 valves, built on six basic designs, with parts 90 per cent interchangeable.

Aeronautical Products, Inc., Detroit, Mich., manufacturers of aircraft precision parts, more than doubled employment and plant space, with a further substantial boost in prospect for 1943. The company's training program for precision workers resulted in 90 per cent of the total personnel having been company-trained by the beginning of 1943. Rearrangement of machinery, adapting older machines to new tasks and the purchase of equipment for new production outlets resulted in many short-cuts which helped to increase output.

Aeroproducts Division of General Motors, Dayton, O., designers and manufacturers of advanced controllable pitch, constant speed propellers, was in full-scale production for the Army and Navy Air Forces. Designed in cooperation with the Army Air Forces, the Aeroproducts hydraulically-operated propeller was developed as a single compact unit, for easy installation and maintenance on fast pursuit ships. In addition, it had a "hollow shaft" to allow firing of a cannon through the hub. Production of this type was of such quantity and quality that Aeroproducts took over the job of supplying propellers for all the "flying cannon" planes. Based upon Aeroproducts' pioneering design of hollow, ribbed-steel blades, engineers also secured



AEROPRODUCTS PROPELLER

Aeroproducts Division of General Motors Corporation completed its new dual rotation propeller, built as a self-contained unit with its own hydraulic system. Research for this contra-rotating propeller, which is equipped with Aeroproducts' hollow, ribbed-steel blades, was sponsored by the Army Air Forces. The propeller is of automatic, constant speed, controllable pitch design and the only external mechanism outside the propeller unit itself is the control lever in the cockpit.

Army approval of a four-blade propeller and of an automatic-controlled dual rotation propeller. Production of the four-blade propeller for the most powerful pursuit ships was under way. Like the three- and four-blade Aeroprops, the six-blade contra-rotating propeller was unit-constructed, containing within itself the motivating power to create pitch change without external aid, thereby cutting installation and maintenance time.

Aircraft Accessories Corporation, Burbank, Calif., increased production, manufacturing facilities and personnel to keep up with the constantly expanding requirements of the airplane manufacturers. It developed many new products and improved those already in production. A new product was the new AAC Brake Valve for the foot pedal operation of brakes on planes weighing in excess of 12,000 lbs. Other new products included were ultra high frequency radio beam transmitters and precision radio components. Several thousand improvements in manufacturing processes resulted in marked savings in manhours and material requirements as well as important gains in production.

Aircraft Hardware Manufacturing Company, Inc., New York, makers of many types of constructional hardware for aircraft, continued manufacture of its standard line of bolts, nuts and turnbuckles. The firm's stainless steel department was expanded with special screw machine parts and swedging terminals being among the most important items in sales.

Aircraft Mechanics, Inc., Colorado Springs, Colo., produced a large number of welded tubular assemblies and intricate forgings for aircraft.

Aircraft Screw Products Company, Long Island City, N. Y., produced its Aero-Thread screw thread system which provided a thread lining for the tapped hole which engaged the threads of the screws. The inserts were made of hard, smooth, precision-shaped wire of stainless steel or phosphor bronze. The system claimed the advantages of low cost, protection against wear and abrasion in light metals and increased holding power.

Aircraft Welders, Inc., Wichita, Kans., had more than quadrupled plant facilities and was supplying the aircraft manufacturers with increasingly heavy orders for aircraft tubular stuctural frames such as engine mounts, nacelle frames, tail wheel assemblies, landing gear parts and other welded specialties.

AiResearch Manufacturing Company, Inglewood, Calif., was in day and night production on its recent development of automatic control of oil temperatures in aircraft engines by means of their device regulating the shutters on the coolers, or in some planes, the exit flap which takes the place of the shutters on the cooler itself. The company also developed light weight supercharger intercoolers which cooled air between the supercharger and the carburetor; and it

also brought out a combination Prestone radiator and oil cooler for use on planes with liquid-cooled motors.

Concurrent with heat transfer development, AiResearch pioneered in perfecting a cabin pressure control system for the comfort of personnel flying at high altitudes. The AiResearch system eliminated the use of bulky flying apparel or oxygen, except as emergency equipment. It was capable of maintaining an 8,000 foot cabin pressure at any airplane altitude, but automatically regulated internal or cabin pressure to compensate for the structural strength limit of the cabin, which might, for instance, be able to withstand a differential pressure of 8,000 to 35,000 feet. Other refinements of this pressure control system were under way to extend the pressure cabin ceiling to 50,000 feet by 1943.

Allied Control Company, New York, produced a line of high speed latching and power relays for aircraft radio, flight, firing and communication control equipment.

Alloys Foundry, Inc., Wichita, Kans., added to its reorganized staff X-Ray technicians and technical foundrymen for its production of aluminum and magnesium sand castings.

Aluminum Company of America, Pittsburgh, Pa., reflected in its activities the rapidly quickening tempo of the war. A host of new plants, capable of handling all phases of aluminum production and fabrication were under construction, including many for the Defense Plant Corporation. It was estimated that when these units were completed and the 1943 peak production reached, there would be a capacity in this country to make 2,100,000,000 pounds of aluminum annually—63 per cent more than the total world production in 1938. Of this total, Aluminum Company of America expected to produce a major portion in its own plants and those leased from the Government. Forging output of the company was 25 times that before the war. Production of castings had multiplied 11 times; extruded shapes and tubing, nine times. A single sheet mill was turning out every month one and a half times as much high strength alloy sheet, such as is used in warplanes, as the whole country used in a year before the war. One of the Company's new sheet mills could roll aluminum sheet 50 times faster than in 1940. Two similar mills were nearing completion in the Middle West and Northwest early in 1943. At the beginning of the war, aluminum ingot sold for 20 cents a pound. Four price reductions by 1943 brought this down to 15 cents a pound, aluminum pig was offered on the market as low as 14 cents a pound. Despite the demand for tremendous quantities of aluminum for war equipment, the company found time to continue its research and experimentation, with resultant improvements in material and technique. Of particular interest to the aviation industry was a new forged aluminum cylinder head which went into production early in 1943. Improved methods of fabricating likewise were developed.

Brazing was being used extensively in the construction of many light weight assemblies, and the application of spot welding was no longer considered experimental in aircraft work.

American Bosch Corporation, Springfield, Mass., substantially increased its production of aviation magnetos, keeping well ahead of schedule. American Bosch also commenced large-scale manufacture of a new development, the induction vibrator weighing 30 ounces.

American Magnesium Corporation, Cleveland, O., a subsidiary of Aluminum Company of America, was a fabricator of magnesium and magnesium alloy products. While not a producer of the magnesium metal, it had facilities for the manufacture of magnesium alloy products in every commercial form. The company's entire output, however, was devoted to war purposes, and practically all to the manufacture of aircraft.

American Propeller Corporation, a subsidiary of the Aviation Corporation, Toledo, O., made its first shipment of one-piece hollow steel propeller blades in June, 1942, and early in 1943, the company was increasing plant facilities by 50 per cent. Large scale production of the hollow steel blades for warplanes was made possible by a double, continuous manufacturing line about three-fourths of a mile in length. For each blade design, overhead and roller conveyors handled the chrome-nickel-molybdenum tubing through an exacting sequence of operations that turned out one-piece hollow blades of precision balance and interchangeability.

American Screw Company, Providence, R. I., continued to supply the aircraft industry with wood, machine and sheet metal screws and miscellaneous hardware.

American Tube Bending Company, New Haven, Conn., manufacturers of tubular parts of ferrous and non-ferrous metals; all built to the designs and specifications of its customers, increased production 100 per cent with an increase of 18 per cent in personnel and 30 per cent in productive floor space. Improved inspection methods resulted in a three per cent decrease in parts rejections.

Apex Machine & Tool Company, Dayton, O., manufactured joint socket wrenches, power bits and hand drivers and other specialized tools for aircraft production.

The Aro Equipment Corporation, Bryan, O., produced propeller hubs for both wood and steel blade propellers on training planes. Large numbers of fluid segregators were delivered and mass deliveries of vacuum pumps were scheduled. Facilities were set up for producing oxygen demand regulators. Aro engineers completed a number of special engineering projects assigned by the Army Air Forces. Production of aircraft products was consolidated in a new addition to the Aro factory, and an extensive employee training program was put into effect.

Atlantic India Rubber Works, Inc., Chicago, Ill., was devoting

solely to war work its extensive resources and facilities for supplying molded and extruded rubber parts for the manufacturer of aeronautical equipment.

Automatic Electric Company, Chicago, Ill., pioneer manufacturer of automatic telephone systems, devoted much of its production activities to the construction of supply relays, stepping switches and other electrical control devices for installations in the field of military aeronautics. The company developed aircraft lighting systems, motor con-

B G IGNITION HARNESS TEST SET

A product of the B G Corporation, it was designed to determine whether wire insulation and terminal sleeves are in good condition. It supplements the new B G high voltage spark plug test set.

trols, interior telephone systems, landing controls, radio apparatus and numerous similar applications for military and civilian use.

The B G Corporation, New York, contributed toward the improved operation of American aircraft power plants by supplying test equipment, including a high-voltage spark plug test set designed for checking spark plugs to determine whether they are in a satisfactory electrical condition. The electrical circuit included a high-voltage bridge, in one leg of which were incorporated the spark plug under test and the pressure chamber. By quenching the spark with high-pressure air or gas in the pressure chamber, a predetermined potential could be applied across the insulation of the spark plug. If an electrical leak occurred, it was indicated by the glow of the neon bulb. No glow indicated a good plug. With this test, therefore, it was possible quickly to establish whether or not the insulation of the spark plug was electrically secure. If it was secure, a spark could occur between the electrodes of the spark plug in the presence of engine operating pressures when the gaps were within the limits of .010 to .030 inch. That test set supplemented the ignition harness test set introduced previously. This was designed to check ignition harnesses to determine whether the wire insulation and terminal sleeves were in a satisfactory condition. Operation was from standard AC sources of voltage, and by means of a transformer, permitted the application of a high potential across the insulation of the wire from the conductor to the radio shielding. With this instrument the source of trouble could be located quickly, easily and accurately. B G also had undergoing tests early in 1943 a recently designed spark plug incorporating the use of a resistor, which had been found to decrease the rate of electrode erosion. To eliminate troubles frequently experienced with spark plug terminal sleeves, a new type ceramic sleeve was offered to replace the impregnated paper-base type. The ceramic sleeves were non-water-absorbent.

B. H. Aircraft Company, Long Island City, N. Y., continued to supply the Government and the aircraft industry with fabricated sheet-metal parts of various kinds and styles.

The Bell Company, Inc., Chicago, Ill., produced hydraulic fluids to meet Air Forces specifications. Both mineral oil and castor oil types were available. Bell had accomplished considerable research on hydraulic fluids to operate at extremely low temperatures, and this information was available to the industry.

Bendix Aviation Corporation, Bendix Products Division, Landing Gear Department, South Bend, Ind., manufactured landing gear equipment, including Bendix pneudraulic shock struts, wheels, brakes, master cylinders and power brake valves. A great expansion of facilities was made in step with the war effort. In addition to new facilities in South Bend, a manufacturing unit in Wayne, Mich., was operating to capacity. A number of plants in various parts of the coun-

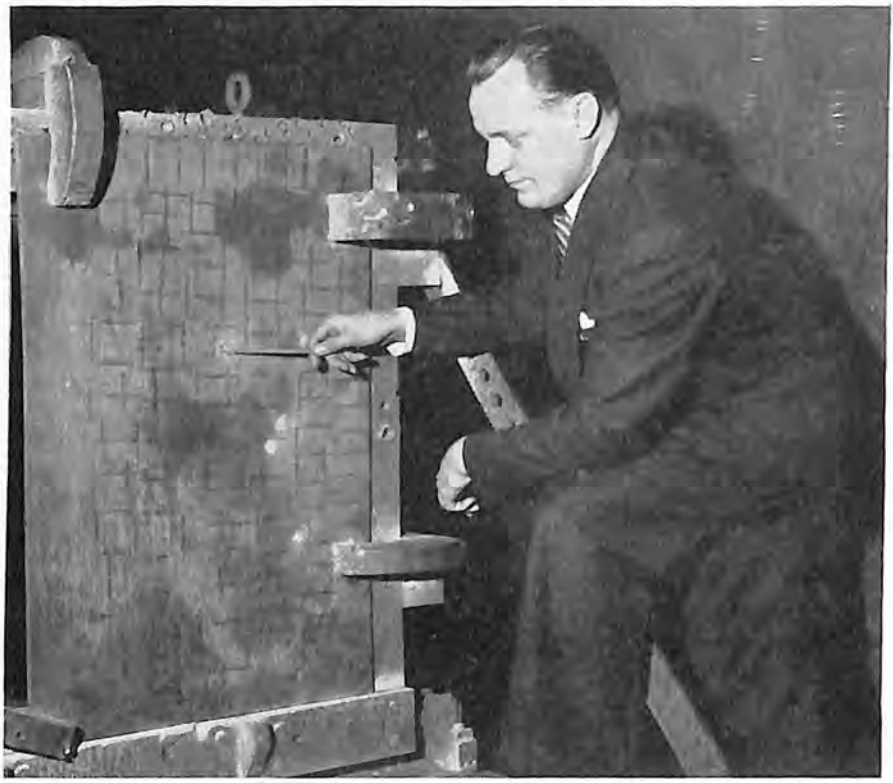
try became subcontractors. Some of these plants manufactured complete assemblies, while others provided parts and subassemblies for the major operating units. More than 50 items of equipment manufactured by this department were standard on planes. Stromberg injection aircraft carburetors, produced by the Stromberg Department, were standard equipment on many American military airplanes. The carburetor had new standards of performance, adding to the safety, speed, maneuverability and range of the plane.

Bendix Aviation, Ltd., North Hollywood, Calif., manufactured both hydraulic controls and radio accessories, specified on many military airplanes. Bendix hydraulic controls included the two, four and five-way selector valves, check valves, sequence valves, relief valves, hand pumps, pressure regulators, power brake valves, hydraulic-electric switches and actuating cylinders. Whenever possible Bendix incorporated its exclusive plastic poppets in the design of its hydraulic units. Bendix introduced its new continuous shell hydraulic pressure accumulator which was specified on several new airplanes. Radio equipment manufactured by Bendix included light-weight communication systems, interphone systems, control panels, generator and fuel pump filters, antenna switches, range filters, vacuum relays, dynamotors and generators.

The Benwood-Linze Company, St. Louis, Mo., was in war production on its patented dry-plate metallic rectifiers. It reported that great progress had been made in selenium rectifiers, also covered by Benwood-Linze patents, which, because of their light weight, small size and dependable performance made them of especial value where other types of metallic rectifiers were not practical. Besides being conversion devices, they were particularly useful in other applications such as valves, voltage limiters and variable resistances.

The Black & Decker Manufacturing Company, Towson, Md., was in war production on portable electric tools for the aircraft industry. New electric speed drills, sanding devices, grinding and punching accessories and electric tools of many varieties were engineered to the heavy production requirements of airplane, aircraft accessories and similar fabricating and assembly operations. An important product was the heavy-duty Holgun, an electric hand drill, widely utilized through aeronautical plants.

Boots Aircraft Nut Corporation, New Canaan, Conn., developed many new applications for its weight-saving, all-metal, vibration-proof wing-style nuts in its research and development laboratory. New methods of manufacture as well as expanded plant facilities enabled the company to increase its output of nuts and nut assemblies to keep pace with the huge demands of war. A circular gang channel was introduced which not only incorporated the feature of removable nuts but offered completely fabricated shapes, contoured, if necessary, to fit specific applications. The new Boots Rol-Top Hexagon nut was an



BREEZE CORPORATIONS' ARMOR PLATE TEST

J. T. Mascuch, President, Breeze Corporations, inspecting aircraft armor plate which has just been subjected to .50-caliber machine gun fire in special testing range. Armor piercing ammunition merely fuses into shapeless bumps or depressions stopped by the tough plate now produced more rapidly by special processes developed by Breeze.

all-metal, heavy-duty, self-locking nut designed to resist high temperature, gasoline and other destructive elements, and became standard for aircraft engines. The company's line of anchor nuts, both stationary and floating types, was made available with dimple countersunk rivet holes, permitting their immediate use where flush mounting was desired, thus eliminating costly machine countersinking. The company introduced the Boots Cage Nut which provided the first acceptable method of fastening plywood to plywood, or plywood to metal, where removability was desired. The Cage nut incorporated the familiar Boots self-locking nut in a basket mount which, when collapsed by a clinching tool into the plywood, securely gripped sheets of varying thicknesses.

Boston Insulated Wire & Cable Co., Dorchester, Mass., continued to manufacture on a large scale lighting, power and instrument wire

and cable for aircraft. In 1942 the company completed conversion of its entire plant to production of high quality aircraft cable meeting specifications even more rigid than the Army-Navy standards. Facilities were provided for manufacture of every type and size of electric cable used on aircraft, from heavy battery cables to small instrument leads, multiple conductor cables, coaxial transmission cables, bonding cable and shielding, as well as numerous types of radio cables. The many special pieces of apparatus going into the construction of a bomber requiring specially designed cables with the proper number of conductors and gauge sizes also were produced on special orders.

Breeze Corporations, Inc., Newark, N. J., engaged 100 per cent in fulfilling war contracts, continued to expand its plant structures, equipment and personnel, which accounted for greatly increased production of assemblies for aircraft, anti-aircraft, tanks, warships and ground defense equipment. The high productivity obtained, plus further certain expansion, was attributable directly to long-range planning by the company which began preparing for all-out war effort three years before Pearl Harbor. New developments or refinement of war products included a faster and more efficient technique of manufacturing aircraft armor plate which withstood exacting tests in a special testing range. Further improvements were made and production accelerated in cartridge starters and radio ignition shielding, conduits and fittings, conduit junction boxes, swaging machines and hand swaging tools, electrical connectors, resistance type thermometers, tab controls, ammunition rounds counters, internal tie rods, tachometer, fuel pump and remote control drives and other equipment. A new line of multiple-circuit electrical connectors was further perfected for use at firewall, generator, radio and instruments with improved contacts. The Breeze fuel-air ratio indicator afforded a fast, accurate reading of the fuel-air mixture based on the analysis of exhaust gas. The cartridge engine starter secured its energy from a shell using slow-burning fuel to generate the required power at a controlled rate which provided ample torque without danger of shock to engine parts. The starter could be used without drain on the airplane batteries, as the shell was fired by the current from a flashlight cell.

Buhl Stamping Company, Detroit, Mich., added exhaust systems to its wartime products. A new process in the casting of medium-hard dies was developed for use on conventional type presses, assuring uniform stampings in moderately large quantities at a minimum initial expense.

The Cambridge Instrument Company, Inc., New York, pioneer manufacturers of the aero-mixture indicator, continued to expand plant area and facilities. Millions of gallons of aviation gasoline were saved by pilots using the aero-mixture indicator, and the need for this flight instrument in the war effort imposed major tasks in scheduling production to meet the demand. Designed for single and multi-engine

FABRIC TEST FOR GAS LEAKAGE

The Cambridge permeameter determines the rate at which a given gas permeates through proofed fabrics or sheet material.

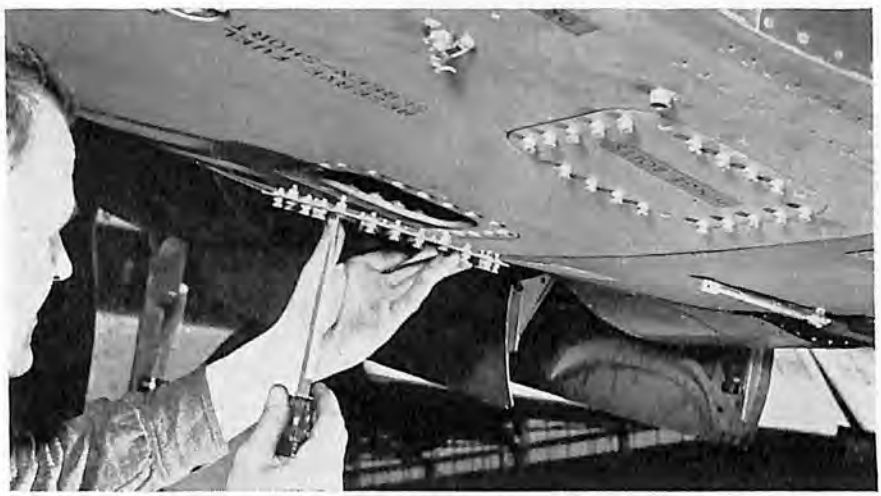
planes, military or commercial, the Cambridge aero-mixture indicator determined the fuel-air ratio of the engine mixture by analyzing a sample of the exhaust gas, and provided a continuous guide so that the pilot obtained optimum performance of engines, maximum cruising radius, payload and safety. Cambridge also made available the test-stand exhaust gas tester, an accurate yet inexpensive means for making distribution tests and for quickly and accurately determining the efficiency with which fuel is burned in any or all cylinders of an engine under test. Another important Cambridge development of importance in the war effort, was the fabric permeameter, a rugged and convenient instrument for the production testing of fabrics or sheet materials treated to hold or exclude gases. It determined the permeability of fabrics to be inflated with helium, hydrogen or other gases, and was invaluable to processors of fabrics for balloons, life rafts, life jackets and gas masks. Cambridge also produced many other types of precision instruments.

Camloc Fastener Company, New York, completed several major developments in its high speed fasteners. They were designed to hold securely access panels that must be removed quickly and often. Single-hole mounting in both inside and outside sheets required only simple

closing tools, and effected substantial savings in installation-time in aircraft plants, as well as in maintenance-time when planes were in active service. Camloc was particularly adaptable to curved sheet installations and in locations where high shear loads and limited deflection were encountered. Spotting tolerances are 1/32 of an inch or more, depending on depth of the dimple. The unique removable stud assembly enabled last minute adjustments to be made quickly and easily. Experimental and research work was conducted steadily in Camloc's own laboratory in New York. Camloc engineers also designed a unique sealing cap which provided absolute protection against dust, air and moisture. The cap was tested for 24 hours continuously under a pressure of 40 lbs. per square inch without loss. Another recent development was a riveted type fastener to meet manufacturing difficulties that required this kind of installation. Camloc increased production 600 per cent in 1942.

Cannon Electric Development Company, Los Angeles, Calif., was in full-out war production of electrical cable connectors for aircraft circuits varying from six to 500 volts and with cycle variations running from direct current to a frequency of 14,000. The wide variation in conduit sizes and the number of conductors in a given conduit made it necessary for Cannon to supply connectors in many sizes with many different contact arrangements.

Cardox Corporation, Chicago, Ill., brought out its new airport fire truck using carbon dioxide at controlled low temperature. With its mass discharge of carbon dioxide, the airport fire truck proved highly effective in crash fires by knocking down heat and flame for



CAMLOC FASTENERS ON WING PANEL

A typical Camloc application on an access panel on the lower side of the plane's wing. The fasteners are locked quickly with a single turn of the closing tool.

rescue of plane personnel. The truck carried three tons of liquid carbon dioxide in a refrigerated storage unit. Small quantities of water supplemented the use of the carbon dioxide through the same discharge nozzles. Cardox also applied the same principles to fire extinguishing systems in test cells of engine plants.

Champion Spark Plug Company, Toledo, O., was in production on an all-ceramic insulated spark plug meeting the exacting requirements of high-output aviation engines, following exhaustive tests participated in by various Government agencies and aircraft engine manufacturers. The importance of the all-ceramic insulation was enhanced because of the dwindling supply of mica upon which the United Nations could draw. The ceramic plug, too, was reported to perform effectively under the higher temperatures and pressures of the latest high output engines. The ceramic "body," composed of a variant formula of Champion's long familiar Sillimanite insulating material, was fired in different kilns and at different temperatures than had been standard practice. Results, as stated by the company, included: Immunity from heat and chemical reaction, freedom from fuel, oil and moisture absorption which brings on "shorts", inherent high heat conductivity with consequent higher range between pre-ignition and fouling, absolute uniformity of material, homogeneous structure eliminating air spaces and preventing leaks, easily cleaned and serviced, and controlled manufacture, assuring uniform quality standards. Recent additions to the Champion Spark Plug Company's Toledo plant made available 30,000 square feet of floor space devoted exclusively to the manufacture of Champion aviation spark plugs. Increased production, stepped up more than 1,000 per cent over the previous year, resulted in a material reduction in costs.

Chandler-Evans Corporation, South Meriden, Conn., was bringing into production a new carburetor testing plant in the Middle West, in which carburetors of CECO design, manufactured by subcontractors, were made ready for use. The output of this plant was many times the capacity of the Meriden plant. Production was further increased in Meriden on the current line of CECO fuel pumps, largely by increased use of subcontractors for the manufacture of parts. With the general adoption of Protek-Plugs in the standard packing procedure for aircraft engines, the production of these dehydrators was increased to take care of all requirements. No critical materials were required in the manufacture of Protek-Plugs. New developments included extending the size range of the carburetors and fuel pumps, presentation of a simplified design fuel pump which lent itself readily to mass production, and the adaptation of Protek-Plugs to varied uses other than engine packing.

Chicago Aerial Survey Company, Chicago, Ill., engaged since 1924 in producing aerial photographic surveys, maps and oblique views, enlarged their manufacturing operations and continued manu-

facture of the "Sonne" aerial camera, the result of many years of development experience. The company held numerous contracts with the Army Air Forces.

Chicago Metal Hose Corporation, Maywood, Ill., with 40 years experience in flexible metal hose development was in full war production for the aircraft industry, including flexible aircraft engine fuel and oil line hose and fittings, hose for hydraulic service and flexible metal hose and tubing for radio and electrical shielding conduits and fittings.

C. P. Clare and Company, Chicago, Ill., which originated the idea of "custom-building" relays to meet specific engineering demands as opposed to the rigid limitations of the ordinary "telephone-type" relays. Clare had developed several new relays precisely built for aircraft and mobile applications, of which the Clare Type K d.c. Relay was an outstanding example. Dwarf-size and feather-weight, this relay was custom-built for designs where fractions of inches and ounces count; where the ability to control high frequency circuits was imperative; and where resistance to constant vibration and sudden, severe shocks was a must. It was so compactly built and so tightly welded together that it employed no anti-vibration springs, no bearings or other devices which might shake loose.

The Cleveland Pneumatic Tool Company, Cleveland, O., manufacturer of Aerols (shock absorbing landing gear units) and Cleco pneumatic tools, further increased its manufacturing capacity and developed several new and improved products for the aircraft industry. Because of the great demand for Aerols, production was boosted and construction was begun on a new, modern plant. Opening early in 1943, this new plant was devoted solely to Aerol production. Three to five thousand men were employed. Several new aircraft air tools were introduced, including the Cleco 9D020 drill which operated in any plane and at any angle, and the Cleco 41-L squeezer which had parallel jaw action to prevent "clinched" rivets. There were also several improvements in the Cleco sheetholder. A system was introduced whereby each size was colored differently to insure ready identification. Because they were readily repairable, a repair and exchange service was established. Repair and exchange stations were set up at the main plant and various branch offices so that the user could have damaged Cleco sheetholders promptly repaired or exchanged.

Clifford Manufacturing Company, Boston, Mass., extended its facilities for serving the aircraft industry with basic materials for engine cooling and cooling control. It manufactured the Hydron thin-wall extruded tubing for aircraft radiators, oil coolers, intercoolers and heat interchangers for liquid and air-cooled engines; and also turned out the Hydron thin-wall hydraulically-formed metallic bellows for use in all types of temperature and pressure control devices for engine cooling systems, carburetors and superchargers.

Cook Electric Company, Chicago, Ill., manufacturers of more than 80 products for aircraft, communications and industrial applications, introduced the Cook relay and the Cook "Spring-Life" metal bellows. The Cook balanced armature relay was a double action interlocking control unit with balanced armature control. It could be tailor-made to fit into designs where its small size and light weight were essential, and was built ruggedly to take severe shocks and constant vibration for aircraft usage. The Cook "Spring-Life" bellows were placed on the open market. They were constructed from individually fabricated diaphragms or flanges, joined alternately at inner and outer peripheries. Fabrication of the simple flange permitted use of tough tempered metals such as phosphor bronze, steel or Monel metal. the "Spring-Life" method of construction made it possible to build bellows in practically unlimited diameters and pile-ups, and they were used in temperature and altitude control units for controlling air and gas mixtures at any altitude

The Cox and Stevens Aircraft Corporation, Mineola, N. Y., specialized in precise navigational instruments and computers for aerial navigation. A staff of engineers, specializing in computer design, developed a group of instruments to simplify navigational problems, and computers and indicators that provided a pilot with quick and accurate information relative to optimum performance and flight balance. The Cox and Stevens navigational computer was available in two sizes, the smaller being of pocket size. It solved all drift, course, heading and ground and air speed problems by setting up the complete wind triangle visually so that the pilot actually could see just what he was doing. It eliminated dangerous errors, which even the most seasoned pilot might make when calculating a course in the conventional method. In the upper half of the instrument was a circular type logarithmic computer for speed, time and distance calculations, altitude and air speed correction, as well as simple multiplication and division. The Cox and Stevens aircraft load adjuster, of the slide rule type, was designed for a particular model airplane, and was used to determine the proper loading of an airplane for safe and efficient flight. The Cox and Stevens aircraft flight co-ordinator was designed and made to order for a particular airplane and engine combination, and was based on performance data furnished by the manufacturers of the plane and engines. It enabled a pilot to solve problems of speed, fuel consumption, blower ratios and all engine and propeller settings, for all conditions of altitude, temperature and gross weight and required no adjustment or maintenance. Other computers for various phases of aerial navigation included a computer for figuring ground speed from drift meter readings, an indicator for calculating timed turns, an aerial slide rule, a D/F bearing convertor, a Polaris correction computer, another for determining radius of action, an ingenious parallel motion device for use with plotting boards.

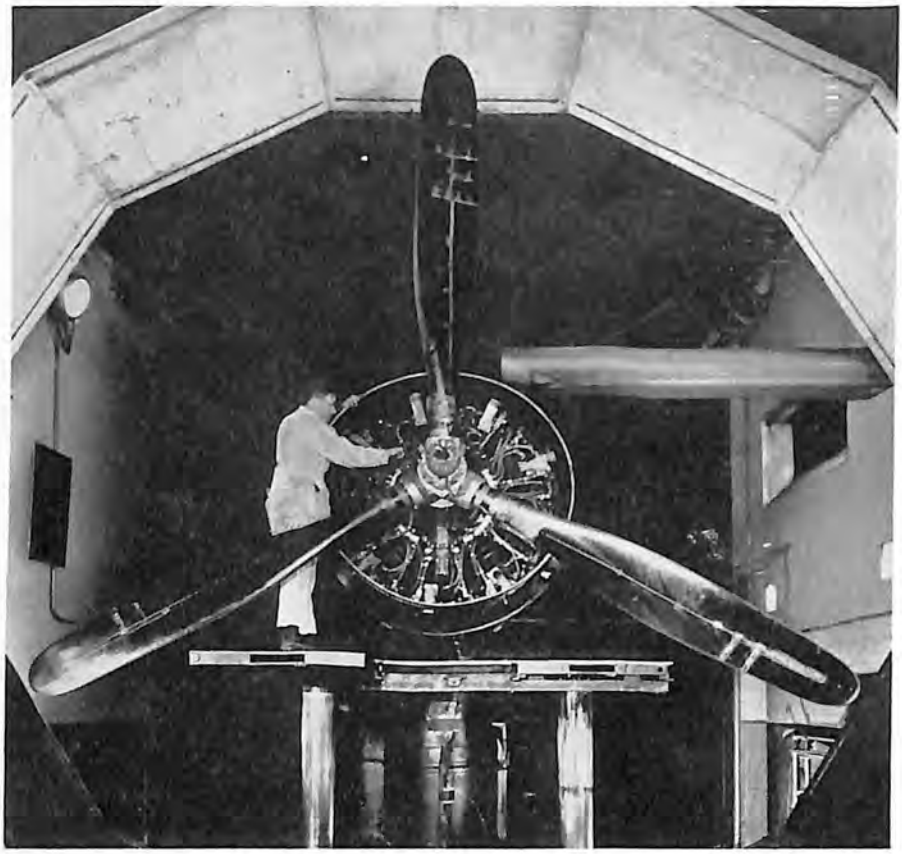
Crescent Insulated Wire & Cable Company, Trenton, N. J., manufactured for the airplane industry many types of electrical wires and cables, including aircraft power and lighting cables and synthetic and flame-proof insulations. Crescent Permacord was a tough, flexible, heavy duty portable cord or cable with a minimum amount of rubber. Under wartime needs it was most suitable for use where protection was required from abrasion, crushing, heat, oils and greases, and weathering. It was permitted construction under W.P.B. rubber restriction for service on portable drills and tools, industrial appliances and welding machinery. The flexible, rubber-insulated copper conductors were enclosed in a protective jacket of rubber, vulcanized to an outer cover of heavy, hard-twisted Seine twine, impregnated to be weatherproof. It was used for years principally by steel plants for their most severe portable cable jobs.

Curtiss-Wright Corporation's Propeller Division, Caldwell, N. J., developed a six-blade dual rotation propeller and automatic engine speed synchronizer, and at the same time supplied Curtiss Electric constant speed, full-feathering propellers as standard equipment on Army and Navy fighter, bomber and patrol planes. The Propeller Division more than quintupled employees and tripled its floor space in two years. Record production in 1942 was achieved by vastly augmented personnel, including an increasing number of women, and by many new engineering methods and specially designed machinery. Another outstanding Curtiss-Wright contribution to the aircraft industry was a giant 16½-ft. hollow steel blade electric propeller.

The Curtiss-Wright dual rotation propeller was the first to be built on the principle of electrically controlling the pitch of hollow steel blades. It was designed especially for high-speed military aircraft with 2,000 h.p. engines and for those requiring restricted diameter. Aviation engineers claim that the dual rotation increases by 5 per cent the propeller efficiency of fighting planes which cut the air at more than 400 miles per hour, and that it vastly improves control of a single-engine plane by eliminating torque—twist effect—of a single rotation propeller upon the airplane.

The Curtiss Automatic Engine Speed Synchronizer, which equalized instantaneously the speed of propellers of engines, was lauded by engineers for the greater precision it added to control of multi-engine aircraft while at the same time reducing to a minimum the strain upon pilot and flight engineer.

Another achievement of the Curtiss-Wright Propeller Division was the 4-blade propellers developed especially for the Martin B-26 Marauder twin-engine Army bomber and the Republic high-altitude Thunderbolt fighter. They permitted the most efficient use of the 1,850 to 2,000 h.p. available in those powerful machines. Again, for the greater demands of high-performance aircraft, whether high flying boats, transports or fighting planes, the Division concentrated upon



ONE OF THE WORLD'S LARGEST

This giant 16½ foot hollow steel blade electric propeller was developed by the Curtiss-Wright Corporation's Propeller Division, its immediate use being for the Boeing twin-engine flying boat. It is shown undergoing tests.

increased strength in its product. The superior strength of the hollow steel blade, an early Curtiss development, was of great value to fighting planes because of steel's resistance to erosion by salt water and also because this type of propeller did not nick easily when taking off from rough landing fields. Blade shank cuffs, which improved air-cooling of engines and reduced shank drag, was another contribution, as was the development of the Curtiss hollow hub, through which the aircraft cannon, like that used on the Bell Airacobra, was fired.

Among the manufacturing improvements of the Curtiss-Wright Propeller Division were new heat-treat furnaces and a moving propeller assembly line. Hydraulically rotated ovens not only tripled production but saved many manhours and eliminated lost motion. They were operated from a 38-foot-long control board, resembling a small powerhouse, and were capable of handling practically every type of

blade now in production. The assembly line, or conveyor installed in one of the Division's plants, stepped up production output by continuously carrying parts and blades from one operation to the next, thereby saving considerable manhours on each operation.

Denison Engineering Company, Columbus, O., produced its model HSPT3 "hydroilic" spark plug tester, which developed air pressure up to 750 lbs. per sq. in. within 15 sec. and maintained it at least a minute. Testing time averaged only 30 sec. per plug. The plug was seated in an adapter, and action of the cylinder clamped the plug into an air-tight chamber. The desired voltage and pressure were selected, and the action of the plug recorded. Safety features included forcing the operator to move two levers—one with each hand—in opening or closing the clamping mechanism, thus making it impossible for him to have his hands in or about the clamping mechanism where he might be injured. Also, the circuit to the spark plugs was completed only after the plug was clamped into position, and the circuit was automatically broken when the clamp was released. The operator, therefore, could handle the plug in complete safety. The stand was a welded steel frame mounted on swivel casters and equipped with start-stop push buttons, high and low pressure air gauges, low pressure needle valve, adapters, oil level gauge, high voltage connector, low voltage terminal and operating levers.

Diebold Safe & Lock Company, Canton, O., in its 84th year as a manufacturer of safes and experience in making steel harder as proof against drills, torches, nitroglycerine and other kinds of attack, was in full war production on case-hardened armor plate for aircraft. The company's personnel had increased more than 1,000 per cent in two years.

The Dix Manufacturing Company, Los Angeles, Calif., developed a new hydraulic protective valve for landing wheel brakes, which served to eliminate danger of any other unit in the braking systems stealing pressure from the brakes, if the line pressure should fall below the safety minimum. The valve was loaded with a spring just strong enough to hold it shut against a pressure of 700 lbs. Dix also produced a new aviation type universal joint which, the company claimed, could be operated at an exceptionally great angle.

Dowty Equipment Corporation, New York, manufactured landing gear and hydraulic equipment for aircraft on an ever increasing scale, with expansion of facilities and production increased by the acquisition of larger premises in Long Island City. The Dowty Patent Liveline Hydraulic Pump and the gear pump for gun turret actuation formed the major portion of production in that field. Production was in full swing on a tricycle landing gear for Army fighter planes and a primary trainer.

The Dumore Company, Racine, Wis., was in production on a line of highly specialized motors for cowl and wing flaps, anti-icer

equipment, photographic and armament accessories. Many devices were built into the motors to secure dependable operation in paralyzing cold or desert heat.

The Duramold Division of Fairchild Engine & Airplane Corporation, Hagerstown, Md., reported significant progress in the application of the Duramold plastic bonded plywood process to various types of aviation equipment, ranging from elements like turtle decks and bomber tail cones to completion of the twin-engine bomber crew trainers for the Army Air Forces. The development of the latter aircraft, designated the Fairchild AT-13 (two Wasps) and AT-14 (two Ranger 12s), was such that an entire plant was set up for their manufacture. Important developments in the Duramold process were in progress. Possibilities in its application to combat aircraft were indicated by the highly succesful de Havilland Mosquito, British bomber powered by two engines and built throughout of wood. Pioneered as a means of utilizing wood in accordance with modern engineering knowledge and to simplify construction problems, such as the elimination of rivets and riveting, the Duramold process was available when the employment of wood in the war effort became an important answer to the shortage of critical aircraft materials. Starting some years ago with the manufacture of stabilizers for the Ranger-powered Cornell (PT-19) trainer, used in large numbers by the United States and other United Nations' Air Forces, the applications were extended to include turtle decks, fins and flaps for the same airplane, tail cones for the Martin B-26, droppable fuel tanks and other units.

Dzus Fastener Company, Babylon, N. Y., continued to supply the industry with its line of fasteners.

Eagle Parachute Corporation, Lancaster, Pa., was assigned the patent license on a new type of parachute canopy designed to retain all the advantages of the standard circular parachute and at the same time eliminate or greatly reduce its disadvantages. It was easily packed, quite resistant to destruction, and at the same time reduced oscillation, with freedom from streamlining, and increased maneuverability.

Eagle had manufacturing rights to the "Parasuit," a streamlined flying outfit incorporating the parachute canopy and harness with the suit. The one compact unit—an ingenious combination of flying suit, parachute and inflatable supporting gear—was especially suitable for flying conditions where there was limited space in the aircraft. This parachute was worn like a coat. It was flexible and frameless, permitting a snug fit. The usual protuberance of a seat, back, or chest pack was absent. Flying personnel were able to perform their duties with increased efficiency in the most restricting compartments. Narrow apertures could be entered without inconvenience. This "chute within a suit" was a real asset for flying over any water. The set of rubber lungs could be automatically inflated by the simple pull

of a lever. The resulting buoyancy of the lungs would keep a man's head above water for hours. Eagle continued to manufacture for the air services. One type of parachute in production was a training outfit for the U. S. Marine Corps Paramarines. It consisted of a 28-ft. canopy packed in a back pack, and a 24-ft. canopy in an emergency chest pack. The back pack could be opened either automatically by a static line attached to the plane or manually by a rip cord assembly.

The Eastman Kodak Company, Rochester, N. Y., introduced its Matte Transfer Paper to supplant Eastman Matte Transfer Film in the reproduction of drawings and templates. Matte Transfer Paper could be laminated to metal or plywood, forming a sensitized plate to which accurate drawings were transferred by various photographic methods. By this method, templates that formerly required several weeks to lay out were being reproduced in a matter of minutes. With the photographic method of template reproduction, the time between the completion of engineering drawings for a new plane and the test flight of that plane was reduced two to four months. Another outstanding advantage was reduction in template cost. Kodak's new rare-element glass was being used for aerial lenses supplied to the Army Air Forces. Made of tantalum, tungsten and lanthanum, the rare-element glass was the first basic discovery in optical glass since 1886. It had a much higher refractive index than previously available optical glass. The result was a lens giving greater speed without loss of definition and covering power. Eastman continued to supply many types of film, paper and chemicals for aerial photography.

Eaton Manufacturing Company, Cleveland, O., put into operation or had under construction new buildings and additions to its 12 plants which would provide a 50 per cent increase in floor space. Approximately half of these expanded facilities was allocated to the increased production of sodium-cooled valves, a product developed by Eaton's Wilcox-Rich Division, and the remainder to propeller shafts, crankshafts and a variety of smaller aircraft engine parts.

Eclipse Aviation Division of Bendix Aviation Corporation, Bendix, N. J., continued through increased subcontracting of products and improved production facilities to increase materially its output of vital aviation accessories for warplanes. Eclipse engineers continued to refine numerous aviation accessories, making them more adaptable to mass production methods and at the same time incorporating changes to increase performance. New accessories included several new types of starting equipment, the most important being a radically new lightweight aircraft engine starter designed around the proven features of both inertia and direct cranking starters, and capable of delivering ample starting torque to the largest aircraft engines in production or contemplated. A lightweight, compact hand inertia starter incorporating a newly designed hand cranking attachment, which greatly added to the flexibility of application, was developed. Several

modifications of combination inertia and direct cranking electric starters were placed in production. Refinements, including simplification of design on standard production combustion starters was carried on and resulted in increased production. In addition considerable development work was done on a combustion starter incorporating an integrally mounted multiple breech. Considerable hydraulic development and research work was carried on to keep pace with, and anticipate the requirements of the industry. Gerotor mechanisms were redesigned and placed in quantity production. Several 1,000 P.S.I. engine driven spur gear pumps successfully passed endurance and cold test requirements, followed by volume production. Larger spur gear pumps to meet the increasing demand for higher hydraulic pressures were being designed and were reaching the final test stage. Piston pumps for pressures above 1,500 P.S.I. also were under development. Electrically operated by two solenoids, a hydraulic flow shut off valve for high flow, low pressure applications was developed. With modifications this valve could be adapted to other flow and pressure characteristics. Electric gear reduction units were improved, and new types introduced to broaden their application to aircraft for retracting landing gear, operation of wing flaps or any other function requiring high torque characteristics. Eclipse heavy duty motors, inherently rugged and dependable after years of development, were redesigned to obtain compact, lightweight components with increased power and more efficient operating characteristics for application to the new electric gear reduction units. Generators and regulators also were improved and refined. Experimental work on carbon pile regulators was carried on to improve performance and increase capacity. A system using anti-hunting circuits was added to carbon pile regulators on laboratory test to eliminate hunting experienced from parallel generator operation on auxiliary power plants where engine impulses created a large acceleration, bringing instantaneous speed of the generators appreciably above and below average speed. Research was under way to improve brushes in order to increase efficiency at high altitudes. A complete series of lightweight, high speed, engine driven generators with outputs ranging from 375 to 6,000 watts at speeds ranging from 2,200 to 10,000 r.p.m. were produced in ever increasing quantities. Units having greater capacities continually were developed and tested. Development work was completed on several types of Eclipse motor generator sets and inverters, and they were placed in quantity production. A low tension booster coil was designed to supply power to the magneto primary, replacing the current type of booster coil which delivered spark direct. Recognizing the importance of the operating valves and control equipment in attaining most effective ice removal by the inflatable de-icer method, considerable work was done by Eclipse, and many of the 1943 military warplanes were to be equipped with the new manifold-solenoid de-icer system. Much work was done toward

the standardization of de-icer systems into two or three basic types for applications to all types of aircraft. A new self-contained electric driven Roots blower and snap-action distributor combination unit was developed for pursuit aircraft and for the empennage de-icers of large aircraft. Much research was devoted to the development of an electronic control for use with the manifold-solenoid system to provide completely flexible control of all phases of de-icer inflation and deflation to suit the particular kind of ice encountered. Engine driven air pumps as used for vacuum operated instruments and de-icers, absorbed considerable engineering effort, directed mainly toward simplification for production and improvement of altitude performance. Application of engine driven roots positive air pumps to cabin pressurizing of fighter and small bombardment type aircraft was satisfactory. The inherent ruggedness of design plus the simplicity of the control of airflow on both single and multi-stage types has met with favor in the industry. Multi-speed as well as multi-stage models, either direct engine driven or electrically driven, were available. Experimental units for pressurized altitude suits, pressurized ignition systems and de-icer operation were under test. High output variable speed centrifugal blowers complete with controls were developed for cabin supercharging of large aircraft. Some types were in production. With the trend toward the use of straight alcohol in place of an alcohol-glycerine mixture for the anti-icing of propellers, windshields and carburetors, a new line of anti-icer pumps was developed. These pumps were very light in weight and of compact form. Eclipse continued to supply a complete line of automatic engine controls. Many new problems had arisen in this field in connection with new engines and new operational problems. While considerable work was done on electrical controls, and there were some indications of a trend towards such controls, the hydraulic type regulator had many merits difficult to duplicate electrically.

Edo Aircraft Corporation, College Point, N. Y., specialists in the manufacture of seaplane floats for airplanes of all sizes was awarded the Army-Navy E for manufacturing accomplishment. Edo supplied float gear as standard equipment for the Army, Navy, Marine Corps and Coast Guard, as well as for other air forces. The Edo semi-monocoque type of construction had proved itself under extreme war conditions. Edo's exclusive Navy type beaching gear materially decreased the time required for launching land based seaplanes. Plant facilities were increased, as was the number of employees. Special machinery was developed to speed up production.

Eisemann Corporation, New York, produced its model LA aircraft magneto for 2, 4, 5 and 6 cyl. engines. It had a unitcast housing with integral mounting flange, a single-piece cast magnet rotor, self-lubricating bearings, complete sealing against entry of oil or fumes and simplicity of design and operation. It was of the two

pole rotating magnet type, delivering two sparks per rotor revolution displaced 180°, and hence was driven at one and one-half times crankshaft speed. It was of the jump spark distributor type, nickel electrodes being employed in both the distributor rotor and the plate. Spark timing was fixed, retarded spark for starting being obtained by an impulse starter attached to the magneto. It was integrally radio shielded, provisions being made on the cable holder plate for readily adapting a radio shielding cable harness. Ventilation was provided by large area screens, both flame and explosion proof, mounted in the bottom of the magneto housing and the rear cover plate. It was protected, where required, from crankcase oil and oil fumes by synthetic rubber spring type oil seal operating in conjunction with an oil slinger mounted on the rotor shaft. The effectiveness of this construction was proven in actual field service.

The Electric Auto-Lite Company, Toledo, O., was in production on a number of items for use in the aircraft manufacturing industry, including spark plugs, power, lighting and instrument wire, booster coils, current relays, generators, stampings, molded plastics, instruments and gauges, instruction plates, ignition cable, batteries, die castings and gun firing solenoids.

The Exact Weight Scale Company, Columbus, O., was in wartime production of scales with mechanical overweight and underweight indication for balancing connecting rods, pistons, propeller blades and other moving parts. The high speed at which war planes were compelled to operate required the closest weight tolerances, especially in the manufacture of moving parts. The Shadowgraph scale, also manufactured by The Exact Weight Scale Company, had a shadow indication and was used for very close industrial weighing, approaching laboratory accuracy on a production basis. It also was used for close balancing of connecting rods, pistons, impregnating valves, controlling molded parts and the production weighing of numerous other parts used in airplanes.

Farnham Manufacturing Company, Buffalo, N. Y., brought out new designs of spar millers in 1942. The machines which Farnham introduced to the aircraft industry in 1940 did much to speed up production of fighting planes. The use of milled spars increased as the need for heavier, more maneuverable planes became apparent. Each new ship necessitated a new spar miller design to produce the new spar design. One of the largest manufacturers of military aircraft built a separate spar cap factory devoted to the production of milled spars for various types of military aircraft. All the spar machining equipment in this plant was designed and built by Farnham. In addition to the development of spar miller designs, the company redesigned its line of mill countersinkers. Production of the standard 36 in. and 48 in. gap machines increased, while special frame shapes were designed for unusual countersinking jobs. They included a series of

three machines to perform all the countersinking operations on the leading edge skins for an entire wing, and also a carriage countersinker for spars or other long units.

Federal Products Corporation, Providence, R. I., produced dial indicators and dial gages, and new designs continually were being developed to speed up production. They were used in aircraft and other mechanical industries where the trend was to the finest tolerance possible. Federal caliper gages, both inside and outside, were typical examples of this use. They were exceptionally convenient for checking all kinds of dimensions and were adapted especially to general shop use. Jaws of various capacities and shapes, other than the standard jaws, were supplied. Special contacts of different shapes and of varying degrees of hardness also were available. Patterns, cores, castings, forgings, plastics, dies and sheet material, were among hundreds of products checked with these gages. Federal also produced comparators, depth gages, grinding gages, hole and bore gages, adjustable snap gages, thickness gages and thread gages.

Felt Products Manufacturing Company, Chicago, Ill., supplied the aircraft industry with a line of gaskets and other sealing materials manufactured of felt, cork and other materials.

Fenwal Incorporated, Ashland, Mass., supplied its improved Thermoswitch, which could be used for high temperature alarm in the cooling system of liquid-cooled engines, carburetor air intake temperatures and lubricating oil temperatures, as well as a heater accessory for cabin temperatures or cold weather starting. Fenwal also developed a continuous flow fire detector for aircraft. It was a copper conductor-wire on which insulating beads were threaded, with this assembly enclosed in a tin alloy tube. The surface of this tube was then copper-plated. The operating principle was that a flame applied to this assembly would cause the tin alloy to fuse and fill the area between the beads, thereby completing an electrical circuit between the conductor and the copper plating on the exterior, which had not been affected. The speed of operation installed on an engine was observed at .6 sec. The tubing was installed on the engine diaphragm, and in addition could be installed on the fire wall of the accessories section, and electrically connected to a suitable alarm so that the pilot could operate manually the fire extinguishing equipment.

Firestone Aviation Products Corporation, Akron, O., was manufacturing under subcontract wing panels, ailerons, flaps and tips. In addition it was supplying self-sealing fuel tanks and shatterproof oxygen cylinders for high altitude planes; also a wide variety of accessories, including airplane tires, tubes, wheels, brakes, pilot and crew seats and cushions, air sprint struts, seadrome contact lighting buoys for day and night operations by sea-based planes, foamed latex cushions, pads and wing filler, inflatable life belts, vests and pads, inflatable rubber boats and pararafts, oxygen masks, plastic lenses, pontoons,

FIRESTONE BULLET-SEALING GAS TANK

propeller anti-icing shoes, windshield de-icers, bomb cases, rubber hose, brake lining, batteries, engine mountings, torsion bushings, non-metallic pressurized cabin bushings, non-metallic aileron horn bushings and a variety of smaller items.

Foote Bros. Gear and Machine Corporation, Chicago, Ill., in 1941 equipped a special plant for production of gears for aircraft engines. Before that time, the extreme precision demanded of such gears required that they be made almost by laboratory methods, but a vastly stepped-up aircraft program made these methods too slow. The task undertaken by Foote Bros. was the production of aircraft gears of extreme precision by mass production. How this was accomplished is, of course, a military secret, but early in 1943 in three large plants Foote Bros. precision gears were rolling off production lines by the hundreds of thousands for military aircraft engines.

The Formica Insulation Company, Cincinnati, O., producers of mechanical and electrical parts, doubled capacity and put many operations on a 24-hour basis. Among the specialties manufactured for the aircraft industry were control pulleys, fairlead bushings and spools, buttons, tubes and punched parts, air pump vanes, propeller shanks, fluorescent name plates and trailing edge filler blocks. The advantages of the material from which these accessories were fashioned were its light weight—the specific gravity was 1.3—the fact that it was chemically inert and resistant to corrosion, non-absorbent and

possessing a low coefficient of thermal expansions. A recent development was instrument panels for night flying printed in fluorescent inks so they glowed when illuminated with black or invisible light. The panels were protected by a plastic film protecting the fluorescent lettering from grease and making them easy to clean without injury to the markings.

The G & O Manufacturing Company, New Haven, Conn., was in production on their line of engine cooling radiators and oil coolers for the aircraft industry.

General Bronze Corporation, Long Island City, N. Y., operated plants in the East and Middle West, producing a large variety of items for the Army, Navy, Signal Corps and the Air Forces, and also for numerous prime contractors furnishing equipment for the use of the armed forces of the United States and their Allies. This firm had excellent facilities for producing non-ferrous metal castings, as well as sheet and plate fabrications and weldments. It was awarded the Army-Navy E.

General Controls Company, Glendale, Calif., attained high operating efficiencies on direct current in a newly improved series of electric valves for aircraft use. The improvement was a basic design avoiding some of the inherent constructional features of typical solenoid valves that rendered stationary designs unsuitable for aircraft use or on moving or vibrating machinery. For controlling gasoline, hydraulic oil, anti-icing fluid, cabin heating fuel, air or other gases, various types of single-way, normally open or closed valves were made. Three-way or four-way selectors simplified pilot supervisory control, pressure and temperature problems, and reduced weight. The company also was pioneering developments of magnetic type automatic valves especially capable of operation in any position or offsetting the effects of vibration.

General Electric Company, Inc., Schenectady, N. Y., increased manufacturing facilities for the production of a wide variety of accessories used in aircraft. These products included motors, dynamotors, control devices, voltage regulators and relays, superchargers, switches, wire, radio transmitting and receiving equipment, magnetos, generators, instruments and Mycalex, a stone-like insulating material. General Electric was in full time war production on aeronautical equipment. It paid particular attention to the improvement and increased production of turbo-superchargers, so necessary for satisfactory aircraft performance at high altitude. It also increased facilities and improved the design of armament and fire control equipment for protection of high altitude aircraft.

General Engineering Company, Buffalo, N. Y., introduced its new G-3000 automatic multiple riveter for mechanized riveting on a wide variety of work including the heaviest bomber assemblies. Usually difficult jobs such as heavy bomber spars, which once were done by

hand, could be run through the General machine automatically. The automatic control required only quick attachment of a template at one or two points on the part to be riveted. Two riveting heads could be operated individually or together. It could place rivets running parallel to the axis of motion, at an angle or on a curve, and several loading crews could set up assemblies in sequence while the machine was operating. It could use any kind of rivet, including countersunk. The saving in manpower was as high as 30 to 1.

Globe Steel Tubes Company, Milwaukee, Wis., specialized in the manufacture of steel tubing of uniform quality produced under laboratory control.

The B. F. Goodrich Company, Akron, O., continued to step up production of aeronautical supplies for military needs with the expansion of plant facilities for the production of bullet-sealing fuel cells and de-icers. De-icers were being made in four of the company's plants. Other Goodrich products were tires and tubes, brake expander-tubes, bullet-sealing hose, life rafts, oxygen equipment, and hundreds of sponge, molded and extruded items. Adaptation of synthetic rubber in the manufacture of many of these items was continued with outstanding success. Development of non-skid treads for the smooth contour tires on fast military aircraft was an important contribution, and an improved tread design for transport planes proved successful in operation. Early tests of a new snow and ice tire indicated excellent performance. Incidentally, this product was one of the first tested on the B. F. Goodrich plane, a Howard Special. New high pressure tail wheel tires were developed to meet special Navy requirements, and an improved solid tailwheel tire, which dissipated heat through a vented treatment of the sidewalls, was developed for use on carrier-based airplanes. Improved brake expander tubes were developed, capable of safely actuating brakes on large four-motored planes, with a wide margin of safety and greatly increased brake life. A major contribution in the continued improvement of B. F. Goodrich de-icers for leading edges was an improved venting that made practical a 15 per cent de-icer coverage on top of the wing of the large Douglas Skymaster C-54 cargo plane. The first all-synthetic de-icers were installed and successfully flight-tested. Small airplanes were equipped with a new thinner de-icer, attached with new synthetic rubber cements, and the necessary tension then acquired through a zipper closure, covered by a flap. Rubber cement attachments had been discontinued in 1936, when the B. F. Goodrich Rivnut was found more satisfactory for fastening de-icers to the larger, transport-type planes. A new power tool which increased the speed of Rivnut installation as much as 400 per cent was developed in cooperation with the Curtiss-Wright Corporation and the Chicago Pneumatic Tool Company making the tool. Improvement in the mechanical equipment for de-icer actuation and control resulted in wide-

spread use of the new equipment on military and transport planes. These included an electrically controlled snap-action distributor, a solenoid-valve single pressure line system, and a small electrically controlled distributor especially designed for use in light planes.

The Goodyear Aircraft Corporation, Akron, O., the tire company's subsidiary set up to handle wartime aviation products, in two years grew from 60 employees to 32,000, a number greater than that employed by the parent company which itself had doubled its employee rolls. Four huge plants were devoted to aircraft work at Akron, including parts for Consolidated, Curtiss, Grumman and Martin warplanes, and a later contract for Chance Vought Corsairs. A branch factory for airplane parts was set up next to the Goodyear cotton plantation in Arizona. Leak-proof fuel tanks, rubber life rafts, life vests and flotation gear for planes were among other Goodyear accessories, while the company continued to expand production of blimps for Navy patrol and barrage balloons for defense against raids, and air attacks at sea. Goodyear airplane wheels were produced in increasingly large quantity.

The Govro-Nelson Company, Detroit, Mich., continued at capacity the manufacture of its automatic drilling unit which was in wide use in the aircraft industry. The unit, made in several sizes, was designed primarily for the protection of small drills, particularly where they broke at an angle to the surface or in corners or ribs. By employing

GOODYEAR NON-SKID PLANE TIRE
Thousands of spiral metal springs are embedded into the tread to increase resistance to skidding.

the principle of centrifugal force for feed pressure and by regulating the rate of feed through the use of weights, the unit permitted drilling faster than was possible with power feed mechanism which must be set to protect a partially dull drill. Meeting of hard spots in the material or drilling with overly dull tools, did not break the drill.

Grimes Manufacturing Company, Urbana, O., designers and manufacturers of aircraft lighting equipment, was America's only concern operating 100 per cent in this field. The company supplied all types of standard lights for Army and Navy service; and engineered many new special items to the requirements of aircraft manufacturers. In 1942, Grimes was awarded the Army-Navy E for high achievement in production of war lighting material.

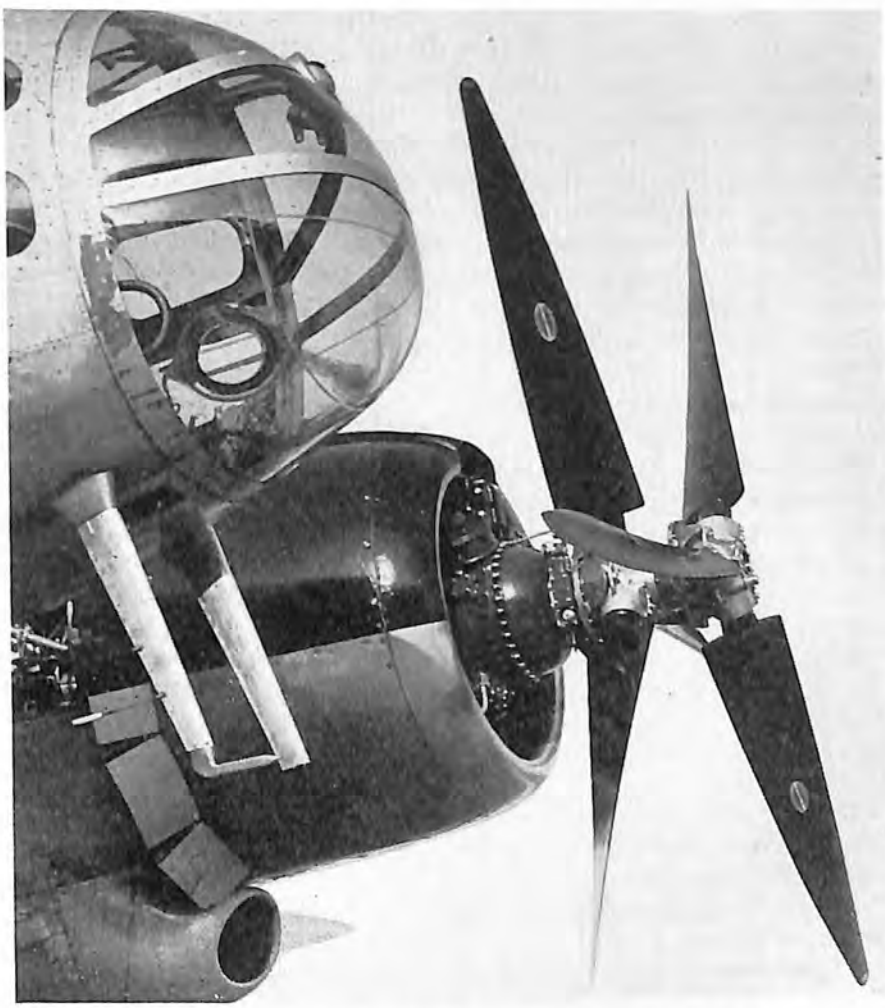
Hamilton Standard Propellers Division of United Aircraft Corporation, East Hartford, Conn., continued to meet heavy schedules. Manufacturing facilities were expanded by leasing and placing in full operation a former textile mill at Norwich while early in 1943 another mill at Darlington, at Pawtucket, R. I., was leased for further plant space. Added to the main plant at East Hartford and the Westerly, R. I., plant opened in 1941, this brought to four the number of plants and rounded out Hamilton Standard's expansion program which started before the emergency. In addition to its own plants, Hamilton Standard propellers were being made by four licensees—Nash-Kelvinator, Lansing, Mich., Frigidaire at Dayton, O., Canadian Propellers, Montreal, Canada, and Remington-Rand, Johnson City, N. Y.

As a further contribution, Hamilton Standard established a training school for enlisted personnel of Services at the Westerly plant. Several hundred men received specialized instruction in servicing and repair of propellers, and then went back to the field to train others and direct the job of keeping propellers in operation under all conditions. A "base hospital" for the salvaging of damaged propeller blades was also set up at Westerly where thousands of blades, bent and twisted in crack-ups of training and combat planes and bearing bullet holes as battle scars, were straightened and repaired. Among the outstanding developments announced by Hamilton Standard was the first flight of an American-built dual-rotation propeller. The result of eight years of research and study, this new propeller consisted of two three-bladed propellers mounted on co-axial shafts—one propeller revolving clockwise and the other counter-clockwise.

Harlow Aircraft Company, Alhambra, Calif., was in production on de-icing tanks and tail subassemblies under subcontract and were making production jigs for Lockheed, Vega and Vultee—Harlow also was doing subcontract work on gliders for Timm Aircraft.

Harvill Corporation, formerly Harvill Aircraft Die Casting Corp., Los Angeles, Calif., die casting, hydraulic equipment and standard parts manufacturers, added two new divisions and expanded activities in die-casting. The two new divisions added were the Hydraulic

Division, housed in a newly acquired plant, and the Products Division operated out of the main plant. Successfully introduced by the Hydraulic Division was a new hydraulic hand pump used in aircraft to supply auxiliary power by manual operation, in event of emergency, to raise and lower the landing wheels, operate flaps and bomb bay doors, and for testing hydraulic systems while the airplane is on the ground and the motors not operating. Three models of the pump were produced, all with 1½ in. cubic displacement. Featuring simplified construction, made of only 13 parts, extreme light weight and strength, the pressure molding process of manufacture reduced the



HAMILTON STANDARD DUAL ROTATION PROPELLER

Each set of three blades revolves counter to the other. This propeller was developed by Hamilton Standard Propellers Division of United Aircraft Corporation.

amount of machining time normally required on pump bodies 40 per cent. The Hydraulic Division helped to alleviate a critical bottleneck in the aircraft industry by producing plug valves. Formerly produced from forged stock, with a great number of hand and automatic screw machine operations necessary, the Harvill plug valve, using a new manufacturing technique, was produced by exclusive pressure mold casting process which eliminated approximately 83 per cent in machine tool time, reduced by more than 50 per cent the amount of materials required and utilized 100 per cent of the raw materials. After months of research, the Products Division of Harvill developed its Plasti-Seat for training, pursuit and bomber aircraft. Fabricated from non-strategic materials and using a new method of impregnating fabric with an ethyl cellulose plastic, a more efficient seat was created, light in weight, yet exceeding all strength requirements. The only metal portions on the Harvill Plasti-Seat were the mounting brackets, shoulder harness and adjusting fittings.

The Die-casting Division assisted in the preparation of a new aluminum alloy castings-pressure mold. This was an entirely new class of casting which was based largely on advance techniques created by the Harvill engineering department. The specification provided for minimum mechanical properties in excess of any properties heretofore credited to cast aluminum alloy with a minimum tensile strength of 39,000 lbs. per sq. in. and an elongation of 4½ per cent in 2 inches. All values heretofore obtained were exceeded and this specification was approved by the Army Air Forces for use in structural applications. Simultaneously with that development was Harvill's introduction of the flotation inspection process, a porosity segregation process based on relative specific gravities.

Haskelite Manufacturing Corporation, Grand Rapids, Mich., had been supplying plywood to the aircraft industry continuously since its products first were used in aircraft during the first world war. Constructions of almost any specified combination of weight, strength and thickness, as well as choice of woods or species and different ratios of ply thicknesses could be supplied by Haskelite engineers in any size required. The Haskelite bonding agent was an infusible, water-resistant phenolic resin, which on setting, produced a bond as strong as the wood itself. Haskelite's newest and most versatile product was Plymold, a molded plywood which could be fabricated over simple dies, either in simple or compound curvature.

Hayes Manufacturing Corporation, Grand Rapids, Mich., producers of aircraft parts, parachutes and dies and stampings, continued turning out outer wing panels for a military prime contractor, and one of its three main plants was re-equipped and devoted exclusively to this production. In its stamping division, Hayes switched to the production of structural parts for planes, such as ribs and fairings. Hayes was one of the six largest producers of parachutes. At the

same time the company had increased manyfold its production of a shell section for Navy torpedoes.

The Hewitt Rubber Corporation, Buffalo, N. Y., was in production on self-sealing fuel tanks and machine gun heater hose. The bullet-sealing tanks were both flexible and rigid types, and were manufactured by assembly line methods. The machine gun heater hose was made up primarily of heat resistant asbestos fabric.

Hyland Machine Company, Dayton, O., was in production on parts for the aircraft industry, including special clips and clamps, various types of manual control assemblies, fork ends, rod ends forged and milled from bar, screw machine and turret lathe products and small stampings.

Industrial Sound Control, formerly the Homestead Insulation Company, Hartford, Conn., engineers and contractors for heat, cold and sound insulation, utilized Soundstone acoustical stone cast in blocks or slabs in treating test cells at the plants of numerous aircraft engine manufacturers. Because of the noises developed during full throttle test of powerful engines and propellers, the noise level in an untreated structure goes as high as 165 decibels. By treating the stacks or flues in the test houses, the firm was able to reduce this noise level to below 100 decibels. The company completed installations at the Pratt and Whitney, Wright Aeronautical, Ranger, Jacobs and Lycoming plants.

Intercontinent Aircraft Corporation, Miami, Fla., a wholly owned subsidiary of Consolidated Vultee Aircraft Corporation, was in full production on inner-wing sections for the Vengeance dive bomber. Part of the necessary flight equipment was installed in the completed wing sections before these were shipped to the Consolidated Vultee plant in Nashville, Tenn. Intercontinent also was producing nose cowls, rudders and stabilizers for the Vought Corsair as well as tail sections for Stinson.

International Flare-Signal Division of the Kilgore Manufacturing Company, Tipp City, O., made major additions to its production facilities during 1942 to meet the increased volume of orders from the United States and foreign governments for flares, signals and other military pyrotechnics. On September 22, 1942, it was awarded the Army-Navy E for outstanding achievement in war production.

I. Jacoel Cable Splicing Equipment Company, Inc., Buffalo, N. Y., increased production 60 per cent, and developed its No. 9 splicing machine, bench type, with a capacity of $\frac{7}{8}$ in. diam. of cable. It weighed 80 lbs., and was provided with a pair of adjustable jaws to accommodate various sizes of thimbles or bushings. The company also developed its type 1 splicing kit with a capacity of $\frac{1}{16}$ in. to $\frac{5}{16}$ in. in diam. of cable. The kit consisted of the standard Jacoel production type splicer and carried all necessary hand tools.

Jefferson-Travis Radio Manufacturing Corporation, New York,

specialized in two-way radio communication equipment for mobile service by means of portable units, as well as on ships, vehicles and airplanes. The Fonda Recorder was a Jefferson-Travis product. It recorded on continuous cellophane strips that made possible the recording of music or voices for 8 or more hours. Because of this special feature it was widely used in aviation.

Jessop Steel Company, Washington, Pa., enlarged its plant facilities and increased production of specialty steels for the aircraft industry, including featured tool and die steels for machining and forming body and engine parts, also high speed steels, carbon tool steels, high carbon-high chromium die steels, hot work steels and special alloy steels, also stainless steels and irons, propeller blade steel and airplane armor plate.

Jowein Inc. Aircraft Division, Jamaica, N. Y., carried on experimental and development work and prepared for production of subcontract parts for Navy aircraft. The company increased production of fuel oil and hydraulic strainers, filters and screens, torpedo director stowage containers and other accessories for Navy warplanes.

Joyce Aviation, Inc., Chicago, Ill., through its Airchox Company division, was in full-out war production on parachute harness fittings, the "hardware" on which a pilot's life depends when he has to bale out. The Joyce engineers in collaboration with the Air Forces Materiel Command at Wright Field developed a new line of harness fittings, with the help of experts from the Youngstown Sheet & Tube Company. Coining replaced the forging method of peacetime production, largely because it could be done with available personnel. The company perfected a method of deep drawing of heavy sections of cold 4130 steel sheet and bar stock in thicknesses up to three-fourths of an inch.

Justrite Manufacturing Company, Chicago, Ill., produced its line of safety cans for storage and handling of explosive and inflammable liquids; also a twin-bulb electric lantern providing a forward beam of 634 candle power, plus light to the sides.

Kellogg Switchboard & Supply Company, Chicago, Ill., supplied communications equipment, including small capacitors for aircraft radio receivers and transmitters and complete telephone crash alarm systems for installation at airports and ground stations. Typical of the advanced types of communication equipment which are manufactured by Kellogg was the throat microphone. This unit, consisting of a pair of small, compact microphones fitted snugly against the throat, transmitted words directly from the vocal cords. Air-borne noises like the roar of engines and the racket of machine gun and cannon fire were kept out of the microphone. The voice alone went through, clear and ungarbled. In addition, this type of microphone left the operator's hands free for other tasks—especially important in the case of single-seat combat planes, where one man had to handle all the

work—flying, navigating, operating the radio and firing. Hand microphones, used mainly by the air forces in planes and ground stations, as well as palm-type microphones also were made in large quantities. Head and chest sets (transmitter and receiver units) for connecting into radio and telephone systems; special aviation headset receivers with soft rubber "ear-muffs," jack boxes and volume control boxes for use with aircraft interphone equipment and other purposes; rubber covered cords with attached jacks and plugs; multi-contact plugs and sockets used in aircraft radio equipment and band switches were among the Kellogg products. Communication equipment for ground use by aviation units of the Services included manual and relay operated crash alarm telephone systems for use at airports. They made it possible to report accidents from stations located at various parts of a flying field to other stations simultaneously, including the fire department, control tower, central office, hospital and medical center.

Kent-Moore Organization, Detroit, Mich., for 22 years service engineers to the automotive industry, was specializing in the design and manufacture of special tools for aircraft maintenance and repair as an aid in ground crew training. Among the special tools were the crankshaft turning and aligning wrench, which provided a means for rotating the engine crankshaft with propellers removed, and the propeller low pitch setting gauge to set the blades to low pitch position before installing the power unit.

Walter Kidde & Company, New York, developed and placed in production several new compressed gas safety devices, vastly increased output of equipment already in production, expanded plant facilities to 20 times their former size, put 16 times as many employees on the payroll, and speeded up individual manufacturing and assembly operations from 25 to 400 per cent through institution of a work simplification program. Among the new products were a light weight, shatterproof oxygen and carbon dioxide cylinder; an oxygen recharging pump for use at advanced field bases where water and power lines are not available; a small inflation cylinder for parachute rafts; a water sensitive device which automatically expelled and inflated the raft stowed in a special compartment on carrier based planes; a pendulum device that automatically set off a plane's fire extinguishing system in the event of a crash; a carbon dioxide power actuation system which acted as an emergency source of power when the hydraulic system operating bomb bay doors, retractable landing gear, or brakes was damaged; and a carbon dioxide flooding system for explosion proofing wing and fuselage spaces around gasoline tanks. Equipment already in production on which the output was increased vastly included small portable carbon dioxide fire extinguishers for aircraft cabins; built-in carbon dioxide fire extinguishing systems for protecting engine spaces, a vapor dilution system for auxiliary gas tanks; 2,000 lb. capacity carbon dioxide crash trucks for flying fields

and air bases; and inflation equipment ranging all the way from tiny carbon dioxide bullets for inflating "Mae West" life vests to cylinders containing three or more pounds of compressed gas used for rubber life-rafts, and water wings and flotation bags large enough to support an entire plane. Among the many feats accomplished by Kidde-made equipment during the year was the inflation of the life-rafts to which Harold Dixon, Ensign Gay and the Rickenbacker party owed their lives. The expansion program required to meet this vast increase in production involved the construction of several new factories, including a blackout assembly plant built almost entirely of noncritical materials; and the training of several thousand new workers, including many women.

The Koehler Aircraft Products Company, Dayton, O., manufactured aircraft fuel and oil valves and special items for aircraft, including solenoid valves, oil drain valves, fuel selector valves and strainers.

Kold-Hold Manufacturing Company, Lansing, Mich., which converted entirely to war work, expanded its facilities several times in 1942, manufacturing thermal, sub-zero and stratosphere processing and testing machines. New products included: "Hi-Low" machines for testing aircraft instruments, batteries, wires, metals and various devices over wide temperature ranges; stratosphere chambers for testing aircraft instruments, accessories and parts, as well as all materials which go into plane construction and equipment; hot and cold bath units for rapid-aging of heat-treated parts, expansion fits and temperature processing of sub-assemblies; rivet storage machines both station and centrally located types, for aluminum alloy rivets; aluminum sheet coolers for protection of aluminum 24S-T sheets in much the same manner as the rivets noted above; walk-in chambers to accommodate personnel when required, in the sub-zero testing of larger units, engines, compressors and radios.

Kollsman Instrument Division of Square D Company, Elmhurst, New York, expanded manufacturing facilities more than 400 per cent, keeping its place as one of the largest manufacturers of aircraft instruments in the country, and also expanding into the optical field with the manufacture of drift sights and binoculars. Several new developments in aircraft instruments were made during the year, among them a sensitive air speed indicator with a range of 700 m.p.h. with a complete rotation of the pointer for each 100 m.p.h. and hundreds indicated on a sub-dial. Most outstanding perhaps was a three-in-one combination of dual tachometer and synchroscope in one instrument, with the consequent simplification of indication and saving in instrument board space.

Krembs and Company, Chicago, Ill., was in production on 89 different kinds of fluxes for welding, silver soldering and brazing, each especially designed for a specific metal joining job.

Kropp Forge Company, Chicago, Ill., expanded production facilities substantially during 1942 to get longer production runs in order to meet the increased need for steel forgings for aircraft and other armament applications. As the demand was particularly heavy for drop forgings for aircraft, specialized production was on a large scale. A subsidiary, Kropp Forge Aviation Company, was established, and the new plant for producing drop forgings for aircraft exclusively was completed. The production tonnage of the new plant was approximately four times the company's previous drop forging output. Through the broad use of labor saving equipment, the manpower requirements of the new plant were only two and a half times those of older operations. The company was producing every kind of steel forgings used in aircraft, including airplane engine mounts, cross ties, lugs, bomb release parts, landing gear parts, catapult forks and other stressed parts. Additional Magnaflux equipment was installed in the inspection department so that all the plant's increased output of aircraft forgings could be given this authoritative test for internal defects. The latest inspection equipment for making surface determinations also was employed.

Lasalco, Inc., St. Louis, Mo., offered a complete line of plating and finishing supplies and equipment to the aircraft industry.

Lawrance Engineering and Research Corporation, Linden, N. J., specialized in the development and application of equipment to supply the electrical power for airplane accessory operation independent of the main engine generators. Long-range bombers and patrol aircraft were principal users of such auxiliary power in 1942, and it promised to develop to a stage making it available for all military and

VULTEE STINSON RELIANT

Developed for the British to train their Navy pilots in navigation.

commercial planes of high horsepower. In production at the Linden plant was the Model 30C-2 unit, which comprised a 2-cyl. horizontally opposed 15 h.p. aircooled engine operating a 5 KW generator. Completely enclosed and sound-proofed, it provided DC current for the 24-volt aircraft electrical system. Operation could be controlled remotely without need for continual attention from the crew or flight engineer. Control of r.p.m. was maintained by a governor restricting engine speed to within the full load and no load range. By use of an altitude carburetor loads up to 3 KW could be applied at the rated altitude of 20,000 ft. Standard instruments for recording of oil temperatures and pressures, fuel pressure and cylinder head temperatures also were provided to facilitate remote operation.

Lea Manufacturing Company, Waterbury, Conn., supplied the industry with a flexible burring method enabling the operator to perform both internal and external burring operations with greater precision and greater speed, with consequent reductions in rejections and costs. It consisted of a dry, flexible abrasive cutting head on moving vehicles of all types, including polishing wheels, loose buffs, sewed buffs, string brushes, felt wheels, bobs and cones, and maintained by periodic applications from a bar of patented greaseless compound. Ability of an abrading medium set up in this manner to get into inaccessible places and around sharp corners without destroying tolerances and without transferring any dirt or grease to the working surface, made the procedure important. By constant renewal of the cutting head without stopping power, the operator was able to continue hour after hour uninterrupted by changing wheels.

The Leece-Neville Company, Cleveland, O., was producing for aircraft use, engine-driven, voltage regulated electric generators and their companion control units in 12 volts with capacities of 15, 25, 50 and 100 amperes, and in 24 volts with capacities of 25, 50 and 100 amperes. An engine driven, high-speed 24 volt, 200 ampere generator was developed, and a new and unique voltage regulator employing a new principle was developed for this generator. Leece-Neville voltage regulation provided a comparatively high beginning charge rate to a battery, then permitted the charge to decrease in proportion to the state of charge of the battery, so that by the time the battery was charged, this rate had diminished to a low value that would not harm the fully charged battery. The company was also in production on electric pump motors for aircraft in 12 and 24 volts with capacities from ¼ to 3½ h.p.

Leland Electric Company, Dayton, O., manufactured power units including dynamotors, inverters and aircraft motors designed for use with radio and communications equipment.

Leslie Welding Company, Chicago, Ill., produced a self-balancing die set with which a standard press brake could do much of the work usually requiring a straight side press. The Leslie die set had a posi-

tive aligning means for accurate registry of punches and dies without leader pins, and also a self-balancing feature eliminating horizontal strains.

Liberty Aircraft Products Corporation, Farmingdale, N. Y., manufactured aircraft accessories, precision machine parts, tools, production machine parts to order, screw machine products, milling and gear cutting work, engine cylinders, pistons and crankcases, heat treating and carbonizing in electric furnaces with atmospheric control, cadmium plating and anodizing alloy parts, aircraft sheet metal work, wing assemblies, tail surfaces, pontoons, bomb racks and complete aircraft doping and finishing work. The corporation expanded plant facilities extensively.

The Liquidometer Corporation, Long Island City, N. Y., continued its production of tank quantity gauges for use on military and commercial aircraft. Liquidometer gauges were used to indicate the quantity of fuel, lubricating oil, de-icer fluid, windshield alcohol, or other liquids in tanks. The company expanded its research and development departments which resulted in improved, as well as new, instruments.

Littelfuse Incorporated, Chicago, Ill., manufactured aircraft fuses and accessories, and recorded several new and important developments. With two plants, a new one on the West Coast, completely equipped and staffed, ample facilities were provided to meet the extreme demand. Featured for the unprecedented requirements against shock and vibration, were the Army Air Corps Littelfuses, and 4 AG, 5 AG and 4 AB aircraft Littelfuses, glass or bakelite enclosed. New protection against terrific shell impact, divebombings and sudden surges of motor power, was provided in special fuse factors engineered far in advance. The Littelfuse Locked Cap Assembly was a process by which caps were affixed without cement so firmly that even a shattering blow did not separate them from the fuse bodies. Caps with markings were not lost. Fuse elements were hermetically sealed against moisture and all climatic conditions. Elements twisted at 90° were braced against the most severe vibration. A "Gooseneck" spring-forming at one end of the element (or coil in some uses) absorbed the repeated contraction and expansion which cause crystallization, a common source of element-cracking and fuse failure. Littelfuse Be. Cu. Fuse Clips, a new alloy of beryllium and copper. were designed for the hardest service. They showed exceptionally high tensile strength and modulus of elasticity, with unusual resistance to fatigue, heat and corrosion. Fatigue resistance was well above 40,000 p.s.i. Heat resistance up to 200°C.

Lloyd, Rogers & Company, New York, maintained a staff of tool engineers and designers for processing and tool designing. In addition to this they developed a service known as dimension control, designed to reduce the waste of critical materials resulting from scrap

making machinery and inspection operations. Dimension control could be applied profitably to many components, especially those which required numerous machining operations, those which were pack carburized and those in which concentricity was of prime importance. Any method of control had to be tailored to fit the conditions in the plant where it was applied. As part of this service, the company trained selected members of a manufacturer's organization in its application.

Lord Manufacturing Company, Erie, Pa., originators of shear type bonded rubber mountings, tripled production and completed an extensive building expansion program, and put into operation four new separate sources of supply. A new Dynafocal suspension for double row radial aircraft engines and a new meter mounting for delicate, sensitive, instruments were two of the latest developments.

Lyon-Raymond Corporation, Greene, N. Y., was in full-out war production on aircraft hoisting and servicing equipment, including hydraulic hoists for engines, spotting dollies, elevating cargo-body trailers, mechanical elevating portable cranes, hydraulic elevating tables and open-end lift trucks.

The Warren McArthur Corporation, New York, designed and supplied more than 70 different styles of seats for American warplanes, each scientifically designed for the comfort and safety of the occupant.

McKenna Metals Company, Latrobe, Pa., supplied aircraft and other industrial plants with Kennametal, the steel-cutting carbide permitting rapid cutting and machining of high tensile steel. This tool material permitted aircraft machinists to cut the heat-treated "Chrome-Moly" steel at from three to six times the spindle speeds they formerly used, and to utilize more fully the horsepower and machining abilities of their equipment during the war shortage of both machines and skilled operators. Users gained other advantages from this metal-cutting carbide. The long tool life between grinds saved much time, and also saved time of setting stops, which, on most turret-lathe set-ups was of greater importance than the actual grinding time on the tools. The ability to "hold size" saved frequent adjusting of stops and permitted long cuts to be made without appreciable taper due to tool wear.

Macwhyte Company, Kenosha, Wis., manufactured aircraft cable, swaged cable terminals, tie rods, aircraft slings, and a general line of wire ropes of many sizes, grades and constructions. Floor space was increased and new equipment was added in all lines. Macwhyte "Safe-Lock" swaged cable terminals were manufactured in eye end, fork end, stud end, turnbuckle end, and numerous special types. They were furnished both loose and attached to aircraft cable. Attachments to aircraft cable in cable assemblies, were made to specification lengths with a terminal on each end of the cable, permanently

fastened with a strength more than the cable itself. Macwhyte "Hi-Fatigue" aircraft cables were made from galvanized, tinned and stainless steel, fabricated to reduce constructional stretch and increase fatigue resisting properties. Macwhyte aircraft wire rope slings were manufactured for use on the airplane itself, and for use in the production, handling and shipping of aircraft. On the aircraft itself, slings were used mainly for hoisting and lowering the airplane. The slings were light weight and flexible, and were built into the aircraft so that it could be, by means of a crane, quickly and safely lifted on board ships and aircraft carriers and lifted into dry docks. For internal and external bracing of aircraft, Macwhyte tie rods were produced from cadmium plated carbon steel and corrosion resisting steel.

Manufacturers Screw Products, Chicago, Ill., manufactured a line of screw products including drilled screws in steel, brass, stainless steel and aluminum.

The Marquette Metal Products Company, Cleveland, O., manufacturer of aircraft engine parts and propeller governors, established an aircraft accessories department providing hydraulic and electric Marquette all-weather windshield wipers and alcohol de-icing systems, consisting of tanks, pumps and valves, for use on Army and Navy combat aircraft, as well as cargo and transport planes of the armed forces and commercial air lines. Considerable expansion of production facilities was effected to meet these greatly increased requirements. In addition to the above, Marquette met the further demands for its precision parts and assemblies, such as lubricating oil pumps, fuel oil pumps, oil pressure and relief valve regulators, including the Marquette hydraulic governor and over-speed trips for Diesel engines.

Mercury Aircraft Inc., Hammondsport, N. Y., doubled floor space and equipment, and had three plants in operation. The original plant housed the machine and tool shops and small assembly department. Plant two was devoted wholly to the fabrication of aluminum fuel and oil tanks. The newest and largest plant produced fins, rudders, surfaces and similar larger assemblies. Among the products supplied for aircraft were several types of oil separators for vacuum pumps used in de-icing equipment and fliers relief tubes, venturies, horns, brackets and fittings.

Mercury Chemical Company, Detroit, Mich., devoted 1942 to the production and distribution of new cleaning, deoxidizing, stripping, and other surface-conditioning materials for aircraft and other metals. Although extensive research on the problems had been made some time before, it was not until 1942 that these new chemicals for definite war-production use were production-tested and put into use. The approach to the problem was new in that for the first time an evaluation of cleaning efficiency was based, not on the pH (actual alkalinity or acidity of solutions), but on a totally different approach which remained to be publicized after the war. The particular char-

acteristic of the new products was obtaining, for the first time in industry, chemically clean surfaces in time cycles as much as three times faster than materials previously introduced, without harm to even such tricky materials as aluminum alloys and magnesium. Also, in view of the fact that many new plants could not get such extensive equipment as vapor degreasers or power washers quickly enough for the war effort, each of these products was made to work in a still tank, which could be built readily in new plants from non-critical materials. Mercury products in use in war plants cut out as many as four operations in a single department; made production possible many weeks earlier than hoped for in new defense plants; and in one department of an air depot released 12 men for badly needed use on other shifts.

The Micro Switch Corporation, Freeport, Ill., manufacturer of thumb-size, feather-weight snap-action switches, used in Army and Navy equipment, developed many new types of switches and more than doubled its manufacturing, engineering and research facilities in order to meet heavy wartime demands. More than 1,500 types of switches were produced, and they were used in every phase of the war effort. A new switch incorporated a magnetic blowout. This special switch could handle heavier inductive loads at high altitudes than could be controlled by standard types. Double pole and four pole double throw switches were designed for special aircraft application. A new peanut switch, smaller than the standard Micro switch, was capable of interrupting inductive loads, due to contact operation of .100 in., and was used for signal lamps. Freedom from contact bounce enabled this tiny switch to close lamp circuits on an inrush of as much as 170 amperes, at 18 volts D.C. The basic Micro switch was modified to meet aircraft requirements. Contact separation was increased to .070 in. to insure interrupting capacity of highly inductive loads at altitudes above 40,000 feet.

Moore-Eastwood & Company, Dayton, O., supplied the aircraft industry with tools, dies and special machinery, and produced bomb racks, bomb shackles, gun sights, gun mounting posts, gun mount adapters, filler valves, gun synchronizer generators, pistol mountings, tab controls and cable meters for tow-targets.

Norma-Hoffmann Bearings Corporation, Stamford, Conn., went ahead with augmented production of its lines of precision ball, roller and thrust bearings, adapted for practically every load, speed and duty. In the aviation division, new styles of sealed aircraft control ball bearings, designed to meet special requirements for control applications, were developed and marketed. The company's line included single and double-row, shielded and unshielded, as well as enclosed felt seal bearings with removable seals.

Numberall Stamp & Tool Company, Inc., Huguenot Park, Staten Island, N. Y., expanded facilities for its output of numbering

machines and marking devices especially adapted for use by manufacturers of aircraft and engines. These machines were utilized in numerous industries to mark machine parts, gears, airplane parts and sheet metal, and to stamp details into name plates.

Ohmite Manufacturing Company, Chicago, Ill., developed a new type of construction of ferrule resistors and a new series of oral core resistors. Devoted exclusively to the manufacture of rheostats, resistors, tap switches and chokes, Ohmite supplied industrial, aviation, radio, electronic, and scientific instrument manufacturers. On planes, Ohmite rheostats and resistors were used to control lights, landing gear, bomb releases, gun turrets, booster pumps and other motor driven devices. They also were used as remote position indicators for wing flaps, landing gear, in various bombsights; and in Amplidyne equipment, and in large numbers in communications equipment, production machinery, aircraft test equipment and in instruments of various kinds.

Onsrud Machine Works, Inc., Chicago, Ill., continued development and manufacture of air turbine and high cycle tools and machines particularly suited to aircraft production. A new, improved version of the famous spar miller, known as the A-80-A contour milling machine, was even more versatile than the original. Equipped with four cutter heads, the A-80-A took as many as four cuts in one operation. Two cutters were vertical, and two were horizontal. One of the vertical cutter heads tilted under pneumatic control and since the degree of tilt was governed by a template and could be varied during feed, a cut of varying angle or twist could be made. Besides making short work of milling long extrusions this machine could shape intricate parts direct from billets. Another important new Onsrud product was the EIRI portable router. This air turbine driven router was designed and built as an "odd job" tool for production routing. It was ideally suited for handling many parts impractical to machine on larger routers and could withstand a great deal of punishment from both work and operator. Onsrud "Metered Mist" spindles embodying centrifugal force feed lubrication, made possible still further developments in the Onsrud technique of applying high cutter speeds to many machining operations.

Pacific Aviation Incorporated, Hollywood, Calif., with another division operating a new plant in Los Angeles, was in full-out war production on hydraulic control valves, selector relief valves, triple selector valves, four way gas valves, fuel shut-off valves, landing gear actuating cylinders, wing flap actuating cylinders, engine cowl flap actuating cylinders, landing gear link control cylinders, bomb door operating cylinders, bomb release gears, main landing gear struts and dive flap booster cylinders.

By establishing a unique subcontracting program in the Los Angeles area, the company increased its production facilities by 50 per

cent. It doubled production in 1941, again in 1942, and was to quadruple it in 1943, when women were expected to form 80 per cent of the total employees.

The Palnut Company, Irvington, N. J., met all demands for delivery of huge quantities of Palnut locknuts, for use on war products of all kinds where nut and bolt assemblies must be held absolutely secure even under the severest vibration. Although special wrenches were not necessary for the assembly of Palnuts, they were used to advantage on some applications where the nut was hard to reach. Several types of Palnut wrenches were developed and when put into use on the assembly floor, provided a satisfactory and rapid assembly method for these spots. New uses for Palnuts were found on aircraft assemblies, where the Palnut alone was used to hold small or light weight parts in place. The development of a new line of Acorn type Palnuts was started with the manufacture of the 6-32, 10-24 and ¼"-20 sizes.

Paragon Research, Inc., Buffalo, N. Y., was organized by Paul Dubosclard, chief engineer of Farnham Manufacturing Company, to develop new aircraft machines and improve designs already in production. An important activity was to be the coordination of spar design to the machines necessary to produce them.

Pioneer Instrument Division of the Bendix Aviation Corporation, Bendix, N. J., expanded production and kept abreast of the ever-increasing requirements of the Services. Manufacturing and assembly facilities were extended to include thousands of square feet of additional floor space, and operating personnel was increased proportionately. Despite the unabated emphasis on quantity production, strictest adherence to Pioneer standards of quality and performance was the watchword of the entire organization. Advances in manufacturing and assembly methods continued, with the institution of processes which effected a notable reduction in man-hours per unit produced. Pioneer engineers and laboratory technicians maintained progress in the development of new instruments and methods of instrumentation. Improved types of navigation, flight, and engine instruments were designed, and particular attention was paid to advanced remote-indicating applications. Developments in the field of aircraft automatic-control units were especially significant.

Pioneer Parachute Company, Manchester, Conn., kept pace with extensive research in parachute development and set new production records. Pioneer's new and improved testing tower for parachutes proved so successful that the U. S. Government ordered towers of similar design. With the huge steel tripod tower, driven by a powerful marine engine, Pioneer could reproduce every strain and stress which actual use placed on a chute. During tests, a camera rigged to the tower took slow-motion pictures of every reaction. Less spectacular, perhaps, but no less important to the industry was the con-

stant research conducted by Pioneer to perfect new materials for parachutes. A stellar example is the collaboration with DuPont Company and Cheney Brothers, Manchester, Conn., silk manufacturers and one of the largest producers of parachute fabrics, in the production of a new nylon weave to supplant silk cut off by the war. So successful was the nylon development that the United States became virtually independent of foreign silk sources. Nylon chutes were proving their safety and durability on the battlefronts of the world. Nylon parachute yarn was twisted by a new method, and woven into cloth with the requisite strength and characteristics of parachute silk. Pioneer officials believed that this nylon fabric might even permanently replace silk for parachutes.

Plaskon Company Inc., Toledo, O., was in production on Plaskon resin glue for use in plywood airplane construction. The Beechcraft AT-10 twin-engine bomber pilot-trainer was made largely of plywood built up with Plaskon. Eighty-five per cent of the plane's major subassemblies were supplied by subcontractors who used Plaskon urea-formaldehyde resin glue as a bonding agent which proved stronger than the wood itself.

Presstite Engineering Company, St. Louis, Mo., was in heavy war production of aviation sealing compounds, effective in fast and lasting sealing of aircraft joints, especially riveted fuselage seams and fuel tanks. Presstite sealers were made in various compounds, for weather

PIONEER CHUTE TESTING TOWER

This new model reproduces all strains and other conditions to which a parachute may be subjected in actual use.

seals in fuselage seams, for windshields, windows and gun turrets, sealing joints in aluminum as well as synthetic glass, and other compounds for almost every sealing purpose.

Prestole Division of Detroit Harvester Company, Toledo, O., was in all-out production of fasteners with unusual safety features. A specially designed lightweight gun, manufactured by the company, had a separate, hardened carbon steel holding ring which locked the fastener in the gun during assembly.

Pump Engineering Service Corporation (Pesco Division of Borg-Warner), Cleveland, O., was in production on engine and motor driven fuel pumps, fuel valves; engine driven, motor driven and hand operated hydraulic pumps, hydraulic equalizing flow dividers, hydraulic motors, hydraulic valves and hydraulic accumulators; engine driven and motor driven air pumps, air valves, air filters, oil separators and oil supply tanks; combination air and hydraulic pumps, motor driven anti-icing pumps and test stands. The most important new Pesco product brought out was a pressure-loaded hydraulic gear pump. This development came as a result of requirements for engine-driven pumps to operate at 1,000 lbs. per sq. in. at speeds as low as 500 r.p.m. It provided increased performance, with no practical increase in power required, by eliminating to a large degree the internal leakage found in conventional gear pumps, attained by eliminating the end clearance through an arrangement of the bushings so that they contacted the faces of the gears in such a way as to be exposed to hydraulic pressure in just the right proportion to hold the bushings against the gears. The volumetric efficiency of the pressure-loaded gear pump was slightly above 90 per cent at 1,500 r.p.m.

The Reynolds Metals Company, Aircraft Parts Division, Louisville, Ky., was part of a system of 38 plants strategically located throughout the country, with over 20,000 employees. The Company's Alabama aluminum reduction plant and rolling mills, a complete aluminum processing and fabricating unit, carried through all operations at a single location, starting from the domestic bauxite ore to finished aluminum alloy sheet, ready for aircraft construction.

At the beginning of 1943, the annual capacity of the Reynolds plants was 160,000,000 lbs. of ingot aluminum, more than the combined total production of the U.S.A., France and England as late as 1934, and as much as the combined production of France and England as late as 1939. In addition, the Reynolds fabricating plants had a capacity of over 200,000,000 lbs. a year. While practically all Reynolds-produced and fabricated aluminum went into aircraft production, of special interest was the establishment and expansion during 1942 of the Aircraft Parts Division at Louisville. At several plant locations in that city a total of approximately 300,000 sq. ft. of space was devoted to the fabrication of finished flat and formed aircraft parts for shipment direct to plane builders, ready for assembly.

These fabricating operations included shearing, routing, drilling, stamping, forming, anodizing and painting. Equipment for this work was assembled during 1942 from otherwise idle civilian plants throughout the country, and was adapted to aluminum fabricating operations by the Reynolds staff. Many additional units were still in process of assembly and installation for further expansion in 1943.

The basic principle upon which the Reynolds Aircraft Parts Division was founded, and which contributed to its phenomenal growth, was the fact that the fabrication of aircraft parts can be most economically and efficiently done at the aluminum source. Since by the

FROM MOTOR CARS TO AIRCRAFT

This 1,300 ton mechanical press was stamping out auto bodies in the Detroit area until the war put it into emergency service. It is set up at a plant of the Reynolds Metals Company to press strong aluminum alloy plate into airplane parts.

nature of the work there was a normal 30 per cent loss of metal in trim, shavings, chips and other forms of scrap in the production of aircraft parts, it was clear that this large percentage of metal, amounting to many millions of pounds throughout the industry, could be put back into production easiest, quickest and cheapest by fabricating at the aluminum mill. Here scrap could be remelted immediately and put back into circulation, eliminating the usual long periods of accumulation, segregating and handling costs, and transportation expenses.

The Roberts & Mander Stove Company, Hatboro, Pa., was in war production on catapult cartridge tanks, parachute containers, firewall and cockpit doors for the Navy Corsair plane and sheet metal assemblies, together with the heat treating of armor plate and tubing.

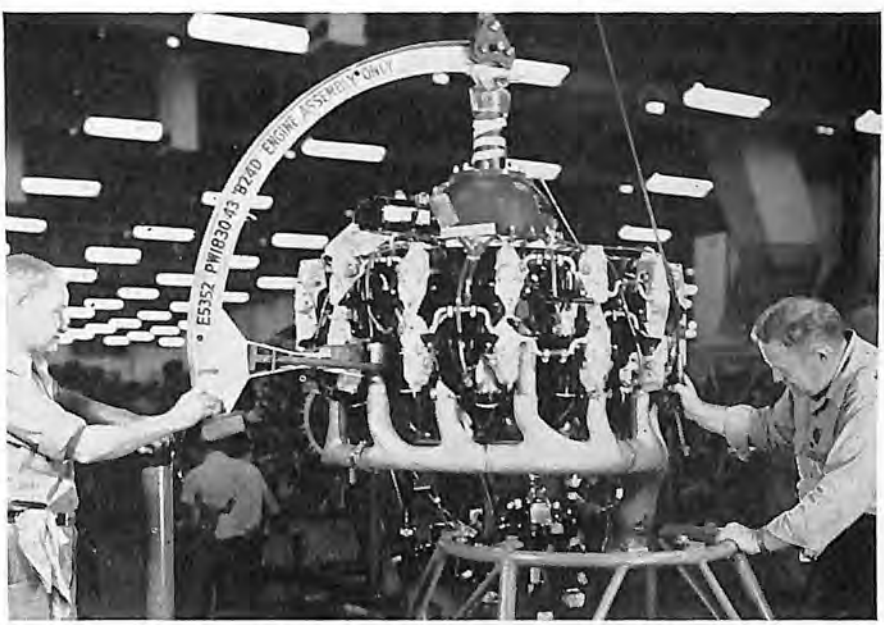
The John A. Roebling's Sons Company, Trenton, N. J., manufactured a complete line of aircraft cords, strands, and swaged terminals; wire rope fittings; aircraft slings; electrical wires and cables; round, flat wires and specialties and woven wire fabrics. Lock-clad control cable, conceived by Lockheed, developed and manufactured by Roebling for use in upper altitudes to minimize effects of stretch and temperature changes in control cables, operated successfully on various types of planes. Roebling installed new improved equipment for the manufacture of aircraft cord and aircraft cord terminals, and for making complete cord assemblies by swaging the terminals to the cord. They also placed in operation new facilities for proof-testing the attachments and for prestressing the complete assemblies to remove constructional stretch and provide uniform operating characteristics from the time the assemblies were first installed in the airplane. For those manufacturers whose control cord assemblies must be tailored to the airplane and prestressed just prior to final assembly, Roebling offered a prestressing rig design for effective removal of constructional stretch.

Rohr Aircraft Corporation, Chula Vista, Calif., supplied assembly line production of complete power plant installations and manufactured parts and assemblies to meet the sharply increased demand of prime aircraft contractors. Rohr for the first time in the history of aircraft manufacture produced an entirely complete engine installation as a subcontractor and shipped it to a prime contractor for installation in an airplane. The power plant assembly was complete with cowling, motor assemblies and components. Its installation in the plane was accomplished in a few minutes rather than the usual time of several days. This production achievement was refined to the point where a streamlined assembly line moved forward constantly with power plants for ever-increasing demands of contractors to whom Rohr supplied the installation. Improvement in manufacturing processes included the tube beading machine which was developed to raise a bead on the end of a tube to give a secure connec-

tion with a piece of flexible tubing. Rohr Aircraft developed a swaging machine in which pneumatic airguns hammered the die as the tube was rotated through it. The tilting arc developed by Rohr Aircraft enabled one man to handle a complete engine in horizontal or vertical position It could be attached to the motor in a few seconds, eliminated the use of additional manpower with complicated machinery and made it possible to handle an engine in a smaller amount of space.

Roxalin Flexible Finishes, Inc., Elizabeth, N. J., introduced a new protective coating for aircraft metals known as Baflex A and using some of the newer plastics for the first time in surface coatings. It could be sprayed, dipped, tumbled or roller coated, and either air-dried in regular lacquer time or permitted force drying at temperatures up to 350° F without damage. The new finish could be used over assembled parts made from several different metals.

S K F Industries, Inc., Philadelphia, Pa., doubled its personnel and facilities to meet the stepped-up demands for aircraft bearings of all types and sizes. Outstanding among the bearings were cylindrical roller bearings for crankshaft main support locations, and deep groove ball bearings to carry combined radial and thrust loads of propeller, starter, rocker arm, magneto and supercharger shafts. Equipped with either cylindrical roller or deep groove ball types of bearings, S K F control pulleys were manufactured to conform to important points and dimensions covered in Army-Navy Specification



ROHR TILTING ARC HANDLING ENGINE

No. 210. Low friction characteristics and high radial capacity in these self-contained bearings resulted in minimum rim wobble. Other advantages were light weight and easy installation.

A. Schrader's Son, Division of Scovill Manufacturing Company, Inc., Brooklyn, N. Y., utilized its greatly expanded plant facilities for tire valves, tire valve replacement parts and tire pressure gauges. The firm also manufactured shock strut valves, a type fashioned on the same principle as the standard tire valve. It had a special high pressure valve core, which was replaceable, and a special high pressure cap. The sealing washer in this model was made of soft copper which formed an air-tight seal when the cap was applied to the valve and tightened with a wrench.

Sciaky Bros., Chicago, Ill., supplied the industry with a variety of welding machines, one a new rocker arm resistance welder, PMCR.2516 for spotwelding aluminum and its alloys. Another Sciaky product was a radial-type gun spot welder with a hydropneumatic booster which could feed a gun able to supply maximum electrode pressure of 1,800 lb. with 90 p.s.i. of air supply.

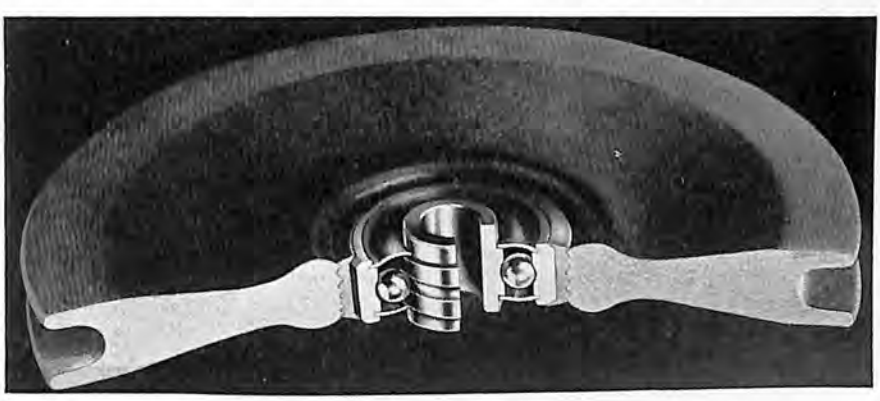
Scintilla Magneto Division of Bendix Aviation Corporation, Sidney, N. Y., supplied Bendix-Scintilla magnetos for all types of airplane engines, spark plugs, switches and radio shielding.

Scott Aviation Corporation, Lancaster, N. Y., developed new aircraft accessories and was in full-out production on high altitude oxygen equipment for fighters and bombers. The company added to its line of light aircraft accessories, which included tail wheel assemblies and space savers for aircraft storage, by designing a hydraulic brake pressure unit. This unit, utilizing a new diaphragm-plunger type of piston, eliminated all the usual master cylinder opportunities for leakage. The company was developing complete landing gear for medium weight aircraft, including the hydraulic shock struts. Scott 40-E aluminum alloy—non-heat-treated but attaining strengths, especially yield strengths, higher than most heat-treated castings—was increasingly used by aircraft companies. It was used extensively in the company's own products for stressed, and for pressure-tight castings and assemblies. The company greatly enlarged its staff of engineers and research specialists, and was developing many new aircraft accessories for war and postwar needs. More than 50 per cent of the Scott machine shop production was done by subcontractors.

Sensenich Brothers, Lititz, Pa., enlarged their airplane propeller plant and increased production. All Sensenich propellers were manufactured of laminated yellow birch wood glued together with cold-setting urea-formaldehyde glue. This glue was waterproof and impervious to fungi. Two large presses were installed solely for glueing test "clubs," for an engine range of from 40 h.p. to 2,000 h.p. Sensenich propellers were accepted by both the Army and the Navy.

The Sheffield Corporation, Dayton, O., developed several gages and precision gaging instruments for the industry. With new production facilities, the company could provide a full range of plain and threaded plug and ring gages as called for in the A-N-GGG-P-363 specifications. By May, 1943, it was to be in production on thread roll snap gages for checking threaded parts. Already in use were several recent developments of the multichek gage for checking several dimensions simultaneously in one quick operation on aircraft cylinders, cylinder barrels and other engine parts. Some of the instruments checked as many as fifteen dimensions on the cylinder barrel at one time, effecting a great saving in inspection personnel, time and costs. A new thread lead checking instrument has been made available for the precision checking of plain and tapered threaded parts and racks, its outstanding feature being a new electric gage head recently developed by Sheffield engineers in collaboration with an electrical manufacturing company. The Sheffield lead measuring instrument could check accurately the lead of finer threads because of the low pressure created in the gaging mechanism. Many new applications of Sheffield's Precisionaire air gage were developed to check internal dimensions. Another application of the Precisionaire was made for the checking of outside diameters of a very thin-walled cylinder having a super-finish. New improvements were made in the Sheffield visual gages, one being development of a new type attachment for checking threads using the three wire measurement, and also small parts. Other developments included a ball bearing checking and sorting machine which checked and sorted bearings ranging in size from ⅛ in. to 11/16 in. diameter at an average rate of 25,000 an hour; a super-precision thread grinder with a multi-ribbed wheel which formed a threaded increment the full width of the wheel in one pass, thus greatly speeding up the grinding of precision threads on aircraft parts.

The Shell Oil Company, Inc., New York, greatly increased its



S K F BALL BEARING IN FORMICA PULLEY

manufacture of aviation fuels and lubricants. Special high octane blending components were developed which enhanced the quality of aircraft fuels and increased the available quantities. Some of these components were made available to the petroleum industry as a whole. Development of new and improved fuels and lubricants, as well as increased production were on the company's 1943 program.

Shure Brothers, Chicago, Ill., were in full-out war production on military microphones, including carbon hand and throat microphones and microphones for use in oxygen masks. New developments included the solving of many acoustical problems incident to the use of this equipment in noisy surroundings. Plant facilities were expanded to take care of the growing production requirements.

Simmonds Aerocessories, Inc., Long Island City, New York, and with expanded manufacturing facilities in New York, Vermont, and California, was prepared to move into full wartime production schedules on the Simmonds-Corsey "Push-Pull" controls, Simmonds-Olaer hydraulic accumulators, Simmonds-Hobson power (boost) controls, Simmonds chronometric radiosondes, and its other specialized aircraft accessories. The Simmonds-Hobson power (boost) control of the Mark 40 type marked Simmonds' entrance into the power control field. This mechanism was designed to relieve the pilot of the need for manually adjusting the manifold pressure of his engines while flying at varying altitudes. The Simmonds-Hobson boost control could most readily be described as an automatic manifold pressure regulator. Although the installation of boost controls in fighter aircraft had greatly accelerated the development of power control, aeronautical engineers predicted its wide application in civilian aviation after the war. The Simmonds-Hobson boost control of the Mark 40 type, which is used as an adjunct to supercharged engines, in addition to simplifying the pilot's job, prevented possible damage to the engine as a result of the development of excessive manifold pressure. The chronometric radiosonde resembled other radiosonde types in using a small balloon to carry aloft a weather recording and radio transmitting device, but differed in that it utilized time measurement in securing and transmitting all data. Calibrated mechanically and directly, the chronometric radiosonde largely eliminated the element of human error which was a factor when calibration had to be calculated. The Simmonds-Olaer hydraulic accumulator, an outstanding development in this category, was an airloaded fluid pressure storage tank of the bottle type, which provided stored power to be called upon for auxiliary purposes.

Sinclair Refining Company, New York, supplied an increasing volume of aircraft engine oil and lubricants to air lines, engine builders, plane manufacturers, and also to aviation branches of the armed forces. Sinclair Pennsylvania 120-GQ Oil, a straight mineral product meeting all important existing specifications, proved its suit-

ability for major air line operation in more than 500,000 engine hours service on American Airlines. In addition to passing successfully the full scale engine test at Wright Aeronautical, Sinclair Pennsylvania 120-GQ obtained approval from Pratt & Whitney, Ranger and other manufacturers of high output engines.

The new Sinclair Oil Jeep saved man hours and time in servicing planes. An aerial hydraulic positioning platform permitted speedy servicing without ladders or monkey-climbing over de-icers and wings. The Oil Jeep also had double swing arms for suction of oil from two engines at once, a 30-ft. suction hose for hard-to-reach drainings and a new type 50-ft. oil hose reel.

Socony-Vacuum Oil Company, Inc., New York, developed new and improved products to aid the war effort, such as Aero PD-535A, a special low temperature grease for use in aircraft controls to give easy operation at temperatures of —70°F for high altitude fighters and still work satisfactorily when subjected to high temperatures of 250°F which might occur on certain parts of aircraft. An improved hydraulic fluid was developed which would not cause the swelling of rubber or synthetic rubber used for seals in the hydraulic control systems yet remained fluid and had other necessary physical characteristics at exceptionally low temperatures. The company played an active part in development of aviation gasoline having an octane number higher than 100, such as 140P, a prototype fuel developed in conjunction with aircraft engine manufacturers and the U. S. Army Air Forces for engines of the future.

Solar Aircraft Company, San Diego, Calif., entered its thirteenth year having expanded all productive facilities for war planes. During the past year a new branch plant in the Middle West was opened, and total factory space and employment increased 150 and 60 per cent, respectively. Solar specialized in design and manufacture of installations for the disposal or utilization of airplane engine exhaust gases. A wide and inclusive number of modern military and commercial airplanes used exhaust systems designed and built by Solar, which developed and improved heat exchangers, flame dampers, jet propulsion stacks, flexible joints, heaters and turbo-supercharged installations. In addition, two welding fluxes (Solar No. 16 and Solar No. 216) differing in melting points, were developed for oxy-acetylene welding of thin 18 per cent chromium—8 per cent nickel, and more highly alloyed, stainless steel sheets, which were also applicable to other chromium-nickel alloys for high-temperature service. No. 16 flux was found useful for atomic-hydrogen welding some classes of materials. These fluxes differed from many others by the close control of boron content and melting point. They were found by usage to make welding of stainless steel easier than the same operation with some other fluxes.

Southern California Airparts, Glendale, Calif., operating on the

WOMEN IN WAR WORK

Acetylene welding on engine exhaust manifolds in the plant of Solar Aircraft Co., at San Diego, Calif.

theory that tooling was one of the most important parts of any job, designed a jig to rotate around a central axis so that all joints to be welded could be turned to an accessible down-hand position. This jig was counterbalanced so that it could be rotated with a minimum of effort. The company also developed a method of profiling tubes accurately, using inexpensive commercially available cutters, which resulted in elimination of time loss in setting up a job and reduction in cost.

A triple punch was designed by the company which in one operation punched three oval holes in a cylindrical tube. Besides insuring accuracy in the part and reducing rejections to zero, the three holes could be punched in less time than formerly required for one hole using the old pin router set-up.

By using different styles of tooling for small and large quantities and development of other types of tools for special purposes, tooling costs were reduced and substantial time saved in fabrication. Southern California Airparts increased to five times its size in a year and in 1943 contemplated a 300 per cent increase in its total volume of business over 1942.

Speedway Manufacturing Company, Cicero, Ill., for more than 35 years were designers and builders of motors from 1/3 to 1/3000 h.p., the latter used to keep animated advertising displays wagging, turning and flashing. The war claimed these little motors and the attention of the technical staff in supplying built-in motors and others for automatic controls and scores of other military purposes.

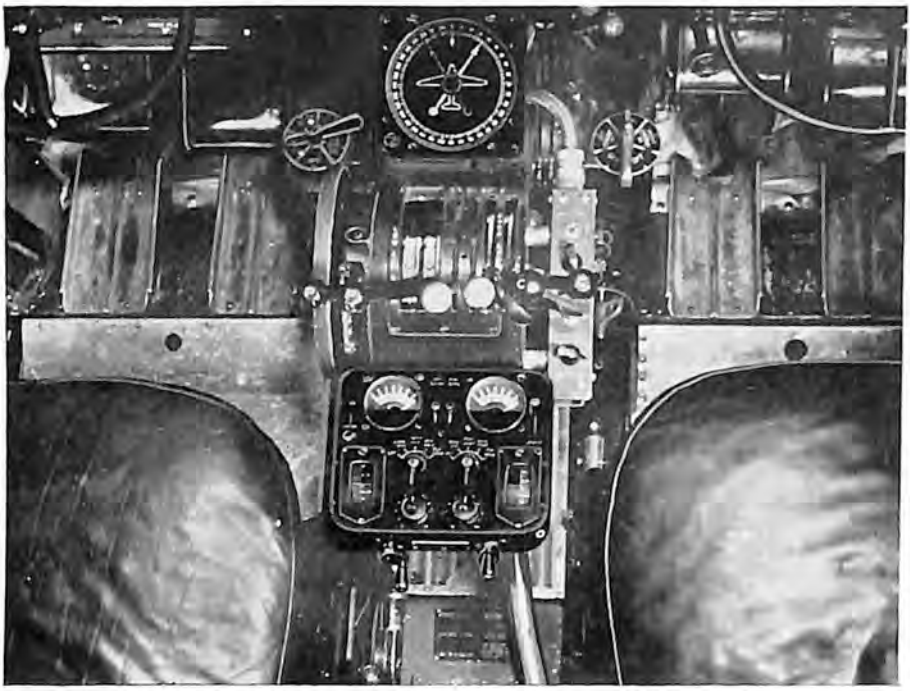
Spencer & Morris, Los Angeles, Calif., representatives for Cleve-

land Tramrail Company and Service Caster and Truck Company in the West, designed variations of overhead and surface material handling systems for major Pacific Coast war industries. Prominent aircraft, steel and shipbuilding plants were served with Spencer & Morris facilities, built to specification.

Sperry Gyroscope Company, Inc., Brooklyn, N. Y., in response to war requirements, continued expansion of its own plants, its subcontracting activities, and intensive development work in aircraft instruments, aircraft armament, anti-aircraft defense, and gyro-marine equipment for the Navy and the merchant service. It also made available Sperry design and technical information without payment of royalties to 16 prime contractors who manufactured Sperry equipment for the armed services. Largest quantity production of aircraft instruments was that of the Sperry Gyro-Horizon and the Directional Gyro, used on all military and naval aircraft in combat service. Refinement of design and increase of production also was achieved in the manufacture of the Sperry gyropilot for aircraft. Among the most important of the company's activities was the design of the offensive and defensive armament for long-range bombers, especially the upper and lower turrets wherein were mounted the guns which made the Boeing Flying Fortresses a powerful factor in air combat. The de-

"DOWN-WELD" FOR EASE OF OPERATION

The "Down-Weld" process, developed by Southern California Airparts, made possible by use of a jig rotating around a central axis.



SPERRY DIRECTION FINDER

sign of these hydraulically controlled turrets was completed, and turrets were in production at the time of Pearl Harbor, and in many cases B17's, headed for Pacific battle areas, took off from California air fields just as rapidly as the mechanics could install the turrets. The Sperry bombsight, while secret for military reasons, was to provide a very interesting chapter in any post-war record of Sperry instruments in battle. In anti-aircraft defense the most notable work was in the substitution of a fabricated steel drum for the cast aluminum drum of the 60 in. high intensity searchlight. This not only represented a change-over to a less critical material; it also resulted in an additional saving in the weight of the equipment. In the years in which the company had been pioneering in the manufacture of gun control directors for anti-aircraft guns there was an impressive increase in the accuracy of anti-aircraft fire. In the First World War about 1,500 to 2,000 rounds were necessary to shoot down a flying target. Reports from Guadalcanal showed that, using Sperry equipment, the average number of rounds required to bring down an enemy plane was from 50 to 60. A major factor in this enhanced accuracy was the Sperry Remote Control for anti-aircraft guns, through which the guns were directly controlled by impulse from the Sperry gun control director, thus eliminating the need for gun pointers operating hand controls.

Sperry Products, Inc., Hoboken, N. J., was in production on exactor hydraulic remote control systems for aircraft. The hydraulic control, developed primarily as auxiliary, or standby, equipment for the electrical control, rapidly was replacing other types. It was adapted readily to both light and heavy loads without need for considerable variations in weight and size. Tremendous forces could be transmitted by hydraulic oil, due to its incompressibility. Instantaneous response in starting and stopping, ease of installation and maintenance, and extreme accuracy were among its major advantages. Leakage resulting in complete failure, was its greatest disadvantage; but this could be overcome by use of protective measures such as auxiliary hand equipment or mechanical safety devices.

The Spool Cotton Company, Crown Fastener Division, New York, specialized in a wide variety of weather-proof covers for aircraft and armament, using the Crown slide fastener.

Spriesch Tool and Manufacturing Company, Inc., Buffalo, N. Y., was in production on automatic bomb releases and shackles; and at the same time was specializing in helping other manufacturers reduce the number of parts in assemblies and effect other production speed-up changes.

The Staley Manufacturing Corporation, Columbus, Ind., developed an engine stand for assembly, tear-down and rebuilding of Allison engines. The stand was gear-driven, with provisions for locking at predetermined angles. All special tools required for the engine cleared the mounting fixtures. The stand was equipped with floor

WOMEN AT WORK AT A SPERRY GYROSCOPE PLANT

stops for holding it rigid when not on the assembly line. The Staley cylinder stand was designed to handle radial engine cylinders during manufacturing and servicing operations. There were other Staley stands for handling a wide range of both radial and in-line aircraft engines.

Long experience in designing and building engine stands, even during the first world war, enabled Staley to develop many features which made for greater speed in assembling, servicing, inspecting and overhauling engines of all types. Many included provisions for the use of interchangeable mounting plates for radial engines. Other Staley features included adjustable arm brackets for obtaining the center of gravity on a wide range of engines, enclosed gear drives running in oil, friction floor stops, removable oil pans and steel ball-bearing casters.

Standard Aircraft Products, Inc., Dayton, O., produced aircraft lighting equipment and control valves as well as precision instruments and accessories for all types of aircraft.

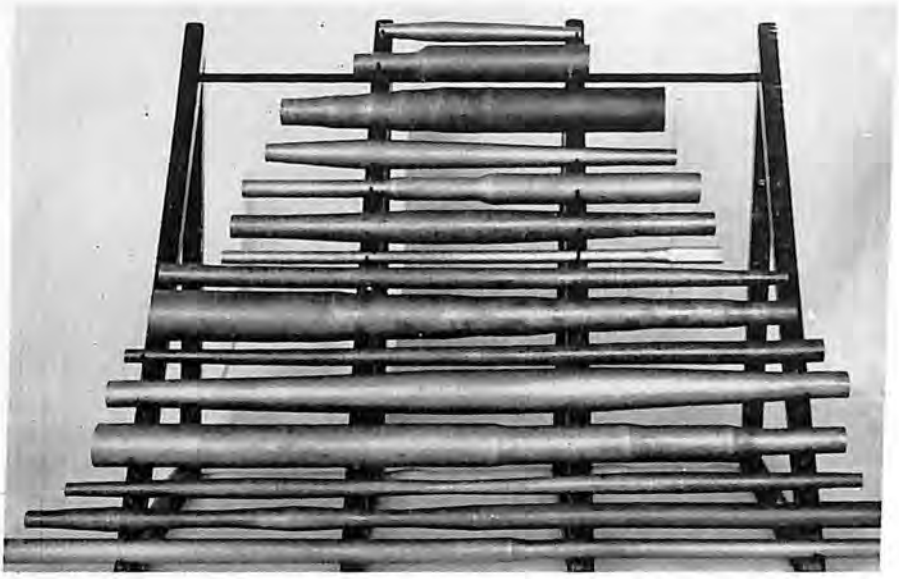
Standard Oil Company of California, San Francisco, Calif., stepped up its activities, including production and shipment of high octane aviation gasoline, aviation oils and aircraft hydraulic fluids, better to serve the war effort. As an example, large emergency orders received from the Government for overseas shipment in barrels of millions of gallons of aviation petroleum products necessitated devoting refinery facilities exclusively to this purpose for extended periods of time. In addition to this enhanced manufacturing and distribution activity, considerable research and development work was undertaken to provide improved products in the way of aromatic aviation fuels, new low pour point aviation oils and improved hydraulic fluids.

The Standard Oil Company of New Jersey, New York, early in 1943 was producing 60 times more high octane aviation gasoline than two years previously Shortly before the war, the company's engineers and technologists developed fluid catalytic cracking, by means of which a single plant could make basic materials for 100 octane as well as many other petroleum products. After Pearl Harbor, three of these units were rushed into operation, cracking petroleum into its many components and then separating these components. Out of a single such plant, operated by only nine men, there was secured in an incredibly short time, such varied petroleum products as propane and propylene, normal butylene, iso-butylene, normal butane and iso-butene, both aviation and motor constituents, synthetic rubber raw materials, blending agents for aviation gasoline and many other products. Five of these units were being completed for the Jersey Company. Twenty-five other fluid catalytic plants were being built by 16 other petroleum companies to which the company made the process available. Along with the company's 100 octane program was its production of many

other petroleum derivatives with an important wartime significance. Typical was Paratone, which, added to oils, permitted them to have a minimum change in viscosity with changes in temperature. Such an oil would not thin out in the Sahara Desert with 140 degrees of temperature nor in the substratosphere 120 degrees below zero. Paratone was used in oils which lubricate tanks, planes and guns as well as in hydraulic oils which lubricate such mechanisms as bomb bay doors on airplanes, gun recoil mechanisms, airplane retractable landing gear and other military tasks. Large quantities were sent to Russia. In addition, the company was turning out such special purpose products as rust preventives for aircraft engines, greases for aircraft control cables, and for use in high altitude flying. Company technicians also surmounted difficulties in producing such products as compass fluids and instrument oils to meet temperatures ranging from +100 degrees to —100 degrees. Coordination of constantly changing inshore and offshore needs of the Army and Navy with all available sources of transportation—tankers, barges, railroads and trucks—was met with energy. The company added to terminals, moved and expanded bulk plants and, of necessity, continued to rearrange facilities in accordance with the day to day demands of logistics. New tank car unloading facilities were built in many parts of the company's marketing area. One result was that tank cars, which formerly made a round trip in 18.61 days, were completing trips on an average of 16.22 days.

The Steel and Tubes Division, Republic Steel Corporation, Cleveland, O., was in production on standard aircraft tubing. The process took flat steel from huge coils, cold-formed it to tubular shape, then electric resistance-welded it to a tube of unusual uniformity in wall thickness, concentricity and ductility. No extraneous weld metal was added. In carbon steel (SAE 1025) and chrome-moly (SAE X-4130) analyses, Republic's Electrunite aircraft tubing was subject to the company's new non-destructive electric test—Farrowtest—claimed to be most sensitive production method of commercial testing for ferrous tubing. In addition to the SAE X-4130 and SAE 1025 analyses, Republic Electrunite tubing also was produced in various carbon, alloy and stainless steels.

The Strippit Corporation, North Tonawanda, N. Y., moved into a new, larger plant during the latter part of 1942, providing greatly increased production and faster deliveries of Wales punching and notching units for the aircraft industry. Production in 1942 was tripled over 1941, and it was anticipated that production would be more than doubled in 1943. Wales punching units were designed especially to punch holes in straight line and scattered patterns in sheets and various metal shapes used in aircraft fabrication. Strippit introduced new Wales open-throat units and also the Wales "E" unit for punching extruded and shaped channels. The Wales CD perfo-



SUMMERILL TAPERED TUBES

They were produced for various aircraft parts at the plant of the Summerill Tubing Company, Norristown, Pa.

rated units and mountings were to be introduced in 1943 under special licensing agreements. The basic principles of Wales punching units provided new short cuts, techniques and economies that sped up the fabrication of airplanes.

The P. A. Sturtevant Company, Addison, Ill., manufactured a complete line of torque measuring wrenches, ranging in size and capacity from small instrument building wrenches of a few inch pounds capacity to great two handled torque wrenches of 7,200-inch pounds capacity. These wrenches were being used widely for gauging or measuring tortional force, as when equalizing the set of screws or nuts by tightening to a predetermined torque, or for measuring the frictional drag in motors or mechanisms. They were used in both manufacturing and inspection departments.

Summerill Tubing Company, Bridgeport, Pa., was in full-out war production on steel tubing, with its output seven times that of 1939. Because of its long record in supplying tubing an increasing number of aircraft manufacturers requested help in producing many types of tapered and formed tubes, as well as machining, grinding and other work for finished and semi-finished parts. As part of its war work Summerill organized a department for handling special shapes, and located more than 20 subcontracting shops to do the required finishing work.

Suncook Mills, New York, was operating on a three-shift basis producing aircraft fabrics under the trade name of Flightex for the

Army and Navy air services and the aircraft manufacturers. Among the products was a special fabric for gliders.

The Superior Tube Company, Norristown, Pa., was producing finished aircraft engine push rods, tubing for instruments, spark plugs and oil lines and also airframe tubing, its monthly output exceeding a whole year's production in the pre-war period. Superior developed substitutes for seamless tubing.

The Surface Combustion Division of General Properties, Inc., Toledo, O., producers of gas fired heat treating equipment developed radiant tube firing, a method widely used by producers of metals and insuring close temperature controls over any predetermined range with precise atmospheric control. Great strides were made in the processing of glass for special shape dials, and as a result wider applications were introduced. Along with heat treatment of glass and metals the S.C. Engineers developed an eminently successful combustion type heater for cockpit heating, gunbreach heating and wing deicing. The heater was produced in a wide range of sizes. Successful tests were completed in both aircraft and pressure chambers, with perfect performance in aircraft at 33,000 feet altitude.

Switlik Parachute Company, Trenton, N. J., was in heavy production on parachutes and other products, bomb-chutes, flare-chutes, safety belts and harnesses, helmets and miscellaneous items. The Switlik chair chute had many exclusive features. Use of nylon as a replacement for silk proved very successful in manufacturing operations, as experience with this and other fabrics, starting back in 1939, had provided a valuable background.

The Tannewitz Works, Grand Rapids, Mich., produced band sawing machinery as an answer to many wood and metal sawing problems encountered by aircraft manufacturers. Tannewitz pioneered the high speed band sawing machine for high speed sawing of sheet metal, aluminum, magnesium, brass, bronze; for sawing gates and risers from metal castings; for sawing dies and templets, and for pattern shop and woodworking departments. For sawing mild sheet steel up to ¼" thick and non-ferrous materials of greater thickness, the Type GH 36" high speed band saw with a direct motor drive, giving a blade speed of approximately two m.p.m., was effective equipment. Mild sheet steel 16 gauge and lighter could be sawed at a rate of 6" to 24" per second. The Type G-1 36" metal cutting band saw, a belt driven unit, was available with a capacity of 19" under the guide, or as a special machine with 32" under the guide, and was designed for sawing gates and risers from aluminum and magnesium castings. It was sufficiently powered to handle the larger airplane engine and cylinder head castings.

The Taylor-Winfield Corporation, Warren, O., introduced the stored energy capacitor discharge spot welder for welding aluminum in aircraft fabrication. A number of models of the Hi-Wave cabinet

were developed, each successively simpler in design and more reliable in operation. Major improvements also were made in spot welder construction with the development of the roller anti-friction welding head and Bellows air lock. Continued research resulted in the development of the Hi-Wave stored energy condenser discharge roller spot welder, wherein the spots were made between the periphery of two welding wheels or rollers driven by an indexing mechanism, permitting speeds as high as 300 spots per minute. Taylor-Winfield also developed a heavy hydraulically operated aluminum spot welder to weld aluminum ranging from two thicknesses .081 in. to two thicknesses .187 in. 24 ST Alclad. The same general type machine was developed with special timing and controls for welding armor plate and other alloy steels by complete heat treating cycle in the welding machine. The company also had a line of precision butt-flash welders for fabricating aircraft structural parts such as landing gears and control fittings from X-4130 steel and other low alloy and high alloy steels. Resistance welding machines also were designed and built for welding operations on high-explosive shells, cartridge cases, ammunition containers, bombs and flares. The company received the Army-Navy E award.

The Texas Company, New York, focused its attention on a research program conducted for the benefit of the civil and military, with emphasis on cooperation with engine, aircraft and propeller manufacturers. Particular attention was centered on development of a low temperature grease for aircraft fittings and military accessories, new aircraft, engine oil giving longer use between drains and controllable pitch propeller lubricant. Contact with the commercial activity in civilian aviation was maintained with a staff of sales and lubrication engineers—with an eye constantly focused on furtherance of commercial aviation. The Texas Company also was nominated as supplier of aviation petroleum products to a score or more Air Forces training detachments, and aided in setting up fueling and lubricating facilities at many of these schools. It was further identified with the war effort by assuming a prominent place in development of high octane aviation gasoline, butadiene for synthetic rubber and toluene for high explosives.

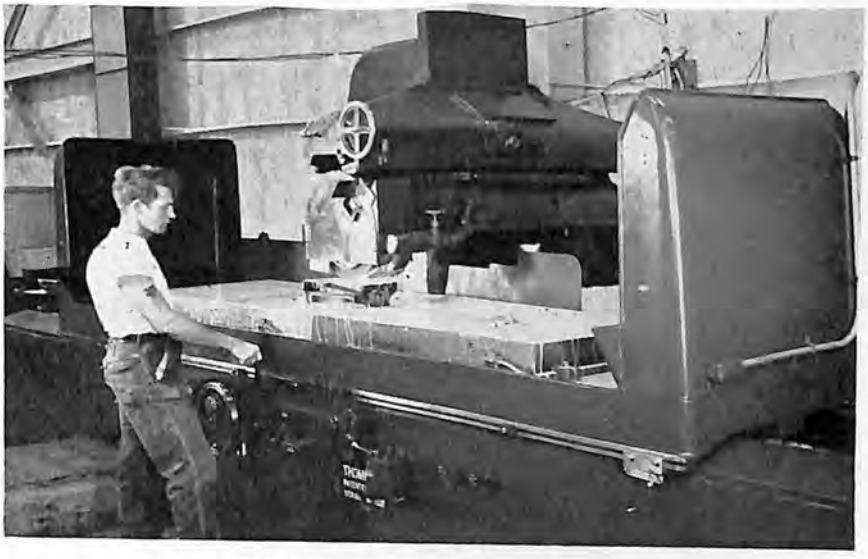
The Thompson Grinder Company, Springfield, O., was in production on hydraulic surface grinders capable of maintaining present day production schedules without sacrificing precision. Many noteworthy improvements were made on the standard line of machines, such as improved spindle construction, automatic down feed with spark-out control which permitted one operator to produce repetitive parts from more than one machine at a time. A special machine was developed to grind channel sections in master rods and articulated rods, removing the tool marks produced by the previous milling operations, thus reducing the time required for polishing to an absolute minimum.

The travel of the grinding wheel head was confined in such a way that it was only necessary to gauge the rod at one point and the entire shape was to the desired dimension well within the required tolerances.

Thompson Products, Inc., Cleveland, O., with company plants in four other cities increased aircraft parts and accessory production 20 times since the beginning of 1940. Aside from large production of sodium-cooled engine valves and approximately 1,000 other hardened and ground parts, the company greatly expanded development and manufacture of accessories such as fuel pumps, high altitude fuel booster pumps, fuel selector cocks and other items. The company in its various plants also was turning out large quantities of shell adapters, Diesel and gas-powered marine engine parts, and engine and chassis parts for half-tracks, tanks, and military cars and trucks.

W. Harris Thurston—Thurston Cutting Corporation, New York, manufactured a complete line of aircraft tapes and fabrics including balloon and glider fabrics, utility cloths, lightweight cloths and other cloths to Army and Navy specifications.

The Timken Roller Bearing Company, Canton, O., increased production of its Timken Roller bearings for landing and tail wheels, tail wheel swivels, rocker arms and other moving parts of aircraft construction where rigidity and free rotation were required. These bearings were widely utilized in landing and tail wheels because of their ability to carry any combination of thrust and radial loads, high mechanical efficiency, large unit capacity and durability. They also per-



THOMPSON SURFACE GRINDER

Type C machine grinding a wedge block at the Douglas plant.

mitted a close adjustment, thus eliminating loose wheels which might cause ground looping. The perfect concentricity of the bearings assured even braking with less wear on tires. In aircraft applications, the bearings not only reduced friction but preserved alignment of moving parts and permitted more rigid mountings. The Timken engineering department was prepared to supply typical lay-outs or prepare specific studies for any position at which installation of the bearings was under consideration.

Tinnerman Products, Inc., Cleveland, O., expanded its line of speed nuts and speed clips until it embraced over 1,500 shapes and sizes. New developments for aircraft assembly included new designs of the flat type, new tubular speed clips, cable clips, a full line of anchor type speed nuts, angle bracket speed nuts, conduit clamps, harness clamps, pulley brackets, junction box clips and special speed nuts and speed clips for plywood and plexiglas assemblies. Most important features of the new Tinnerman developments were big weight savings and marked reductions in assembly time. In some cases these savings ran as high as 80 per cent.

Titanine, Inc., Union, N. J., was awarded the Army-Navy E for production of aircraft primers, clear pigmented and camouflaged dopes and thinners, nitrate, acetate and acetate butyrate, with one department specializing in synthetics to specifications from the Services.

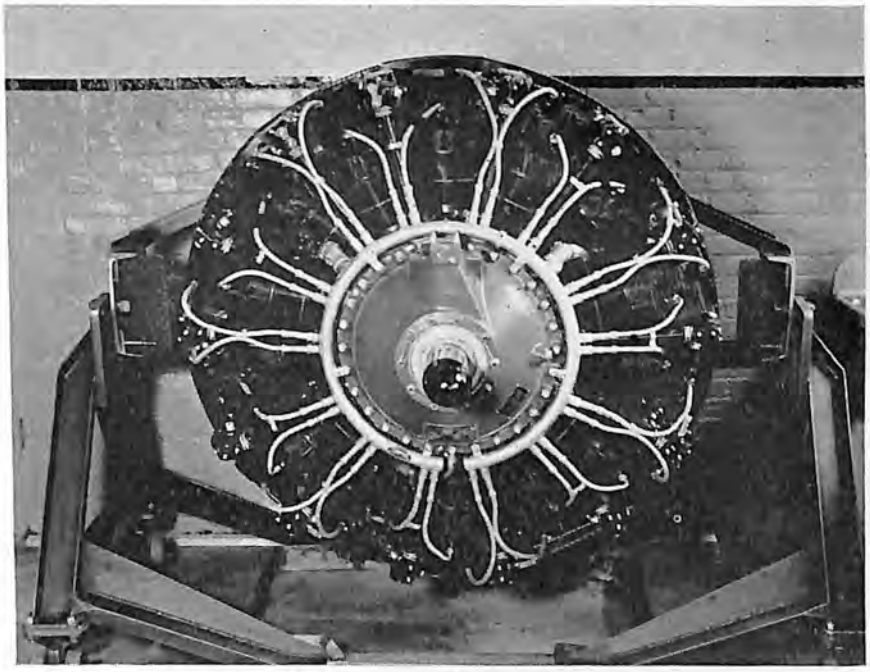
Titeflex Metal Hose Co., Newark, N. J., manufactured for the aviation industry a complete line of radio, power, and ignition shielding. Titeflex radio shielded ignition harnesses were produced in ever increasing quantities to meet schedules set by the engine manufacturers. Titeflex also produced radio shielded spark plug elbows, flexible shielding conduit and fittings, filter units, wiring manifolds, terminal and junction boxes. The well known Titeflex all-metal flexible pressure tubing for fuel and oil lines, instrument lines, and lines for hydraulically controlled devices also was standard equipment under production. Titeflex pioneered and began production on a new type of shielded ignition lead for aircraft motors, known as the Unimold detachable lead assembly, calculated to do away with most of the trouble experienced by airplane mechanics in the replacement and servicing of ignition leads on radio shield assemblies. Instantly detachable from the ignition manifold, to allow immediate replacement, the Unimold lead was integrally molded and completely filled with a homogeneous compound. This high dialectric material was ozone-proof and capable of withstanding the mechanical and electrical abuses experienced on airplane installations and provided a complete radio shielded ignition assembly both moisture tight and free from electrical failure.

Tube-Turns, Inc., Louisville, Ky., manufactured cylinder barrels on 9-inch upsetters, claimed to be the largest in use, and serving to re-

duce spoils. The large upsetter allowed all forging impressions to be encased in the machine. That in turn permitted full use of the great rigidity of the upsetter without spreading or opening of dies. The result was a forging of close grain structure.

Union Aircraft Products Corporation, New York, manufactured junction boxes and conduit fittings, particularly ferrules, collars, couplings, elbows, nuts and adapters, and also expanded its line, resulting in the introduction of its products into the radio field. It introduced Uniprime finish in junction boxes; a unique process removing all high gloss spots imparted to the metal in the process of drawing, and leaving it with a uniform semi-glossy surface, attractive both inside and outside the junction box. It had no chemical action on either electrical equipment or applied paint, and as manufacturers could use a single coating of paint, it represented a substantial saving in money, labor and time.

United Aircraft Products, Inc., Dayton, O., produced an increasing number of their diffusion oil coolers noted for non-congealing, maximum cooling and quick warm-up qualities. They also developed a jacketless oil cooler saving weight and space and having inherent surge protection. An improved oil dilution solenoid valve, consisting of a resilient composition seal on the valve face which assured a perfect seal at all times, became standard Air Forces equipment. The company also produced oil temperature regulators, fuel pumps and



TITEFLEX RADIO SHIELDED IGNITION HARNESS

units, oil dilution solenoids, fuel strainers, Y drain valves, fuel cocks, dial and handles and miscellaneous other parts for aircraft and combat vehicle fuel and oil systems, also hydraulic landing gear struts, tail shocks, accumulators, hydraulic control valves and complete hydraulic equipment.

United-Carr Fastener Corporation, Cambridge, Mass., makers of the "DOT" line of metal fasteners, devoted a large part of its production facilities during 1942 to making fastening devices and stampings for the aircraft industry. Airloc fasteners, used on aircraft cowling, hand holes, access doors, and other places involving similar problems, were notably improved. The scope of the line was extended to include a complete range of standard sizes and fasteners for special applications. The Airloc fastener was adapted for use on plywood. Embodying all of the principles of the tested and proven Airloc fastener for metal, it played an important part in plywood aircraft construction.

United States Plywood Corporation, New York, manufactured parts of its resin-bonded plywood, "Weldwood," for the aircraft industry. Flat and molded Weldwood for fuselages, wing-tips, flaps, tail assemblies and other uses, was hot-press resin-bonded and conformed to Army-Navy specifications. The company also had in production a new plastic resin waterproof glue.

Vapor Car Heating Company, Inc., Chicago, Ill., supplied the industry with its Vapor Cycle Modulation control for positioning cowl flaps or shutters, and designed for accurate regulation. The action was controlled by a thermostat located in the medium to be controlled, in a liquid coolant line or as an actual contact with any engine surface. The thermostat itself was of mercury tube construction with a temperature actuated bulb exposed to the oil, to the coolant or to any other medium being controlled. In the column of mercury above the exposed bulb was a secondary bulb around which, in an insulated container, was a heat winding. Through this winding on the secondary bulb the level of mercury in the tube could be varied artificially by means of the Vapor Cycle Modulation principle. The circuit was arranged so that when the mercury in the thermostat column was above its selected temperature, a portion of the heat was removed from the artificial heat winding. When the mercury broke below the set temperature the artificial heat was automatically restored to the heat winding, causing a rapid cycling action of the thermostat. The cycling rate of the thermostat therefore was a function of the actual temperature within a small range just below the thermostat setting.

Vickers, Inc., Detroit, Mich., manufactured a line of hydraulic equipment for the aeronautical industry. The firm's list of precision products included pressure relief valve, gear type pump or fluid motor, piston type pump or fluid motor, pressure unloading valve, dual directional valve and 5-in. accumulator.

Charles Wagner Litho Machinery Company, Division of National-Standard Company, Hoboken, N. J., developed an accurate and economical method of duplicating templets, following the better known methods used in offset lithography, but because of the demand of aircraft companies for a press with a printing bed of 48″ x 84″ and a vertical adjustment to accommodate plates (or original templets) up to 2″ thick, a special offset press for templet duplication was designed. Of particular interest was the method of adjusting and setting the large and heavy beds at the proper height. A hand wheel was supplied for the initial positioning, and four micrometer screws with dials facilitated the final levelling. To insure accuracy, the beds were heat treated and hand scraped. To obtain perfect register the press was equipped with a floating rack. A set of steel pins, set in both beds, provided a means of gauging the original templet and the duplicate sheets.

Waldes Koh-I-Noor, Inc., Long Island City, New York, developed a new kind of retaining ring, Waldes Truarc which remained circular, whether expanded as external rings or contracted as internal rings, when applied to assemblies.

The Weatherhead Company, Cleveland, O., manufacturers of fittings and flexible hose assemblies, devoted an ever-increasing volume to aircraft production. As designers produced larger planes, the necessity for using hydraulic pressures for actuating and other mechanisms, such as retracting struts, wing flaps and bomb doors became acute. With each new demand, Weatherhead engineering kept pace in the development of flexible hose with proper end fittings to meet each type of service, including universal and bulkhead tube fittings, hose fittings, pipe fittings, hydraulic check valves, vacuum selector valves, hydraulic actuating cylinders and flexible hose assemblies.

The Weber Showcase & Fixture Company, Inc., of Los Angeles, Calif., developed new and important techniques in mass production of aircraft glider wing assemblies. A contribution to increased production in the field was the designing and building by Weber engineers of a cap strip profile planer. With the new Weber-built machine, cap strips were produced in 40 minutes—nine times faster than the old method. Weber also was building many types of assembly jigs so coordinated that all parts were interchangeable. An additional time-saving development was portable electric glue dryers. Formerly, small glued parts had to be set aside until dry. The portable glue dryer cut this drying time and further speeded production.

Weber also produced back rests, radio and navigator table assemblies, compartment doors, ammunition storage racks, oxygen storage racks, chart holders, bomb sling doors, floor tunnel assemblies and flood boards, auxiliary gas tank assemblies; also die stamped cowl ventilators for the Maritime Commission and the Navy.

Wellington Sears Company, New York, continued on an increasingly large scale the manufacture of aeronautical fabrics for use on wing and fuselage structures in airplanes—the company producing more than 25,000 cotton fabrics in its 18 modern mills. Among the firm's best-known lines of airplane cloth was style BA30 grade A, utilized widely on Army and Navy planes.

The Wellman Bronze and Aluminum Company, Cleveland, O., operated at full capacity two large plants devoted to the production of castings. In the older plant were produced castings of heat-treated aluminum, bronze and brass alloys and numerous types of bronzes. In the newer plant operations were confined to patterns and manganese castings. Among the firm's products were cast magnesium generator housings and aircraft landing wheels, cast aluminum pneumatic tool housing and Dowmetal pneumatic tool handles.

Western Electric Company, New York, after the declaration of war, received a tremendous increase in orders for telephonic and radio installations, necessitating a vast increase in plant area, the wholesale conversion of production lines, drastic curtailment of peacetime manufacture and an increase in personnel from 60,000 to 75,000. This resulted in a production increase of seven-and-a-half times the 1941 total. Many startling advances in radio, developed for military use and of a confidential nature, were promised for the postwar era.

A new type of command set was developed by Bell Telephone Laboratories for production in '43. Additional compactness and lightness were features of the new instrument; its weight being about half that of comparable aircraft radio systems.

An example of equipment originally designed for commercial aviation which was taken for military use after the declaration of war, was the 233A radio telephone. Developed and in the process of production in 1941 and 1942, in accordance with air lines specifications, it was adopted by the Navy. Western Electric's 27A radio transmitters and 29A radio receivers, together with its 27B marker beacon radio receivers, were in general military use. An airport transmitter to meet the specific requirements of the Signal Corps also was in the process of development. It consisted of a two-way ground to plane radio transmitter capable of being used for point-to-point radio, teletype and CW telegraphy. Improvements were made in headsets and microphones for aircraft and ground use. The throat microphone, which fitted snugly against the aviator's throat, thus reducing extraneous airborn noises, with improved microphone element had been developed to increase its effectiveness at high altitudes.

Two small microphones for oxygen masks, one magnetic and the other of the carbon type, also were results of the year's research. Notable for their excellence of performance, small size, simplicity of structure and economy of manufacture, these instruments eventu-

ally were to replace the throat microphone for aircraft use at high altitudes. A new headset, featuring receivers with uniform sensitivity to sounds over a wide range of frequencies, was to increase the quality of reception in aircraft radio and intercommunication telephones, supplied either with a headband or installed in an aviator's helmet. The magnetic microphones and the headset receivers had many parts in common which saved considerable time in manufacture and expense to the Government.

Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa., greatly increased its output of aircraft accessories, such as aircraft generators, voltage regulators, relay switches, ammeters, voltmeters, voltammeters, lighting apparatus, Rectox engine starters, Micarta pulleys, molded and laminated Micarta parts, radio receivers and transmitters, and other equipment for planes and plane plants. A new line of aircraft circuit breakers for low voltage direct current circuits was brought out for use both as a switch and a circuit protective device. They were provided with a compensating bi-metal tending to counteract the effect of ambient temperature on the tripping characteristics of the breaker. Development work was carried out on rectified alternating current generating systems with transformers and rectifiers and additional work was started on straight alternating current generators, transformers and control equipment for aircraft. Facilities for the manufacture of dynamotors for radio use were expanded and additional plant capacity was set up for the production of aircraft meters including cross pointer instruments, temperature indicators, and similar aircraft devices.

The S. S. White Dental Mfg. Company, Industrial Division, New York, produced an extensive line of flexible shafts for aircraft use. White engineers were cooperating with the industry in developing applications to power drive or remote control problems.

White-Rodgers Electric Company, St. Louis, Mo., manufacturers of temperature and pressure controls, developed a line of automatic modulation equipment for the control of engine cowl flaps (both air and liquid cooled), oil cooler shutters or flaps, cabin temperature (both supercharged and normal), and carburetor air temperature. White-Rodgers equipment included modulating temperature controls incorporating the White-Rodgers solid-liquid charged element which had been designed to operate at temperatures from minus 90° to plus 600° Fahrenheit without distortion of calibration or range due to changes in altitude or ambient temperature. The company also perfected a differential pressure control for use in conjunction with motorized modulating control units operating oil cooler flaps or shutters.

The Whitney Chain & Mfg. Company, Hartford, Conn., manufactured chains and sprockets for aircraft controls and landing gear equipment.

H. A. Wilson Company, Newark, N. J., supplied the aircraft in-

dustry with a line of precious metal collector rings, silver bearings and other products manufactured from gold, silver and platinum.

The Wipe-On Corporation, New York, developed a number of new finishes and systems for use by the Army and Navy for finishing plywood aircraft and other products made of plastic bonded plywood. Seven years of experience in the finishing of plywood for aircraft use definitely indicated that the prime essentials for a finish for this purpose, should be high moisture resistance combined with durability. Prior to 1942, smoothness of finish was also a requirement, but during 1942, new types of plywood aircraft were produced, which, although still requiring the utmost in durable moisture resistance in the finishing system, necessitated a minimum of film weight ever at some expense to surface smoothness. Together with this development came the need of speeding up finishing time, both by hastening drying time, and by reducing the number of coats. All this resulted in the development of eight new TUF-ON coatings and finishing systems.

The Wittek Manufacturing Company, Chicago, Ill., was in full-out war production on all types of hose clamps for planes and engines, the material being of non-critical mild carbon steel comparable to hose clamps of stainless steel construction. Wittek FBC and FBCA hose clamps were zinc plated for corrosion resistance. The company also manufactured a complete line of roll feeds and reel stands for punch press operations.

Wyman Gordon Company, Worcester, Mass., produced its line of laboratory controlled forgings for the aircraft industry.

CONSOLIDATED PB_2Y_2 CORONADO

This long-range patrol bomber flying boat for the U. S. Navy is powered by four 1,200 h.p. Pratt & Whitney engines and has a wing span of 115 feet.

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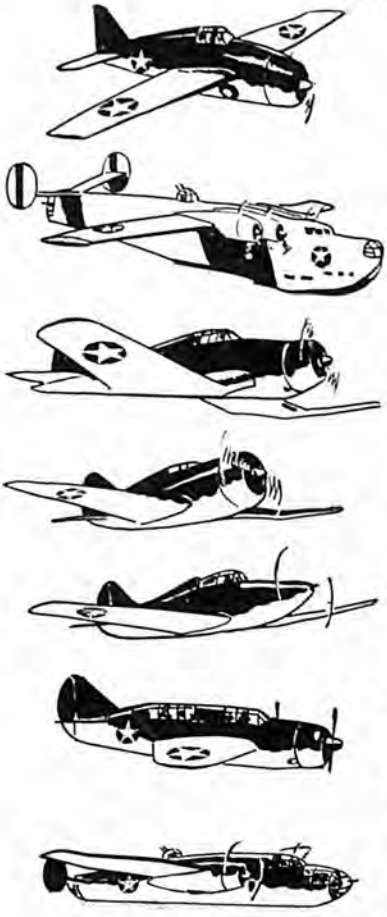

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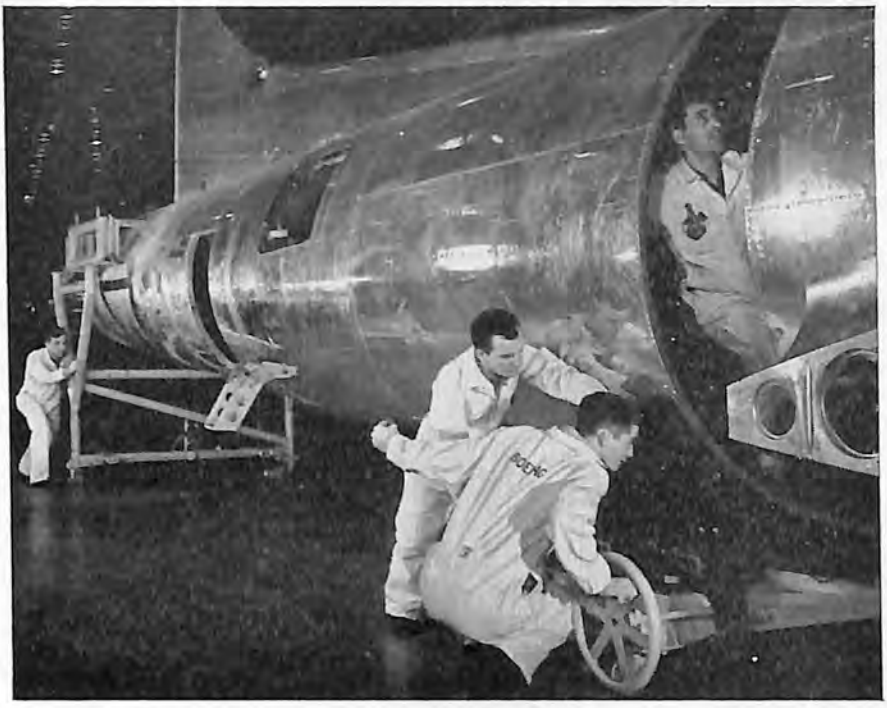

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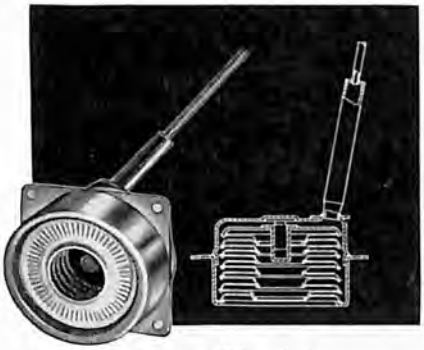

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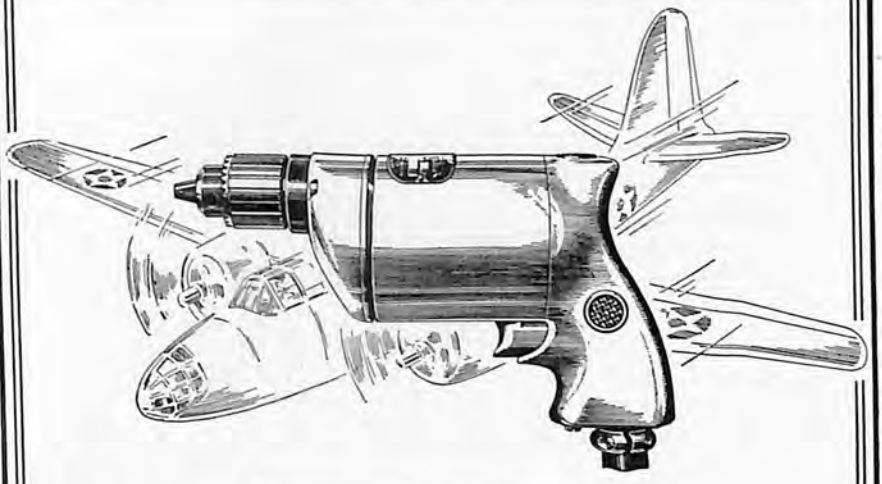
Bendix Products Div., Bendix Aviation Corp.
Chandler-Evans Corp.
Dix Mfg. Co.
Fuel Injection Corp.
Holley Carburetor Co.
Marvel-Schebler Carburetor Div., Borg-Warner Corp.
Zenith Carburetor Div., Bendix Aviation Corp.

CASTINGS & FORGINGS

A & F Aluminum Products Co.
Advance Aluminum Castings Corp.
Airco Tool Co.
Allegheny Ludlum Steel Corp.
Alloys Foundry, Inc.
Aluminum Co. of America
Aluminum Industries, Inc.
American Magnesium Corp.
Ampco Metal, Inc.
Angelus Steel Treating Co.
Arrow Brass Foundry
Atlas Drop Forge Co.
Bordco Manufacturing & Sales Co.
The Bennett Metal Treating Co.
The Billings & Spencer Co.
The Brewer-Titchener Corp.
The Bridgeport Hardware Mfg. Corp.
Buick Motor Div.
The Canton Drop Forging & Mfg. Co.
Castalloy Co., Inc.
Century Metalcraft Corp., Mfg. Div.
Compton Metals Co.
The Cooper Alloy Foundry Co.
Doehler Die Casting Co.
Dollin Corp.
The Dow Chemical Co.
Plastics Dept., E. I. Du Pont de Nemours & Co.
Eaton Manufacturing Co.
Eclipse Aviation Div., Bendix Aviation Corp.
Endicott Forging & Mfg. Co., Inc.
General Bronze Corp.
General Drop Forge Div. of Brown-Lipe Gear Co.
Grinnell Co., Inc.
Harvill Corp.
Highbridge-International Co.
The Imperial Brass Manufacturing Co.
International Stacey Corp.
Interstate Drop Forge Co.
Kropp Forge Co.
Lake Erie Engineering Corp.
Link-Belt Corp.
The Lobdell-Emery Manufacturing Co.
Logan Co.
Milwaukee Valve Co.
Monarch Alloys Co.
Monarch Aluminum Mfg. Co.
Monarch Metal Weatherstrip Corp.
Moore Drop Forging Co.
National Aircraft Equipment Co.
The National Bronze & Aluminum Foundry Co.
The Park Drop Forge Co.
Victor F. Pastushin Co.
The Paulson Tools, Inc.
The Permold Co.
Perry Aircraft Products Corp.
Products Engineering Co.
Ray Day Piston Corp. of Detroit
Revere Copper & Brass Inc.
Scott Aviation Corp.
Shuler Axle Co., Inc.
Stewart-Warner Corp.
Storms Drop Forging Co.
Transue & Williams Steel Forging Corp.
Tube Turns
Utility Electric Steel Foundry
The Variety Aircraft Corp.
Warman Steel Casting Co.
The Wellman Bronze & Aluminum Co.
Wyman-Gordon Co.

CLAMPS

Adel Precision Products Corp.
Adjustable Clamp Co.
Aero Supply Mfg. Co., Inc.
Aero Trades Co.
Aeronautical Radio Mfg. Co.
American Aluminum Ware Co.
American Phenolic Corp.
Armstrong Bros. Tool Co.



BLACK & DECKER HOLGUNS are "standard" with the aircraft industry. More Holguns are being used in more plants to build more war planes than any other type of portable electric drill.

The universal acceptance of HOLGUN is based on two important factors. First, the engineering ability that has combined smooth, dependable power in a compact, easy to handle drill, with style and performance characteristics that exactly suit the aircraft worker. Second, the quality of materials and workmanship which make HOLGUNS stand up and produce for more hours with fewer service interruptions.

HOLGUNS are available in Standard and Heavy Duty types, with a variety of spindle speeds, and can be furnished with end handle or side handle control for working in confined space.

The HOLGUN is one of more than twenty types and sizes of Black & Decker electric drills, ranging in capacity of 3/16" to 1½" The complete Black & Decker line also includes Portable Electric Screwdrivers, Nut Runners, Shears, Sanders, Bench and Portable Grinders, Saws, Hammers, Valve Refacers and Valve Seat Grinders.

The BLACK & DECKER Mfg. Co.

TOWSON, MARYLAND, U. S. A.

Black & Decker — for 32 Years —

"ELECTRIC TOOL HEADQUARTERS"

(Clamps) *Continued*
The M. B. Austin Co.
Automotive Rubber Co.
B. H. Aircraft Co.
Bendix Aviaton, Ltd.
Boots Aircraft Nut Corp.
Buhl Stamping Co.
The Cleveland Metal Stamping Co.
The Columbian Vise & Mfg. Co.
The Corbin Screw Corp.
Detroit Stamping Co.
General Aircraft Supply Corp.
C. M. Hall Lamp Co.
Hardman Aircraft Products, Inc.
Highbridge-International Co.
Hyland Machine Co.
Ideal Clamp Mfg. Co., Inc.
Keystone Tool & Supply Co.
Knu-Vise Inc.
The M B Manufacturing Co., Inc.
Marman Products Co.
Perry Aircraft Products Corp.
Pollak Manufacturing Co.
Prestole Div.
Products Engineering Co.
Screw Machine Products Co., Inc.
H. B. Sherman Mfg. Co.
Solar Aircraft Co.
Steel Forming Corp.
Tinnerman Products, Inc.
Vega Aircraft Corp.
Voges Mfg. Co., Inc.
Waldes Koh-I-Noor Inc.
The Ward Products Corp.
Warman Steel Casting Co.

CLEANERS & CLEANING COMPOUNDS

A C Spark Plug, Div. of General Motors
Acme White Lead & Color Works
Aircraft Specialties Co.
American Air Filter Co., Inc.
American Foundry Equipment Co.
The Automatic Electrical Devices Co.
Cee Bee Chemical Co., Inc.
Circo Products Co.
Clayton Manufacturing Co.
The Cowles Detergent Co.
The Curran Corp.
Detroit Rex Products Co.
Electric Vacuum Cleaner Co., Inc.
Fischer's Surfa-Saver, Inc.
The J. B. Ford Sales Co.
Frazar & Co., Ltd.
Gem Shine Products Co.
General Aircraft Supply Corp.
E. A. Gerlach Co.
The Glidden Co.
Hanson-Van Winkle-Munning Co.
E. F. Houghton & Co.
S. C. Johnson & Son, Inc.
Kelite Products, Inc.
L & R Manufacturing Co.
Lasalco, Inc.
Magnus Chemical Co., Inc.
The Martin-Senour Co.
Mercury Chemical Co.
Permatex Co., Inc.
Phillips Manufacturing Co.
The Phoenix Oil Co.
Pierce & Stevens, Inc.
Pittsburgh Plate Glass Co.
Puritan Co., Inc.
N. Ransohoff, Inc.
Turco Products, Inc.
Wayne Chemical Products Div. of The Wayne Soap Co.

COLLECTOR RINGS, COWLS, STREAMLINES

Aero Parts Manufacturing Co., Inc.
Aero Trades Co.
Aircraft Components Inc.
American Central Manufacturing Corp.
B. H. Aircraft Co.
The Benson Manufacturing Co.
Edward G. Budd Manufacturing Co.
Buhl Stamping Co.
A. T. Case Co.
Columbia Stamping & Mfg. Corp.
Duramold Div. of Fairchild Engine & Airplane Corp.
Engel Aircraft Specialties
General Aircraft Equipment, Inc.
Guiberson Diesel Engine Co.
Hardman Aircraft Products, Inc.
Harvey Machine Co.
Lyon Metal Products, Inc.
P. R. Mallory & Co., Inc.

(Collector Rings, Cowls, Streamlines) *Continued*

Marman Products Co.
Metals & Controls Corp., General Plate Div.
Met-L-Wood Corp.
Packard Manufacturing Corp.
Perry Aircraft Products Corp.
Pollak Manufacturing Co.
Rohr Aircraft Corp.
Solar Aircraft Co.
Tennessee Aircraft, Inc.
Timm Aircraft Corp.
The Variety Aircraft Corp.
Vega Aircraft Corp.
Waldes Koh-I-Noor Inc.
Wallace Supplies Mfg. Co.
H. A. Wilson Co.

CONTROLS

A C Spark Plug, Div. of General Motors
Abrams Instrument Co.
Adel Precision Products Corp.
Aero Parts Manufacturing Co., Inc.
Aero Supply Mfg. Co., Inc.
Aeronautical Manufacturing Corp.
Aeronca Aircraft Corp.
Air Associates, Inc.
Aircraft & Marine Specialty Co.
All American Aircraft Products, Inc.
Allied Control Co. Inc.
American Chain & Cable Co., Inc.
The Apex Machine & Tool Co.
Arens Controls, Inc.
Automatic Electric Co.
Baldwin-Duckworth Div. of Chain Belt Co.
Barber-Colman Co.
Breeze Corporations, Inc.
Burklyn Co.
Chicago Pneumatic Tool Co.
C. P. Clare & Co.
Cook Electric Co.
Cunningham-Hall Aircraft Corp.
Diamond Chain & Mfg. Co.
Dix Mfg. Co.
Durakool, Inc.
Dycer Aviation Supplies
Eclipse Aviation Div., Bendix Aviation Corp.
Eggelhof Engineers
The Electric Auto-Lite Co., Bay Mfg. Div.
Fenwal, Inc.
Geo. J. Fix Co.
Julien P. Friez & Sons, Div. Bendix Aviation Corp.
The Fulton Sylphon Co.
General Aviation Equipment Co., Inc.
General Controls Co.
General Electric Co.
The Hardware Specialties Mfg. Co.
The Hart Manufacturng Co.
Harvill Corp.
Robert Hetherington & Son, Inc.
Hyland Machine Co.
The Imperial Brass Manufacturing Co.
I. Jacoel Cable Splicing Equipment Co.
Klemm Automotive Products Co.
The Langley Instrument & Machine Co.
Lasalco, Inc.
Lear Avia, Inc.
Macwhyte Co.
Mall Tool Co.
Molded Insulation Co.
Moore-Eastwood & Co.
National Machine Products
Pioneer Instrument Div., Bendix Aviaton Corp.
Precision Products, Inc.
Pump Engineering Service Corp.
Richland Auto Parts Co.
Rochester Ropes, Inc.
John A. Roebling's Sons Co.
Shakespeare Products Co.
Simmonds Aerocessories, Inc.
South Shore Machine & Tool Works, Inc.
Sperry Products, Inc.
C. J. Tagliabue Mfg. Co.
Taylor Fibre Co.
Tennessee Aircraft, Inc.
Thompson Products, Inc.
The Toledo Standard Commutator Co.
United Aircraft Products, Inc.
Vapor Car Heating Co., Inc.
Vega Aircraft Corp.
Voges Mfg. Co., Inc.

(Controls) *Continued*
Weltronic Co.
White-Rodgers Electric Co.
S. S. White Dental Mfg. Co.
The Whitney Chain & Mfg. Co.
Woodward Governor Co.

CONTROL STICKS & WHEELS

Aeronca Aircraft Corp.
Aircraft Specialties Co.
All American Aircraft Products, Inc.
American Hard Rubber Co.
American Tube Bending Co., Inc.
Dural Rubber Co.
The Electric Auto-Lite Co., Bay Mfg. Div.
General Aircraft Supply Corp.
Guardian Electric Manufacturing Co.
The Hardware Specialties Mfg. Co.
Harvey Machine Co.
The Lobdell-Emery Manufacturing Co.
Karl Ort
Scott Aviation Corp.
Troyer Aircraft
United States Rubber Co.
Vega Aircraft Corp.
Voges Mfg. Co., Inc.

COVERS

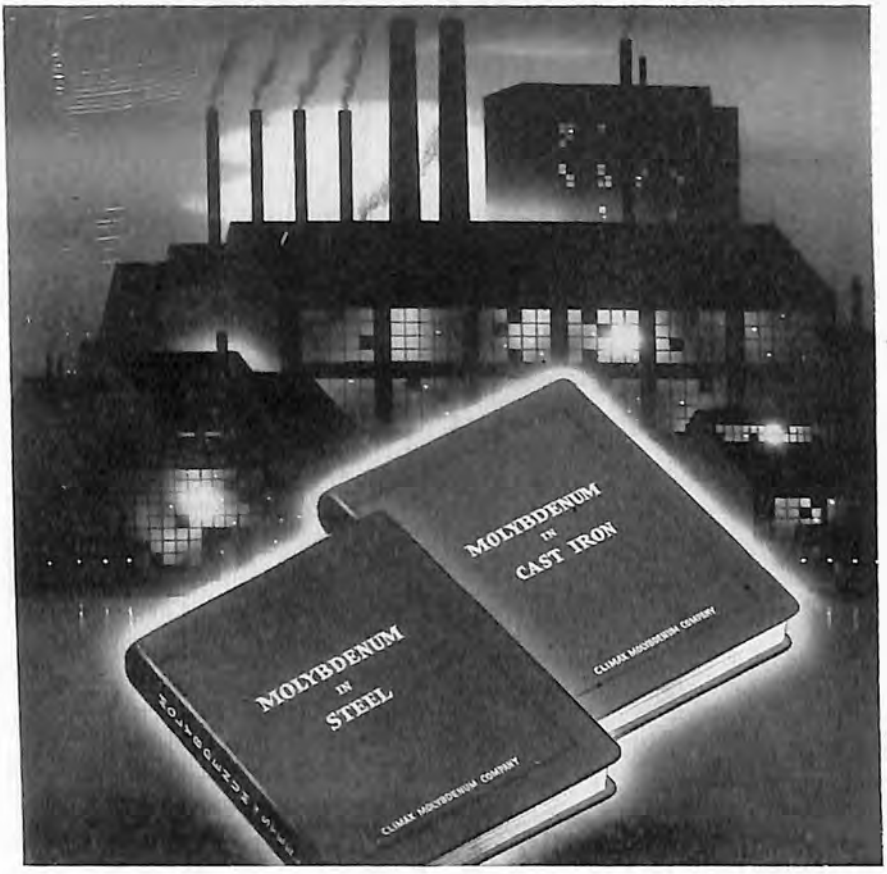
Aero Parts Manufacturing Co., Inc.
Aeronca Aircraft Corp.
Cluff Fabric Products
Plastics Depts., E. I. Du Pont de Nemours & Co.
General Aircraft Supply Corp.
The Hardware Specialties Mfg. Co.
Harlow Aircraft Co.
Heath Co.
Lite-Mfg. Co.
Mellus Brothers & Co.
Monarch Metal Weatherstrip Corp.
Karl Ort
Perry Aircraft Products Corp.
Timm Aircraft Corp.
Vega Aircraft Corp.
Wilber & Son
Worcester Stamped Metal Co.

COWLINGS

Aero Parts Manufacturing Co., Inc.
Aero Trades Co.
Aeronca Aircraft Corp.
Aircraft Components, Inc.
All American Aircraft Products, Inc.
American Central Manufacturing Corp.
Atlantic India Rubber Works, Inc.
The Benson Manufacturing Co.
Boots Aircraft Nut Corp.
Buhl Stamping Co.
Charles W. Carll Sons
A. T. Case Co.
Detroit Sheet Metal Works
Plastics Dept., E. I. Du Pont de Nemours & Co.
Edo Aircraft Corp.
Engel Aircraft Specialties
General Aircraft Equipment, Inc.
Guiberson Diesel Engine Co.
Hardman Aircraft Products, Inc.
The Hardware Specialties Mfg. Co.
Harlow Aircraft Co.
Harvey Machine Co.
Hayes Manufacturing Corp.
Hill Aircraft Streamliners Co.
Lyon Metal Products, Inc.
Perry Aircraft Products Corp.
Pollak Manufacturing Co.
Radel Leather Mfg. Co.
Roberts & Mander Stove Co.
Solar Aircraft Co.
Southern California Airparts
Steel Forming Corp.
Tennessee Aircraft, Inc.
Tietzmann Engineering Co.
Timm Aircraft Corp.
The Variety Aircraft Corp.
Vega Aircraft Corp.

CYLINDER DEFLECTORS, BAFFLES, BRACKETS

Aero Parts Manufacturing Co., Inc.
Aero Trades Co.
Aeronca Aircraft Corp.
American Aluminum Ware Co.
Baltic Metal Products Co.
Buhl Stamping Co.



PRACTICAL DATA FOR PRESENT PROBLEMS

Here are two books designed to help users of Molybdenum steels and irons to conserve all alloying elements, and possibly steel and iron, by getting the most in the way of strength, toughness and wear resistance with the lowest alloy content.

"MOLYBDENUM IN STEEL" covers the fundamental metallurgy of Molybdenum steels. Heat treatment —physical properties—applications —of a number of these steels are treated at length.

"MOLYBDENUM IN CAST IRON" covers the effect of Molybdenum in gray iron, giving suggested analyses for practical applications and detailed discussion of high strength (60,000 p.s.i. and up) irons.

Both books will gladly be sent without charge on request.

Climax Mo-lyb-den-um Company
500 Fifth Avenue · New York City

MOLY

(Cylinder Deflectors, Baffles, Brackets) *Continued*
Buick Motor Div.
Continental-Diamond Fibre Co.
Engel Aircraft Specialties
Guiberson Diesel Engine Co.
C. M. Hall Lamp Co.
Hardman Aircraft Products, Inc.
Pneumatic Drop Hammer Co.
Solar Aircraft Co.
Technical Ply-Woods
Tennessee Aircraft, Inc.
Timm Aircraft Corp.
Twin City Tool Co.
Tyson Roller Bearing Corp.
Vega Aircraft Corp.
Voges Mfg. Co., Inc.
Whitehead Stamping Co.
Worcester Pressed Steel Co.

DEHYDRATED PACKING

Davison Chemical Corp.

DE-ICER EQUIPMENT

Adel Precision Products Corp.
Air Associates, Inc.
Aircraft Components, Inc.
Aircraft Specialties Co.
The Aro Equipment Corp.
The Automatic Electrical Devices Co.
Bellanca Aircraft Corp.
Bertea Products
The Boston Auto Gage Co.
Century Aircraft Co.
Chicago Metal Hose Corp.
Clarostat Mfg. Co., Inc.
Eclipse Aviation Div., Bendix Aviation Corp.
Firestone Aircraft Co.
The Fostoria Pressed Steel Corp.
General Controls Co.
The B. F. Goodrich Co., Aeronautical Div.
Hayes Manufacturing Corp.
The Imperial Brass Manufacturing Co.
The Marquette Metal Products Co.
Mercury Aircraft, Inc.
Pacific-Airmax Corp.
The Parker Appliance Co.
Pittsburgh Plate Glass Co.
Pump Engineering Service Corp.
Solar Aircraft Co.
Steel Forming Corp.
Voges Mfg. Co., Inc.
Wico Electric Co.

DYNAMOTORS

Aeronautical Radio Mfg. Co.
Carter Motor Co.
Clayton Manufacturing Co.
Eclipse Aviation Div., Bendix Aviation Corp.
Electronic Laboratories, Inc.
General Armature Corp.
The Leland Electric Co.
Pioneer Gen-E-Motors
Quality Electric Co.
Robbins & Myers, Inc.
The Toledo Standard Commutator Co.
Westinghouse Electric & Manufacturing Co.

ELECTRICAL EQUIPMENT

Aeronautical Manufacturing Corp.
Air Associates, Inc.
Aircraft & Marine Specialty Co.
Allen Electric & Equipment Co.
American Bosch Corp.
American Gas Accumulator Co.
American Phenolic Corp.
R. B. Annis Co.
Appleton Electric Co.
The M. B. Austin Co.
Automatic Electric Co.
The Automatic Electrical Devices Co.
B. H. Aircraft Co.
Baker & Co., Inc.
Belden Manufacturing Co.
The Benwood Linze Co.
Boston Insulated Wire & Cable Co.
Burndy Engineering Co., Inc.
Bussman Mfg. Co.
Cannon Electrical Development Co.
Champion Aviation Products Co.
Circo Products Co.
C. P. Clare & Co.

WITH THIS COMPLETE LINE IT'S EASY TO BUY

Light-weight precision-balance G-E aircraft **motors** are made from 1/200 to 7 hp. Speeds range from 1750 to 7500 rpm. Series-, compound-, or shunt-wound, they meet various applications. Standard Air Corps flange mounting styles 2 to 4.

Excellent commutation under the most unfavorable conditions makes General Electric **generators** for aircraft a dependable source of electric power. They combine light weight with a high output.

Dynamotors are effective for providing the voltage necessary for radio operation. They are light, compact, and efficient and deliver high outputs. G-E experience in building standard and special dynamotors is assurance of reliable service.

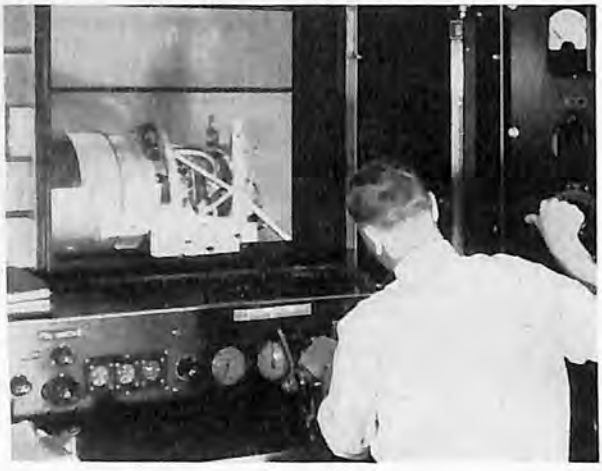
Although it's small, the **G-E Switchette** has double-break contact construction. It weighs only $\frac{1}{3}$ ounce and measures $1\frac{3}{4}$ by $\frac{1}{2}$ by $\frac{13}{32}$ in. Made in single or two-circuit form. One contact normally open—one closed; or vice versa.

Dynamotor contactor—will handle an inrush of 500 amperes at 32 volts. It operates on either 12 or 24 volts, d-c. Provides one single-pole normally open contact; has a 50-ampere rating based on NEMA 8-hour test.

Limit switch, light in weight, especially designed for aircraft applications. It is small and has snap-action double-break contacts that give the switch a high-current rating. It is suitable for applications where vibration is severe.

OF PLANE EQUIPMENT FROM General Electric

Voltage regulators to maintain correct voltage, and **relays** to control generator flow, complete the electric generating system.



General Electric engineering helped promote these developments; also **laboratory testing equipment.** G-E **dynamometers** and **testing equipment** are available to meet any requirements.

Accurate indications are provided from remote stations with G.E. **selsyns,** each of which consists of an indicator and a transmitter. They are particularly well adapted to aircraft since they are compact (as many as four indications can be incorporated on a $2\frac{3}{4}$-in. dial), light in weight, and consume little power. They operate directly from the 12- or 24-volt d-c primary aircraft system. The indicator shown is typical of the line which includes instruments to indicate position, pressure, and liquid level.

In the electrically heated flying suit for high altitude flying, also engineered by G.E., resistance wires, controlled by cigarette-sized thermostats embedded in the material, keep temperature constant. Boots, gloves, and suit are connected separately.

GENERAL ELECTRIC

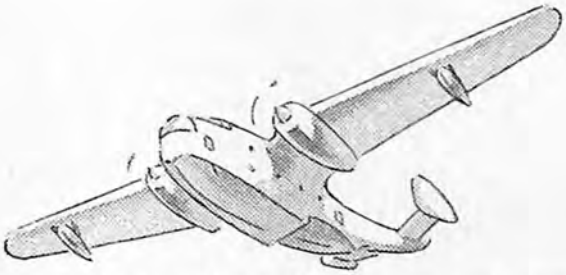
640-102

SCHENECTADY, N. Y.

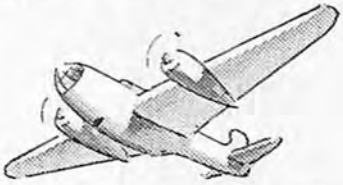
(Electrical Equipment) *Continued*
Clarostat Mfg. Co., Inc.
Cleveland Tungsten, Inc.
Cole-Hersee Co.
Collyer Insulated Wire Co.
Colt's Patent Fire Arms Manufacturing Co.
Cook Electric Co.
Cosco Manufacturing Co.
The R. W. Cramer Co., Inc.
The Crescent Co.
Crescent Insulated Wire & Cable Co.
Curtis Lighting, Inc.
Cutler-Hammer, Inc.
Dejur-Amsco Corp.
Drake Manufacturing Co.
Driver-Harris Co.
Durakool, Inc.
Eastern Air Devices, Inc.
Eclipse Aviation Div., Bendix Aviation Corp.
The Electric Auto-Lite Co., Bay Mfg. Div.
The Electric Auto-Lite Co., Wire Div.
Fairbanks, Morse & Co.
Federal A. C. Switch Corp.
Fenwal, Inc.
Fibre Conduit Co.
The Fostoria Pressed Steel Corp.
General Electric Co.
Guardian Electric Manufacturing Co.
C. M. Hall Lamp Co.
Hardwick, Hindle, Inc.
The Hart Manufacturing Co.
Harvey Machine Co.
Heinemann Circuit Breaker Co.
Henger Seltzer Co.
Hevi Duty Electric Co.
International Resistance Co.
Justrite Manufacturing Co.
Kellogg Switchboard & Supply Co.
Kenyon Transformer Co., Inc.
Lear Avia, Inc.
The Leece-Neville Co.
The Leland Electric Co.
Chas. F. L'Hommedieu & Sons Co.
Littelfuse, Inc.
P. R. Mallory & Co., Inc.
Molded Insulation Co.
The New Haven Clock Co.
North American Electric Lamp Co.
Ohmite Manufacturing Co.
Operadio Manufacturing Co.
Karl Ort
Owens-Corning Fiberglas Corp.
Packard Electric Div., General Motors Corp.
Joseph Pollak Corp.
Poulsen & Nardon, Inc.
H. P. Preis Engraving Machine Co.
R-B-M Manufacturing Co.
Radio Condenser Co.
Radio Frequency Laboratories, Inc.
Robbins & Myers Inc.
Rockbestos Products Corp.
A. W. Rosen & Co.
Seamlex Co., Inc.
Searle Aero Industries, Inc.
The Sound Scriber Corp.
Special Machine Tool Engineering Works
Spencer Thermostat Co.
Square D Co.
The Standard Electric Time Co.
Sterling Electric Motors, Inc.
Technical Products Co.
Televiso Products, Inc.
Tietzmann Engineering Co.
Tingley Reliance Rubber Corp.
The Toledo Standard Commutator Co.
United Aircraft Products, Inc.
The United States Graphite Co.
United States Rubber Co.
Vega Aircraft Corp.
The Ward Products Corp.
Westinghouse Electric & Manufacturing Co.

Auxiliary Motors

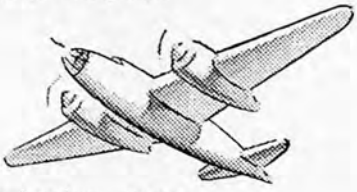
Air Associates, Inc.
Baldor Electric Co.
Barber-Colman Co.
Beckett Electric Co., Inc.
Bertea Products
Bodine Electric Co.
Carter Motor Co.
Chicago Pneumatic Tool Co.
Delco Products Div., General Motors Corp.
Diamond Chain & Mfg. Co.
The Dumore Co.



MARINER: Martin PBM Navy patrol bombers are guarding the sealanes against submarines, surface raiders and enemy aircraft . . . are helping get the convoys through.



BALTIMORE: Martin #187 R. A. F. medium bombers have played a vital role in the North African campaigns, eclipsing the battle records of their predecessor, the Martin "Maryland."



MARAUDER: Martin B-26 Army medium bombers, carrying either bombs or torpedoes, struck telling blows at Midway, the Aleutians, New Guinea, and other fronts.

In war, or in peace, keep your eye on the Martin Star

Martin

AIRCRAFT

Builders of Dependable Aircraft Since 1909

The Glenn L. Martin Company, Baltimore, Maryland, U.S.A.

(Auxiliary Motors) *Continued*
Eclipse Aviation Div., Bendix Aviation Corp.
Eicor, Inc.
Electric Vacuum Cleaner Co., Inc.
Lear Avia, Inc.
The Leece-Neville Co.
The Leland Electric Co.
Owens-Corning Fiberglas Corp.
Quality Electric Co.
Robbins & Myers Inc.
Speed Way Mfg. Co.
The Toledo Standard Commutator Co.
Westinghouse Electric & Manufacturing Co.

Disconnect Plugs

Air Associates, Inc.
Appleton Electric Co.
Edward F. Aymond Co.
Beckett Electric Co., Inc.
The Bryant Electric Co.
Cannon Electrical Development Co.
Cole-Hersee Co.
Cook Electric Co.
H. A. Douglas Mfg. Co.
C. M. Hall Lamp Co.
Kellogg Switchboard & Supply Co.
Kliegl Bros. Universal Electric Stage Lighting Co., Inc.
Molded Insulation Co.
Joseph Pollak Corp.
Pollak Manufacturing Co.
The Pyle-National Co.
United-Carr Fastener Corp.
The Ward Products Corp.

Generators

Aeronautical Radio Mfg. Co.
Carter Motor Co.
Champion Aviation Products Co.
Eclipse Aviation Div., Bendix Aviation Corp.
General Armature Corp.
General Electric Co.
Lear Avia, Inc.
The Leece-Neville Co.
Chas. F. L'Hommedieu & Sons Co.
Moore-Eastwood & Co.
Owens-Corning Fiberglas Corp.
Pioneer Gen-E-Motors
Robbins & Myers, Inc.
The Toledo Standard Commutator Co.
Westinghouse Electric & Manufacturing Co.

Magnetos

Allied Control Co. Inc.
American Bosch Corp.
Eclipse Aviation Div., Bendix Aviation Corp.
Edison-Splitdorf Corp.
Eisemann Corp.
The Electric Auto-Lite Co., Bay Mfg. Div.
Fairbanks, Morse & Co.
General Electric Co.
Owens-Corning Fiberglas Corp.
Scintilla Magneto Div., Bendix Aviation Corp.
Wico Electric Co.

Relays

Automatic Electric Co.
C. P. Clare & Co.
Struthers Dunn, Inc.
General Electric Co.
The Hart Manufacturing Co.

Switches

Acro Electric Co.
Aeronautical Radio Mfg. Co.
Air Associates, Inc.
Allied Control Co. Inc.
Beckett Electric Co., Inc.
Briggs & Stratton Corp.
The Bryant Electric Co.
C. P. Clare & Co.
Clarostat Mfg. Co., Inc.
Cole-Hersee Co.
Colt's Patent Fire Arms Manufacturing Co.
Cook Electric Co.
The R. W. Cramer Co., Inc.
Cutler-Hammer, Inc.
H. A. Douglas Mfg. Co.
Eclipse Aviation Div., Bendix Aviation Corp.

30 Ounce Miracle
that Revolutionizes Starting Ignition

As aviation engines have grown in size and power, one major difficulty has been the problem of providing adequate all-climate starting ignition. Today this problem has been solved by American Bosch Induction Vibrator . . . a simple device small enough to put in one's pocket. From the Equator to the Poles—winter or summer—engines in United Nations planes can now start in a flash and get into the air more quickly.

This development—begun in times of peace under the American Bosch policy of relentless research in every phase of its field—has been completed in time to meet intensified military demand. Broadening the potential battle zone of every plane in which it is installed, it serves the cause of Victory by helping to open new fronts for American and Allied air strategy.

American Bosch Corporation
Springfield, Mass.

Modern Craftsmen in the New England Tradition

AMERICAN BOSCH

AVIATION AND AUTOMOTIVE ELECTRICAL PRODUCTS . . . FUEL INJECTION EQUIPMENT

(Switches) *Continued*
Eisemann Corp.
General Electric Co.
Guardian Electric Manufacturing Co.
The Hart Manufacturing Co.
Henger Seltzer Co.
Robert Hetherington & Son, Inc.
Kellogg Switchboard & Supply Co.
The Leece-Neville Co.
Littelfuse Inc.
P. R. Mallory & Co. Inc.
Micro Switch Corp.
Molded Insulation Co.
Mu-Switch Corp.
Ohmite Manufacturing Co.
Joseph Pollak Corp.
Quality Electric Co.
R-B-M Manufacturing Co.
Scintilla Magneto Div., Bendix Aviation Corp.
Shallcross Mfg. Co.
Square D Co.
The Standard Electric Time Co.
Tietzmann Engineering Co.
Twin City Tool Co.
The Ward Products Corp.
Westinghouse Electric & Manufacturing Co.

Terminals

Air Associates, Inc.
The M. B. Austin Co.
Beckett Electric Co., Inc.
Belden Manufacturing Co.
Burndy Engineering Co., Inc.
Cannon Electrical Development Co.
Cole-Hersee Co.
Connecticut Telephone & Electric Co.
Cook Electric Co.
H. A. Douglas Mfg. Co.
Eisemann Corp.
The Electric Auto-Lite Co., Bay Mfg. Div.
The Electric Auto-Lite Co., Wire Div.
C. M. Hall Lamp Co.
Kellogg Switchboard & Supply Co.
Littelfuse Inc.
Manufacturers Screw Products
Molded Insulation Co.
Joseph Pollak Corp.
H. B. Sherman Mfg. Co.
The Standard Electric Time Co.
Twin City Tool Co.
United-Carr Fastener Corp.
Vega Aircraft Corp.
The Ward Products Corp.
Wolverine Tube Div. of Calumet & Hecla Consolidated Copper Co.

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Aircraft Components Inc.
Aircraft Mechanics, Inc.
Aircraft Welders Inc.
American Tube Bending Co., Inc.
Associated Rubber Products Co.
Atlantic India Rubber Works, Inc.
B. H. Aircraft Co.
The Benson Manufacturing Co.
Jack Best Mfg. Co.
Charles W. Carll Sons
A. T. Case Co.
The Connecticut Hard Rubber Co.
Dural Rubber Co.
Essick Manufacturing Co.
Goodyear Tire & Rubber Co.
Hardman Aircraft Products, Inc.
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Harlow Aircraft Co.
Harvey Machine Co.
Hayes Manufacturing Corp.
Hockaday-Newby Aircraft, Inc.
Houdaille-Hershey Corp.
Carl Hussman-Engineers
Kellett Autogiro Corp.
Kropp Forge Co.
Logan Co.
The M B Manufacturing Co.
The Manhattan Rubber Mfg. Div. of Raybestos-Manhattan, Inc.
Motor Rebuilding Specialties
National Aircraft Equipment Co.
Perry Aircraft Products Corp.
Seiberling Rubber Co.
Skylark Manufacturing Co., Inc.
Southern California Airparts
Tietzmann Engineering Co.
Tyson Roller Bearing Corp.
United States Rubber Co.
Universal Building Products Corp.
Vega Aircraft Corp.

(Engine Mounts) *Continued*
Voges Mfg. Co., Inc.
Wallace Supplies Mfg. Co.
Weltronic Co.

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Air Craftsmen, Inc.
Aircraft Components Inc.
Aircraft Welders Inc.
All American Aircraft Products, Inc.
American Central Manufacturing Corp.
American Tube Bending Co., Inc.
The Beaton & Corbin Mfg. Co.
The Benson Manufacturing Co.
Edward G. Budd Manufacturing Co.
Buhl Stamping Co.
Charles W. Carll Sons
Columbia Stamping & Mfg. Corp.
Engel Aircraft Specialties
Guiberson Diesel Engine Co.
Hardman Aircraft Products, Inc.
Harvey Machine Co.
Hayes Manufacturing Corp.
Inglewood Sheet Metal Works
F. C. Kent Co.
Met-L-Wood Corp.
Perry Aircraft Products Corp.
Pneumatic Drop Hammer Co.
Pollak Manufacturing Co.
Skylark Manufacturing Co., Inc.
Solar Aircraft Co.
Steel Forming Corp.
Vega Aircraft Corp.
Wallace Supplies Mfg. Co.

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Industrial Tape Corp.
The Laidlaw Co., Inc.
The Landers Corp.
The Martin-Senour Co.
The Schwarzenback Huber Co.
Suncook Mills
Uxbridge Worsted Co., Inc.
Wellington Sears Co.

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American Screw Co.
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Bostich, Inc.
Burklyn Co.
Camloc Fastener Co.
Central Screw Co.
Cherry Rivet Co.
Cinch Mfg. Corp.
Continental Screw Co.
The Corbin Screw Corp.
The Dill Mfg. Co.
Dzus Fastener Co. Inc.
Elastic Stop Nut Corp.
General Aircraft Supply Corp.
L. F. Grammes & Sons, Inc.
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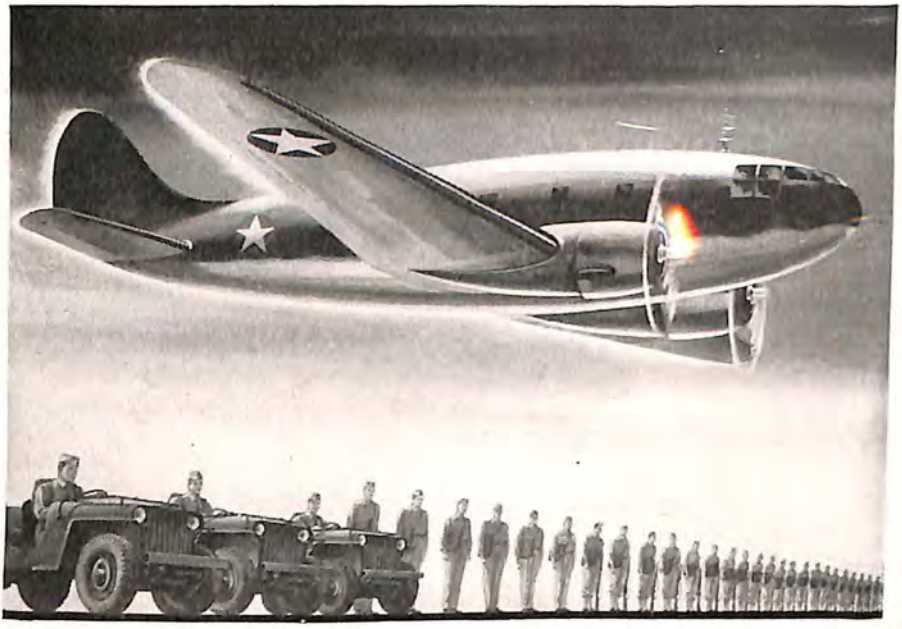
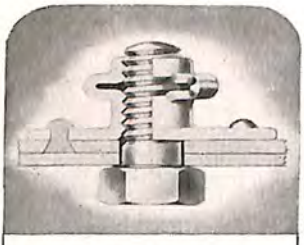
M. D. Hubbard Spring Co.
Ideal Clamp Mfg. Co., Inc.
International Screw Co.
Keystone Tool & Supply Co.
Manufacturers Screw Products
Mid-State Mfg. Co.
The Milford Rivet & Machine Co.
Monarch Metal Weatherstrip Corp.
The National Screw & Mfg. Co.
New England Screw Co.
Karl Ort
The Palnut Co.
Perry Aircraft Products Corp.
Pheoll Manufacturing Co.
Pollak Manufacturing Co.
Prestole Div.
Products Engineering Co.
Reed & Prince Mfg. Co.
Scovill Manufacturing Co.
Screw Machine Products Co., Inc.
Simmonds Aerocessories, Inc.
The Spool Cotton Co., Crown Fastener Div.



50,000 LBS. . . PROTECTED BY A THREAD



A Self-Locking Thread

The Boots Self-Locking Nut is one-piece, all-metal—withstands severest vibration. The self-locking action is obtained by means of the out-of-phase locking collar connected to the lead threads by means of a resilient spring member. All axial play is eliminated.

It's mighty important that the threads on the nuts which hold together vital parts of the Commando troopship should be dependable . . . that they be proof against even the most severe airplane vibration.

Boots All-Metal Self-Locking Nuts are used on these largest of all twin-engined cargo planes. They are unaffected by vibration—literally "outlast the plane."

Boots Nuts weigh less than other self-locking nuts . . . thus they make it possible for the Commando to carry more cargo. And they have greater reusability in maintenance.

The new Boots "Rol-Top" Nut, all-metal, has special advantage for engine application.

BOOTS

Self-Locking Nuts For Application In All Industries

BOOTS AIRCRAFT NUT CORPORATION ★ GENERAL OFFICES, NEW CANAAN, CONNECTICUT

Here they come —
the **CURTISS-COMMANDOS!**

"Swarming down from the skies, Allied gliders and parachute troops captured enemy airfields . . ." More and more in the day's news, words such as these reveal the vital part that transport and cargo planes are playing in the swift invasion of enemy-held areas.

The Curtiss-Commando, the world's largest twin-engined transport, has a leading role in this new and revolutionary phase of the war. These giants of the air telescope weeks into hours and perform prodigies in swift movements of men and materiel.

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The Dole Valve Co.
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Hyland Machine Co.
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The K D Lamp Co.
The Kilgore Manufacturing Co., International Flare Signal Div.
New Jersey Fulgent Co., Inc.
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Pacific Scientific Co.
Pioneer Instrument Div., Bendix Aviation Corp.

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Edo Aircraft Corp.
Federal Aircraft Works
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Hayes Manufacturing Corp.
Heath Co.
Liberty Aircraft Products Corp.
Mercury Aircraft Inc.
Karl Ort
St. Louis Aircraft Corp.
Tennessee Aircraft, Inc.
Troyer Aircraft
United States Plywood Corp.
Vega Aircraft Corp.

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Galena Oil Corp.
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The Phoenix Oil Co.
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Shell Oil Co., Inc., Aviation Dept.
Sinclair Refining Co.
Socony Vacuum Oil Co., Inc.
Standard Oil Co. of California
Standard Oil Co. of Kentucky
Standard Oil Co. of New Jersey
Stewart-Warner Corp.
D. A. Stuart Oil Co.
Sun Oil Co.
The Texas Co.
Tide Water Associated Oil Co.
Valvoline Oil Co.
Wayne Chemical Products Div. of The Wayne Soap Co.
Wolf's Head Oil Refining Co.

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Continental-Diamond Fibre Co.
Crane Packing Co.
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Dural Rubber Co.
Felt Products Mfg. Co.
The Garlock Packing Co.
The Gasket Manufacturing Co.
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The B. F. Goodrich Co., Aeronautical Div.
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E. F. Houghton & Co.
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Linear Packing & Rubber Co., Inc.
McCord Radiator & Mfg. Co.
The Manhattan Rubber Mfg. Div. of Raybestos-Manhattan, Inc.
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Perry Aircraft Products Corp.
The Presstite Engineering Co.
Radiator Specialty Co.
Seiberling Rubber Co.
M. L. Snyder & Son
Spaulding Fibre Co., Inc.
Thiokol Corp.
Tingley Reliance Rubber Corp.
Twin City Tool Co.
United States Rubber Co.
Vega Aircraft Corp.
The Vellumoid Co.
Victor Manufacturing & Gasket Co.
Virginia Rubatex, Div. Salta Corp.
R. D. Werner Co., Inc.
Wilmington Fibre Specialty Co.

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Aeronca Aircraft Corp.
Air-Craft Equipment Div., Anchor Post Fence Co.
Ajax Electrothermic Corp.
American Foundry & Furnace Co.
American Instrument Co.
Carrier Corp.
Circo Products Co.
Clarostat Mfg. Co., Inc.
Continental Industrial Engineers, Inc.
Cutler-Hammer, Inc.
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H. A. Douglas Mfg. Co.
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Pacific-Airmax Corp.
Perry Aircraft Products Corp.
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Machine Hard Steel Aircraft Parts with KENNAMETAL, the *Accepted* Steel-Cutting Carbide

Turning a bomber landing gear cylinder of SAE 4130 with a Style No. 5 KENNAMETAL tool at 180 ft. per min., .046" feed, and 3/16" depth of cut.

Aircraft parts, particularly engine parts, are frequently difficult to machine because they are heat treated to as high as 405 Brinell to obtain desired physical properties. KENNAMETAL-tipped steel cutting tools, however, can machine these hard alloys at practical high speeds and without excessive cratering or tool wear—as shown by the following comparative performance records:

Rough Boring Engine Liners
KENNAMETAL—50 pieces per grind of tool, with 5 mins., 53 secs. machining time per piece.
OTHER CARBIDE TOOLS—15 pieces per grind, with 10 mins. machining time per piece.

Facing Engine Cylinder Sleeves
KENNAMETAL—140 ft./min. cutting speed.
HIGH SPEED STEEL—52 ft./min. cutting speed.

Turning Outside Diameter of Retractor Tubes
(SAE X4130 heat treated to 40–42 Rockwell C)
KENNAMETAL—256 rpm., 500 pieces per grind, fine finish obtained.
HIGH SPEED STEEL—4 times longer machining time, 1/8 as many pieces per grind.

Boring Aircraft Struts
(SAE 4150 heat treated to 402 Brinell)
KENNAMETAL—Roughing cut: Speed 125 ft./min., feed, .014", depth of cut, 3/16". Finishing cut: Speed, 150 ft./min., feed, .014", depth of cut, .010".
HIGH SPEED STEEL—The material was too hard to machine with high speed steel.
OTHER CARBIDES—Another carbide tool failed completely.

PROMPT DELIVERIES OF STANDARD TOOLS

You can get prompt deliveries, and save money, by ordering Standard or Modified Standard KENNAMETAL tools and blanks. Write for Catalog No. 43B listing specifications and prices.

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Aero Trades Co.
Aeroquip Corp.
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Aircraft Components Inc.
Aircraft Standard Parts Co.
Automotive Rubber Co.
Chicago Metal Hose Corp.
The Corbin Screw Corp.
The De Vilbiss Co.
Goddard-Jackson Co.
Goodyear Tire & Rubber Co.
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Screw Machine Products Co., Inc.
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M. L. Snyder & Son
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Tietzmann Engineering Co.
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Voges Mfg. Co., Inc.
Walker-Turner Co., Inc.
The Ward Products Corp.
The Weatherhead Co.
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Aeronautical Manufacturing Corp.
Aeroquip Corp.
Air Associates, Inc.
Aircraft Accessories Corp.
Aircraft Accessories Corp. of Mo.
Aircraft Engineering Products Inc.
Aircraft Specialties Co.
All American Aircraft Products, Inc.
The Aro Equipment Corp.
Associated Foundries & Manufacturers, Inc.
Atlantic Diesel Corp.
Bendix Aviation, Ltd.
Blackhawk Mfg. Co.
Burklyn Co.
Century Aircraft Co.
Chicago Pneumatic Tool Co.
Cook Electric Co.
Cosco Manufacturing Co.
Denison Engineering Co.
Diamond Chain & Mfg. Co.
Dix Mfg. Co.
The Dole Valve Co.
Dowty Equipment Corp.
Eclipse Aviation Div., Bendix Aviation Corp.
Electrol Inc.
Fleetwings, Inc.
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The Gabriel Co.
General Controls Co.
Harvill Corp.
Hoof Products Co.
Houdaille-Hershey Corp.
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F. C. Kent Co.
Menasco Manufacturing Co.
National Machine Products
The Ohio Piston Co.
Pacific Aviation Inc.
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(Hydraulic Controls & Assemblies) *Continued*

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Vickers Inc.
Voges Mfg. Co., Inc.
The Weatherhead Co.
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Irvington Varnish & Insulator Co.
Johns-Manville Sales Corp.
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James Miller Mfg. Co., Inc.
Molded Insulation Co.
Nixon Nitration Works
Karl Ort
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Pacific-Airmax Corp.
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Reynolds Metals Co.
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Voges Mfg. Co., Inc.
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Ack-Ack guns that "see, hear, and think"

THE FIRST EARS to hear enemy bombers at night are mechanical ones in the Sperry-developed Sound Locator. Far more sensitive than human ears, they locate enemy planes miles away, determine their exact position and the direction of their flight.

This done, the "eyes" of the ack-ack guns take over. A battery of 800 million beam candle-power Sperry searchlights, the most powerful in the world, spotlights each enemy raider *automatically.*

Then the "brain" of the guns, the Sperry Universal Director, goes to work.

Working many times faster than the human mind, this uncanny instrument calculates firing data and transmits them to the anti-aircraft guns electrically. Then a Sperry power-control mechanism automatically positions the guns on the target.

The last act in this swift-moving drama comes when the men slam home the shell and press the firing lever.

Anti-aircraft equipment is but one of many things which Sperry is producing in cooperation with our Army and Navy.

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Brooklyn, New York
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SPERRY PRECISION ENGINEERS TO AMERICA

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Karl Ort
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S & M Lamp Co.
Trippe Manufacturing Co.
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Aircraft Welders Inc.
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Atlantic India Rubber Works, Inc.
Axelson Manufacturing Co.
Bendix Products Div., Bendix Aviation Corp.
Century Aircraft Co.
Cleveland Pneumatic Tool Co.
Diamond Chain & Mfg. Co.
Dix Mfg. Co.
Dowty Equipment Corp.
Essick Manufacturing Co.
Foote Bros. Gear & Machine Corp.
The Gabriel Co.
Goodyear Tire & Rubber Co.
The Hardware Specialties Mfg. Co.
Houdaille-Hershey Corp.
Hughes Tool Co.
Lear Avia, Inc.
Michigan Tool Co.
National Aircraft Equipment Co.
Pacific Aviation Inc.
Perry Aircraft Products Corp.
Saylor Beall Mfg. Co.
Skylark Manufacturing Co., Inc.
A. O. Smith Corp.
The Toledo Standard Commutator Co.
Tube Turns
Tuthill Spring Co.
United Aircraft Products, Inc.
Weltronic Co.

LIFE SAVING EQUIPMENT

Airchox Co. Div. of Joyce Aviation Inc.
B. H. Aircraft Co.
Cluff Fabric Products
Davis Emergency Equipment Co., Inc.
Dodge Cork Co., Inc.
Dural Rubber Co.
Eagle Parachute Co.
Goodyear Tire & Rubber Co.
Walter Kidde & Co., Inc.
Mellus Brothers & Co.
Karl Ort
A. Schrader's Son, Div. of Scovill Manufacturing Co., Inc.
Seiberling Rubber Co.
Thiokol Corp.
United States Rubber Co.
Wilber & Son

MACHINE TOOLS

Abrasive Machine Tool Co.
The Acromark Corp.
The Adams Co.
Aeronautical Manufacturing Corp.
Aircraft Production Engineers
American Chain & Cable Co., Inc.
American Foundry Equipment Co.
Angelus Steel Treating Co.
R. B. Annis Co.
The Aro Equipment Corp.
Arter Grinding Machine Co.
Atlas Press Co.
The Avey Drilling Machine Co.
Axelson Manufacturing Co.
The Baird Machine Co.
Bakewell Manufacturing Co.
Barber-Colman Co.
The Bennett Metal Treating Co.
Blacker Engineering Corp.
Bostitch, Inc.
The Bridgeport Safety Emery Wheel Co., Inc.
Briggs-Weaver Machinery Co.
Brown & Sharpe Mfg. Co.
Buckeye Tools Corp.
Buhr Machine Tool Co.
The Bullard Co.
C & W Tool Co.
Chicago Rivet & Machine Co.
The Cincinnati Lathe & Tool Co.
Cincinnati Milling & Grinding Machines, Inc.
The Cincinnati Planer Co.
Jas. Clark, Jr., Electric Co.

For SAFER take-offs and landings

IN GETTING heavily loaded bombers, cargo and troop transport ships safely into the air and in bringing them safely down again, "BENDIX" Landing Gear plays a vital part.

Precision-built "BENDIX-PNEUDRAULIC" Shock Struts, combining compressed air and hydraulic controls, quickly absorb both the minor vibrations and shocks of rough terrain in take-offs and the terrific impacts which are inevitable in landing heavy planes at high speeds.

"BENDIX" Wheels and Brakes have ample reserves of strength and exclusive features that assure fast, but smooth, curbing of the plane's speed. The safety of "BENDIX" Landing Gear is available for any plane. As new planes are introduced, Bendix engineers will gladly design adaptations for each model.

"BENDIX" LANDING GEAR

"BENDIX-PNEUDRAULIC" Shock Struts and "BENDIX" Wheels and Brakes are important members of "The Invisible Crew" of precision equipment which 25 Bendix Plants from coast to coast are speeding to world battle fronts.

THE INVISIBLE CREW — Precision Equipment by Bendix — AVIATION CORPORATION

BENDIX PRODUCTS DIVISION
of Bendix Aviation Corporation
South Bend, Indiana

(Machine Tools) *Continued*
Clayton Manufacturing Co.
The Cleveland Automatic Machine Co.
The Cleveland Punch & Shear Works Co.
The Cleveland Tool Engineering Co.
Consolidated Machine Tool Corp.
Continental Machines Inc.
Continental Screw Co.
Cook Electric Co.
Cosco Manufacturing Co.
The Cyril Bath Co.
Diamond Chain & Mfg. Co.
Dix Mfg. Co.
The Dumore Co.
Durakool, Inc.
Duro Metal Products Co.
Engel Aircraft Specialties
Ex-Cell-O Corp.
Farnham Manufacturing Co.
Farrel-Birmingham Co., Inc.
Federal Machine & Welder Co.
Ferracute Machine Co.
Fitchburg Grinding Machine Corp.
The Foote-Burt Co.
Fowler Aircraft Co.
Fray Machine Tool Co.
Gardner Machine Co.
Gear Grinding Machine Co.
General Engineering Co.
General Manufacturing Co.
The Geometric Tool Co.
Gisholt Machine Co.
George Gorton Machine Co.
Gould & Eberhardt, Inc.
The Govro-Nelson Co.
G. A. Gray Co.
Grob Brothers
The Hall Mfg. Co.
Hammond Machinery Builders, Inc.
Hannifin Manufacturing Co.
Harvey Machine Co.
The Heald Machine Co.
The Hendey Machine Co.
Henry & Wright Mfg. Co.
Hole Engineering Service
The Hydraulic Press Mfg. Co.
International Machine Tool Corp.
I. Jacoel Cable Splicing Equipment Co.
Johnson Tool Co., Inc.
Frank E. Jones Machinery Corp.
Kent-Owens Machine Co.
Keystone Tool & Supply Co.
Kingsbury Machine Tool Corp.
W. B. Knight Machy. Co.
George Koch Sons, Inc.
L & J Press Co.
Landis Machine Co.
H. Leach Machinery Co.
The R. K. LeBlond Machine Tool Co.
The Lees-Bradner Co.
Lehmann Machine Co.
Lempco Products Inc.
Leslie Welding Co.
The Lodge & Shipley Machine Tool Co.
Logan Engineering Co.
Magee Sheet Metal Machinery Co.
Marburg Brothers Inc.
Metallizing Engineering Co. Inc.
Michigan Tool Co.
Micromatic Hone Corp.
Miller & Crowningshield
W. K. Millholland Machinery Co.
The Monarch Machine Tool Co.
National Broach & Machine Co.
The National Machinery Co.
Norton Co.
Ohio Units
The Oilgear Co.
Onsrud Machine Works, Inc.
The Oster Mfg. Co.
Pannier Bros. Stamp Co.
The Parker Appliance Co.
The Peck, Stow & Wilcox Co.
Perry Aircraft Products Corp.
Physicists Research Co.
Pioneer Engineering & Mfg. Co.
The Porcupine Co.
Porter-Cable Machine Co.
Pratt & Whitney, Div. Niles-Bement-Pond Co.
H. P. Preis Engraving Machine Co.
Preston Machine Tool Sales Co.
Procunier Safety Chuck Co.
Products Engineering Co.
Reed-Prentice Corp.
Rivett Lathe & Grinder Inc.
S & M Lamp Co.
W. J. Savage Co.
Schauer Machine Co.
W. A. Schuyler

(Machine Tools) *Continued*
Seiden Pneumatic Tool Co.
The Sheffield Corp.
South Bend Lathe Works
Southern Engineering Co. Inc.
The Standard Electrical Tool Co.
Standard Machinery Co.
Sundstrand Machine Tool Co.
Sunnen Products Co.
The Taft-Peirce Mfg. Co.
The Tannewitz Works
Taylor Manufacturing Co.
Taylor-Hall Welding Corp.
M. N. Thackaberry
The Thompson Grinder Co.
Tietzmann Engineering Co.
Tubular Rivet & Stud Co.
U. S. Tool Co.
Universal Boring Machine Co.
Vard Inc.
The John W. Vogler Co., Inc.
Vonnegut Moulder Corp.
Walker-Turner Co., Inc.
Wallace Supplies Mfg. Co.
Baxter D. Whitney & Son Inc.
Wittek Manufacturing Co.
The Yoder Co.

MACHINERY & MACHINE PARTS

American Machine & Metals, Inc.
E. W. Bliss Co.
Detroit Surfacing Machine Co.
Engineering & Research Corp.
Farrel-Birmingham Co., Inc.
The Geometric Tool Co.
Tinius Olsen Testing Machine Co.
H. P. Preis Engraving Machine Co.

MANIFOLDS

Aero Trades Co.
Aircraft Components Inc.
Aircraft Engineering Products Inc.
All American Aircraft Products, Inc.
American Tube Bending Co., Inc.
B. H. Aircraft Co.
Breeze Corporations, Inc.
Buhl Stamping Co.
Engel Aircraft Specialties
Guiberson Diesel Engine Co.
F. C. Kent Co.
Marman Products Co.
Perry Aircraft Products Corp.
Pollak Manufacturing Co.
Solar Aircraft Co.
Tennessee Aircraft, Inc.
Vega Aircraft Corp.
Wallace Supplies Mfg. Co.
Weimer Metal Crafts Corp.

MISC. ENGINE EQUIPMENT

Ace Manufacturing Corp.
Aeronautical Products, Inc.
Aircraft & Marine Specialty Co.
Aircraft Engineering Products Inc.
Aircraft Screw Products Co., Inc.
Airesearch Manufacturing Co.
All-Weather Springs
Allen Electric & Equipment Co.
American Airport Equipment Co.
American Bosch Corp.
American Tube Bending Co., Inc.
The Bowling Green Rubber Co.
T. M. Chapman's Sons Co.
Circo Products Co.
Clifford Manufacturing Co.
Dix Mfg. Co.
Eaton Manufacturing Co.
Eggelhof Engineers
Farrel-Birmingham Co., Inc.
Federal Aircraft Works
Firestone Aircraft Co.
Geo. J. Fix Co.
The Govro-Nelson Co.
Foote Bros. Gear & Machine Corp.
The Fulton Sylphon Co.
The Hartford Machine Screw Co.
Harvill Corp.
Indiana Gear Works
Industrial Wire Cloth Products Corp.
The Marquette Metal Products Co.
J. E. Menaugh Co.
Motor Rebuilding Specialties
The National Bronze & Aluminum Foundry Co.
The Ohio Piston Co.
Karl Ort
Pacific Gear Works of Los Angeles
Perry Aircraft Products Corp.
Precision Products, Inc.

(Misc. Engine Equipment)
Continued
Purolator Products, Inc.
Richland Auto Parts Co.
Solar Aircraft Co.
Staley Manufacturing Corp.
Superior Tube Co.
Thompson Products, Inc.
Tietzmann Engineering Co.
Tube Turns
Vega Aircraft Corp.
Walker-Turner Co., Inc.
Western Automatic Machine Screw Co.
Whiting Corp.
The Whitney Chain & Mfg. Co.
N. A. Woodworth Co.

MISC. HARDWARE

The Acromark Corp.
Aero Screw Co.
Aero Supply Mfg. Co. Inc.
Air Associates, Inc.
Aircraft & Marine Specialty Co.
Aircraft Hardware Mfg. Co., Inc.
Aircraft Screw Products Co., Inc.
Aircraft Standard Parts Co.
Airsealand Aircraft Inc.
The Allen Manufacturing Co.
Alloys Foundry, Inc.
Edward F. Aymond Co.
The Bennett Metal Treating Co.
Briggs-Weaver Machinery Co.
E. W. Carpenter Mfg. Co.
The Cleveland Metal Stamping Co.
Continental Screw Co.
P & F Corbin
The Corbin Screw Corp.
The Dayton Manufacturing Co.
Dycer Aviation Supplies
The Electric Auto-Lite Co., Bay Mfg. Div.
Fischer Special Mfg. Co.
The Folmer Graflex Corp.
L. F. Grammes & Sons, Inc.
The Hardware Specialties Mfg. Co.
The Hartford Machine Screw Co.
Harvill Corp.
John Hassall, Inc.
Highbridge-International Co.
M. D. Hubbard Spring Co.
Hyland Machine Co.
Kennedy Name Plate Co.
Keystone Tool & Supply Co.
Manufacturers Screw Products
Master Lock Co.
Monarch Metal Weatherstrip Corp.
Karl Ort
J. A. Otterbein
Victor F. Pastushin Co.
Penn Rivet Corp.
Perry Aircraft Products Corp.
Pollak Manufacturing Co.
Poulsen & Nardon, Inc.
Precise Tool & Manufacturing Co.
Precision Products, Inc.
Reed & Prince Mfg. Co.
Republic Steel Corp.
S & M Lamp Co.
Sawyer Belt Hook Co.
Soss Manufacturing Co.
The Spool Cotton Co., Crown Fastener Div.
Stewart-Warner Corp.
Swift Lubricator Co.
Tennessee Aircraft, Inc.
Tietzmann Engineering Co.
Vega Aircraft Corp.
The Vlchek Tool Co.
Voges Mfg. Co., Inc.
E. R. Wagner Manufacturing Co.
Waldes Koh-I-Noor Inc.
Weber Showcase & Fixture Co., Inc.
Whitehead Stamping Co.
Wrought Washer Mfg. Co.
The Yale & Towne Mfg. Co.

OIL SEALS

Armstrong Cork Co.
Arrowhead Rubber Co.
Associated Rubber Products Co.
Atlantic India Rubber Works, Inc.
Jack Best Mfg. Co.
The Bowling Green Rubber Co.
Chicago Rawhide Manufacturing Co.
Cook Electric Co.
Crane Packing Co.
Dodge Cork Co., Inc.
Eggelhof Engineers
Firestone Aircraft Co.
The Garlock Packing Co.

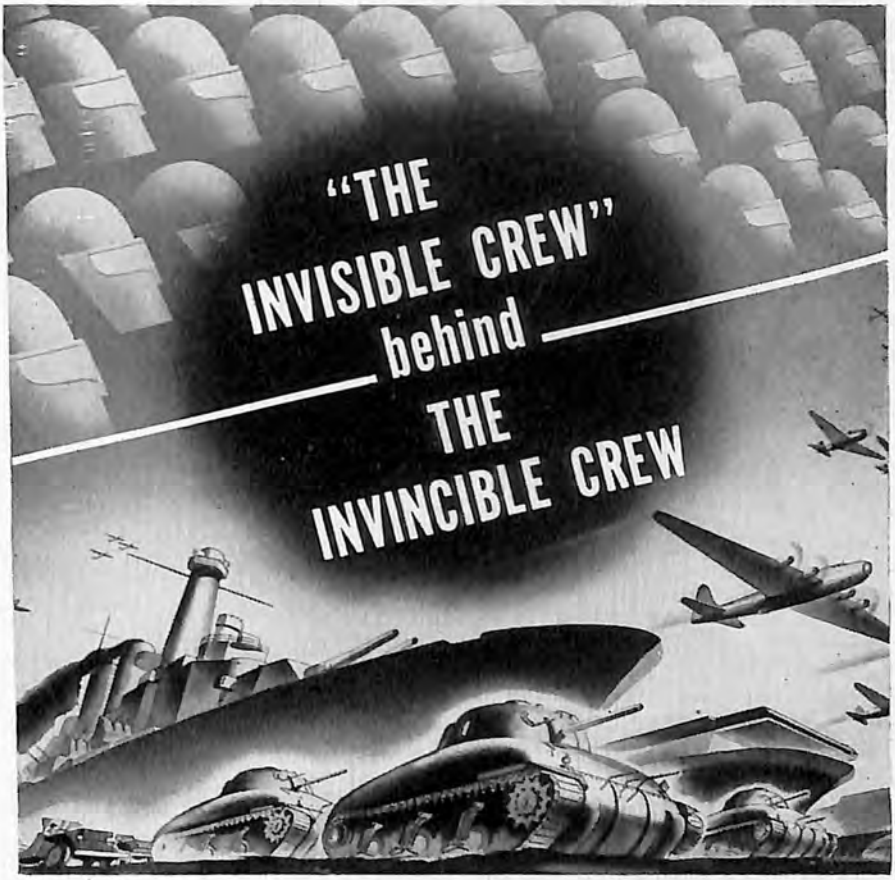
(Oil Seals) *Continued*
The B. F. Goodrich Co., Aeronautical Div.
Graton & Knight Co.
E. F. Houghton & Co.
Chas. W. House & Sons, Inc.
Johns-Manville Sales Corp.
Koppers Co., American Hammered Piston Ring Div.
Linear Packing & Rubber Co., Inc.
McCord Radiator & Mfg. Co.
The Manhattan Rubber Mfg. Div. of Raybestos-Manhattan, Inc.
Owens-Corning Fiberglas Corp.
Permatex Co., Inc.
Perry Aircraft Products Corp.
The Presstite Engineering Corp.
Radiator Specialty Co.
Simplex Products Corp.
Thiokol Corp.
Tingley Reliance Rubber Corp.
The United States Graphite Co.
Victor Manufacturing & Gasket Co.
Worcester Stamped Metal Co.

PAINTS, VARNISHES & FINISHES

Acme White Lead & Color Works
Adhere, Inc.
Aluminum Industries, Inc.
Ault & Wiborg Corp.
Avondale Chemical Co.
The Barrett Div., Allied Chemical & Dye Corp.
Belloil Paint Products Co.
Berry Brothers
Black Bear Co., Inc.
Brooklyn Varnish Mfg. Co., Inc.
Andrew Brown Co.
Celanese Celluloid Corp.
Cook Paint & Varnish Co.
Dura-Products Mfg. Co.
Durez Plastics & Chemicals, Inc.
The Egyptian Lacquer Mfg. Co.
W. P. Fuller & Co.
General Aircraft Supply Corp.
The Glidden Co.
Hilo Varnish Corp.
S. C. Johnson & Son, Inc.
Jones-Dabney Co.
Lowe Bros. Co.
The Martin-Senour Co.
Monsanto Chemical Co.
Monsanto Chemical Co., Merrimac Div.
Murphy Varnish Co.
Karl Ort
Paasche Airbrush Co.
Perry-Austin Manufacturing Co.
Pierce & Stevens, Inc.
Pittsburgh Plate Glass Co.
Pratt & Lambert, Inc.
Pyroxylin Products, Inc.
Randolph Finishing Products Co.
Roxalin Flexible Finishes Inc.
Seidlitz Paint & Varnish Co.
Sewall Paint & Varnish Co.
Sherwin-Williams Co.
Thiokol Corp.
The Thresher Varnish Co.
Titanine, Inc.
United States Varnish Co.
Valentine & Co., Inc.
Wailes Dove-Hermiston Corp.
Wesley Lacquer Co.
The Wilbur & Williams Co.
Wipe-On Corp.

PANELS

Aero Parts Manufacturing Co., Inc.
Aero Supply Mfg. Co. Inc.
Aero Trades Co.
Aeronca Aircraft Corp.
American Aluminum Ware Co.
American Central Manufacturing Corp.
Bellanca Aircraft Corp.
Brasco Manufacturing Co.
Continental-Diamond Fibre Co.
Duramold Div. of Fairchild Engine & Airplane Corp.
C. M. Hall Lamp Co.
Lite Mfg. Co.
Littelfuse Inc.
Met-L-Wood Corp.
Mica Insulator Co.
Molded Insulation Co.
The Murray Corp. of America
Reynolds Metals Co.
Rohr Aircraft Corp.
Spaulding Fibre Co., Inc.
The Standard Electric Time Co.



AS AMERICA'S invincible fighting crews launch offensives this year, another crew – "*The Invisible Crew*" of "BENDIX" Precision Equipment – moves with them into combat.

Sharing action in the air, "*The Invisible Crew*" starts mighty aircraft engines, feeds them air and fuel in the right proportions, provides them with timed sparks. It lifts landing gear, operates wing flaps and bomb-bay doors, prevents ice from forming on wings and propellers, guides pilots to pin-points on the planet and cushions their safe landings.

Thus, "*The Invisible Crew*" fights on every battle front, as more than 60,000 Bendix men and women push production in ever increasing volume to help shorten the war.

THE INVISIBLE CREW
Precision
Equipment by
Bendix
AVIATION CORPORATION

(Panels) *Continued*
Stewart-Warner Corp.
Synthane Corp.
Technical Ply-Woods
Timm Aircraft Corp.
United States Plywood Corp.
Vega Aircraft Corp.
The Ward Products Corp.
Weber Showcase & Fixture Co., Inc.
Westinghouse Electric & Manufacturing Co.

PARACHUTES & PARACHUTE PARTS

Airchox Co., Div. of Joyce Aviation Inc.
Belding Heminway Co.
Dural Rubber Co.
Eagle Parachute Co.
Fowler Aircraft Co.
General Aircraft Supply Corp.
Hayes Manufacturing Corp.
Lite Mfg. Co.
J. E. Menaugh Co.
Karl Ort
Pioneer Parachute Co. Inc.
Switlik Parachute Co.
The Washburn Co.
J. W. Wood Elastic Web Co.

PARTS

Aerco Corp.
Aircraft Hardware Mfg. Co., Inc.
Alpha Metal & Rolling Mills, Inc.
Ampco Metal, Inc.
B. H. Aircraft Co.
Briggs Manufacturing Co.
Goodyear Aircraft Corp.
Intercontinent Aircraft Corp.
Jowein Inc., Aircraft Div.
The Marquette Metal Products Co.
Marman Products Co.
Moore Drop Forging Co.
Karl Ort
Penn Rivet Corp.
Southern Aircraft Corp.
Spartan Aircraft Co.
N. A. Woodworth Co.

Aluminum Parts

A & F Aluminum Products Co.
Ace Manufacturing Corp.
Aero Parts Manufacturing Co., Inc.
Aero Trades Co.
Aeronautical Manufacturing Corp.
Aeronca Aircraft Corp.
Aeroproducts Manufacturing Co.
Aeroquip Corp.
Agawam Aircraft Products, Inc.
Air Associates, Inc.
Aircraft & Marine Specialty Co.
Aircraft Engineering Products Inc.
Aircraft Hardware Mfg. Co., Inc.
Aircraft Parts Development Corp.
Aircraft Specialties Co.
Airsealand Aircraft Inc.
All American Aircraft Products, Inc.
Aluminum Co. of America
Aluminum Industries, Inc.
Aluminum Ladder Co.
American Aluminum Ware Co.
American Armament Corp.
American Screw Products
Angelus Steel Treating Co.
The Apex Tool Co., Inc.
Armstrong Cork Co.
Associated Foundries & Manufacturers, Inc.
Atlantic Diesel Corp.
Automotive Rubber Co.
Bellanca Aircraft Corp.
Jack Best Mfg. Co.
Brasco Manufacturing Co.
Buhl Stamping Co.
Buick Motor Div.
Charles W. Carll Sons
A. T. Case Co.
Chicago Rivet & Machine Co.
Cinch Mfg. Corp.
The Cleveland Metal Stamping Co.
Columbia Stamping & Mfg. Corp.
Compton Metals Co.
Continental Machines Inc.
Continental Screw Co.
Cunningham-Hall Aircraft Corp.
Curtis Lighting, Inc.
Dahlstrom Metallic Door Co.
DeYoung Bros. Machine Shop
Doak Aircraft Co., Inc.
Doehler Die Casting Co.

(Aluminum Parts) *Continued*
Dollin Corp.
Doolittle Radio Inc.
Eaton Manufacturing Co.
Edo Aircraft Corp.
Engel Aircraft Specialties
Essick Manufacturing Co.
Ex-Cell-O Corp.
Fleetwings Inc.
The Garlock Packing Co.
General Aviation Equipment Co., Inc.
Hardman Aircraft Products, Inc.
The Hardware Specialties Mfg. Co.
Harlow Aircraft Co.
Harvey Machine Co.
Harvill Corp.
Heath Co.
Henger Seltzer Co.
Hyland Machine Co.
The Kawneer Co.
George Koch Sons, Inc.
E. Konigslow Stamping & Tool Co.
Liberty Aircraft Products Corp.
The Lobdell-Emery Manufacturing Co.
H. K. Lorentzen, Inc.
Lyon Metal Products, Inc.
The M B Manufacturing Co.
Manlove & Spaulding Mfg. Co.
Manufacturers Screw Products
Menasco Manufacturing Co.
Mercury Aircraft Inc.
Met-L-Wood Corp.
Molded Insulation Co.
Monarch Aluminum Mfg. Co.
Moore-Eastwood & Co.
The Murray Corp. of America
National Aircraft Equipment Co.
The National Bronze & Aluminum Foundry Co.
National Machine Products
The Ohio Piston Co.
Pacific-Airmax Corp.
The Permold Co.
Perry Aircraft Products Corp.
Precision Products, Inc.
Pressed & Welded Steel Products Co., Inc.
Ray Day Piston Corp. of Detroit
Revere Copper & Brass Inc.
Reynolds Metals Co.
Roberts & Mander Stove Co.
Rocky Mountain Steel Products, Inc.
Rohr Aircraft Corp.
Saylor Beall Mfg. Co.
Scott Aviation Corp.
Southern California Airparts
Special Machine Tool Engineering Works
Steel Forming Corp.
The Steel Products Engineering Co.
Teicher Manufacturing Corp.
Tennessee Aircraft, Inc.
Thompson Aircraft Products Co.
Thompson Products, Inc.
Timm Aircraft Corp.
Tube Turns
Tubular Rivet & Stud Co.
Twin City Tool Co.
Tyson Roller Bearing Corp.
Union Aircraft Products Corp.
Utility Fan Corp.
The Variety Aircraft Corp.
Victor Metal Products Corp.
Voges Mfg. Co., Inc.
Wallace Engineering Co.
The Weatherhead Co.
The Wellman Bronze & Aluminum Co.
Willard Storage Battery Co.
Worcester Pressed Steel Co.
Worcester Stamped Metal Co.
The Yale & Towne Mfg. Co.
Zierold Metals Co.

Cork Parts

Armstrong Cork Co.
The Automatic Electrical Devices Co.
Jack Best Mfg. Co.
Detroit Gasket & Mfg. Co.
Dodge Cork Co., Inc.
Felt Products Mfg. Co.
Perry Aircraft Products Corp.
Twin City Tool Co.
Voges Mfg. Co., Inc.

Felt Parts

Armstrong Cork Co.
The Automatic Electrical Devices Co.
Automotive Rubber Co.
Backstay Welt Co.
Jack Best Mfg. Co.

A plane builder sees

that ingenuity and teamplay can save us blood and tears

THERE IS A NEW electrolytic etching technique of duplicating templates for new-design warplanes. It saves 5 weeks in getting a new model from blueprints to fighting planes on the front. The "Northrop group" developed this technique, offers it to all U. S. plane builders.

There's a new "Heliarc" process by which magnesium and certain other alloy metals can at last be welded into aircraft parts. There's an improved way of cleaning and preparing sub-assemblies for spot welding. These processes also have been turned by Northrop into the "pool" every U. S. plane factory is free to use. Into this same "all-for-one-one-for-all" pool other aircraft builders are turning new processes and discoveries.

Not only techniques, but production facilities are now shared by the industry. For instance, besides its own aircraft, Northrop has been making dive bombers designed by another company . . . engine nacelles for a bomber manufacturer . . . and tail-assemblies for a flying boat builder.

Today all of the aircraft builders in the United States are working as one. Because to do so will save American blood and tears.

NORTHROP AIRCRAFT, Inc.

NORTHROP FIELD, HAWTHORNE, CALIFORNIA

MEMBER AIRCRAFT WAR PRODUCTION COUNCIL, INC.

(Felt Parts) *Continued*
The Booth Felt Co.
Felt Products Mfg. Co.
The Felters Co., Inc.
Chas. W. House & Sons, Inc.
Perry Aircraft Products Corp.
Standard Felt Co.
Twin City Tool Co.
United States Rubber Co.

Fibre Parts

Armstrong Cork Co.
The Automatic Electrical Devices Co.
Automotive Rubber Co.
Edward F. Aymond Co.
Jack Best Mfg. Co.
The Cleveland Metal Stamping Co.
Columbia Stamping & Mfg. Corp.
Continental-Diamond Fibre Co.
Doolittle Radio Inc.
Felt Products Mfg. Co.
General Aviation Equipment Co., Inc.
Los Angeles Stamp & Stationery Co.
National Aircraft Equipment Co.
Owens-Corning Fiberglas Corp.
Perry Aircraft Products Corp.
Spaulding Fibre Co., Inc.
Taylor Fibre Co.
Technical Ply-Woods
Twin City Tool Co.
United States Rubber Co.
The Vellumoid Co.
Voges Mfg. Co., Inc.
Wilmington Fibre Specialty Co.

Leather Parts

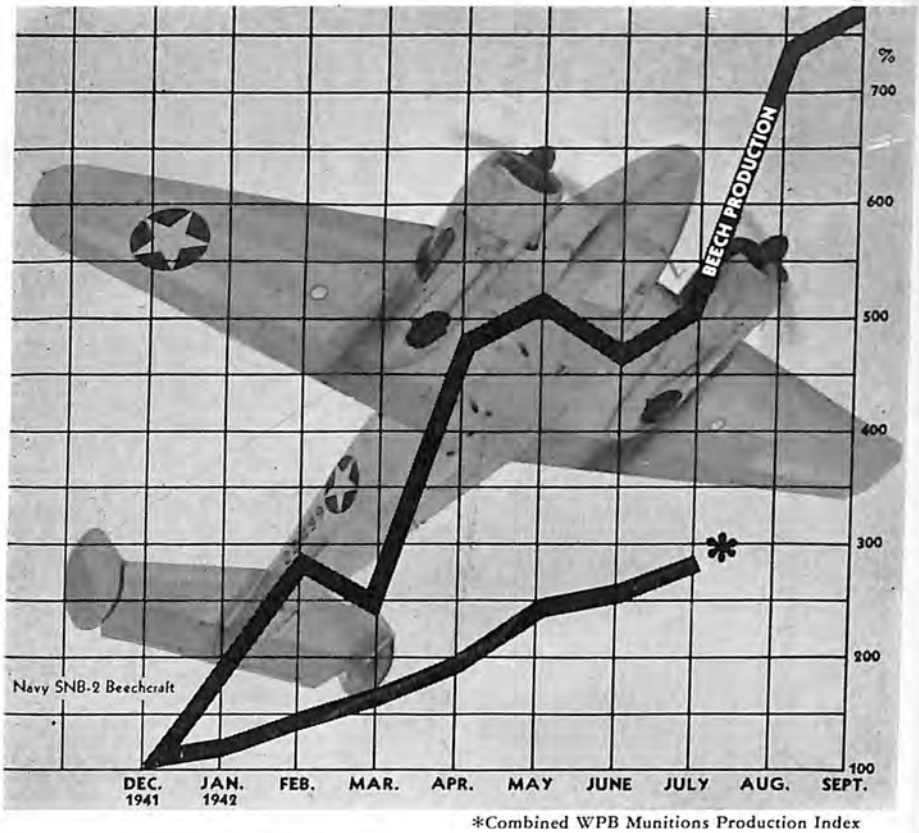
Backstay Welt Co.
Jack Best Mfg. Co.
Blanchard Bros. & Lane
Cleveland Tanning Co.
The Conneant Leather Co.
The Garlock Packing Co.
Graton & Knight Co.
Hamilton-Wade Co.
E. F. Houghton & Co.
Lackawanna Leather Co.
Radel Leather Mfg. Co.
Twin City Tool Co.

Magnesium Parts

Aeroproducts Manufacturing Co.
Agawam Aircraft Products, Inc.
Aircraft Engineering Products Inc.
Airsealand Aircraft Inc.
Aluminum Industries, Inc.
Aluminum Ladder Co.
American Magnesium Corp.
The Apex Tool Co., Inc.
Associated Foundries & Manufacturers, Inc.
Atlantic Diesel Corp.
Brasco Manufacturing Co.
Buick Motor Div.
The Cleveland Metal Stamping Co.
Cunningham-Hall Aircraft Corp.
Doak Aircraft Co., Inc.
Doehler Die Casting Co.
The Dow Chemical Co.
Ex-Cell-O Corp.
Hardman Aircraft Products, Inc.
The Hardware Specialties Mfg. Co.
Harvill Corp.
Henger Seltzer Co.
National Aircraft Equipment Co.
National Machine Products
The Permold Co.
Revere Copper & Brass Inc.
Rocky Mountain Steel Products, Inc.
Special Machine Tool Engineering Works
The Steel Products Engineering Co.
Tennessee Aircraft, Inc.
Timm Aircraft Corp.
Voges Mfg. Co., Inc.
Wallace Engineering Co.
The Weatherhead Co.
The Wellman Bronze & Aluminum Co.
Worcester Pressed Steel Co.

Plastic Parts

Aeroproducts Manufacturing Co.
Aircraft Parts Development Corp.
American Phenolic Corp.
Associated Foundries & Manufacturers, Inc.
Edward F. Aymond Co.
Bellanca Aircraft Corp.
Brasco Manufacturing Co.



*Combined WPB Munitions Production Index

Performance

Like the aircraft it makes for our country, the Beech organization has demonstrated a high performance factor. The graph above indicates the rate-of-climb of Beech production in the first year of our total war.

Beech Aircraft

CORPORATION

BEECHCRAFTS ARE DOING THEIR PART

WICHITA, KANSAS, U. S. A.

Plaskon *Resin-Bonded Wood* Trainer Planes

are tremendously strong and durable

Wood, bonded and joined with Plaskon Resin Adhesive, now is making possible the volume production of tremendously strong and durable airplanes. Typical examples are the AT-10 Trainers now being produced by Beech Aircraft Corp., Wichita, Kansas.

Plywood or laminated wood made with Plaskon Resin Adhesive is tough, splitproof, resilient, and fire-resistant. In every shear test of wood bonded to wood with Plaskon Resin Adhesive, under all types of service, the wood fails *first*—the glue line holds! The glue is waterproof, and completely resistant to bacteria and fungi.

Plaskon Hot Press and Cold Press Adhesives are being used in large quantities for cargo planes; training planes; merchant ships; supply barges; airplane propellers, fuselages, wings, noses, pilot seats; gliders; landing ramps; life rafts and buoys; army skiis; prefabricated houses; truck bodies; and many other wartime jobs.

Plaskon Resin Adhesives at present are available only for high-priority applications. Plaskon Company, Inc., 2112 Sylvan Avenue, Toledo, Ohio. World's Largest Producers of Urea-Formaldehyde Resins.

Plaskon Waterproof Resin Adhesives

1. Type 201-2 (two-part) and Type 250-2 ready-mixed (hardener incorporated) cold-setting urea resin adhesive for assembly gluing and lumber laminating. These fully meet the requirements of Air Corps Spec. 14110, Navy Aeronautical Spec. G-29, Army-Navy Aeronautical Spec. AN-G-8, and U. S. Navy Bureau of Ships Spec. 52G11.

2. Type 107-2 hot-setting urea resin adhesive for waterproof plywood and general bonding work on hot-press equipment.

3. Type 700-2 hot-setting resin adhesive is specifically designed for use with the "bag" molding processes for making formed plywood and low-pressure laminates. Formed plywood made with this adhesive meets all requirements of Army-Navy Spec. AN-NN-P-511b.

PLASKON

TRADE MARK REGISTERED

RESIN ADHESIVE

Plaskon resin-bonded laminated wood wing spar of the Beech Aircraft Corp. AT-10 Trainer. Root fittings attachments have 25% greater strength than required.

Cross-section of center section spar of the AT-10 Beechcraft Trainer, showing the great number of wood units bonded together.

Plaskon resin adhesive-bonded laminated wood center section spar of AT-10 Beechcraft Trainer. This spar actually is built of over 200 separate pieces of wood.

(Plastic Parts) *Continued*
The Bryant Electric Co.
Catalin Corp.
Celanese Celluloid Corp.
Colt's Patent Fire Arms Manufacturing Co.
Continental-Diamond Fibre Co.
E. I. du Pont de Nemours & Co., Plastics Dept.
Duramold Div. of Fairchild Engine & Airplane Corp.
Durez Plastics & Chemicals, Inc.
The Electric Auto-Lite Co., Bay Mfg. Div.
Erie Resistor Corp.
The Formica Insulation Co.
General Aircraft Supply Corp.
General Aviation Equipment Co., Inc.
Harvill Corp.
Heath Co.
Mica Insulator Co.
Monsanto Chemical Co.
Molded Insulation Co.
Nixon Nitration Works
Owens-Corning Fiberglas Corp.
The Parker Stamp Works, Inc.
Pittsburgh Plate Glass Co.
Plaskon Co., Inc.
Rohm & Haas Co.
Spaulding Fibre Co., Inc.
Square D Co.
Stricker-Brunhuber Corp.
Taylor Fibre Co.
Twin City Tool Co.
Universal Moulded Products Corp.
Victor Metal Products Corp.
Vidal Research Corp.
Voges Mfg. Co., Inc.
Weber Showcase & Fixture Co., Inc.
R. D. Werner Co., Inc.
Westinghouse Electric & Manufacturing Co.

Plywood Parts

Aircraft Products & Equipment Corp.
All American Aircraft Products, Inc.
Bellanca Aircraft Corp.
California Panel & Veneer Co.
Duramold Div. of Fairchild Engine & Airplane Corp.
Fleetwings, Inc.
Hardman, Peck & Co.
Harbor Plywood Corp.
Harvill Corp.
Haskelite Manufacturing Corp.
Heath Co.
Met-L-Wood Corp.
National Aircraft Equipment Co.
National Aircraft Materials Corp.
Owens-Corning Fiberglas Corp.
J. V. G. Posey & Co.
Roddis Lumber & Veneer Co.
Technical Ply-Woods
United States Plywood Corp.
Universal Moulded Products Corp.
Vidal Research Corp.
Weber Showcase & Fixture Co., Inc.

Rubber Parts

Armstrong Cork Co.
Arrowhead Rubber Co.
Associated Rubber Products Co.
Atlantic India Rubber Works, Inc.
Automotive Rubber Co.
Backstay Welt Co.
Jack Best Mfg. Co.
The Bowling Green Rubber Co.
Bridgeport Fabrics, Inc.
The Connecticut Hard Rubber Co.
Detroit Gasket & Mfg. Co.
Felt Products Mfg. Co.
Firestone Aircraft Co.
The Garlock Packing Co.
The B. F. Goodrich Co., Aeronautical Div.
Goodyear Tire & Rubber Co.
Hamilton-Wade Co.
Heath Co.
The Johnson Rubber Co.
The Manhattan Rubber Mfg. Div. of Raybestos-Manhattan, Inc.
Owens-Corning Fiberglas Corp.
Perry Aircraft Products Corp.
Seiberling Rubber Co.
M. L. Snyder & Son
Thiokol Corp.
Tingley Reliance Rubber Corp.
United States Rubber Co.
Virginia Rubatex, Div. Salta Corp.
R. D. Werner Co., Inc.

HOLLOW CORE WELDWOOD PANELS

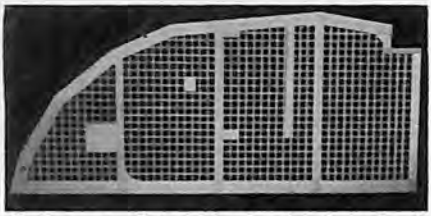
Maximum Stiffness with Minimum Weight

IN floor boards, doors, bulkheads, chart boards, navigator's tables and other structures deflection is critical and the saving of ounces, paramount.

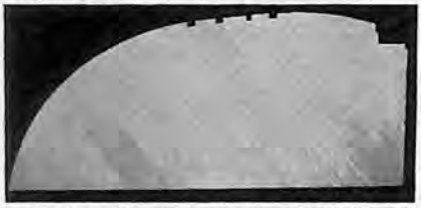
These rigid units are fabricated to specification from manufacturers' blueprints in a USP plant devoted, for more than a decade, solely to this type of construction—every unit an example of that precision workmanship which comes only with long experience.

Weldwood angle irons and "U" channels for jeep tracks, Flat Aircraft Weldwood and Molded* Weldwood are likewise made to specification, and are characterized by a uniformity which results from thorough knowledge of plywood manufacture combined with scientifically controlled machinery and expert personnel.

Angle irons of Weldwood! For use at critical points in light-weight assemblies.



Hollow core of panel for bomber floor board, showing light-weight construction of exceptional strength.



Face of panel, made of Aircraft Weldwood, which is permanently bonded to top and bottom of core.

Flat and Molded Weldwood for fuselages, wing-tips, flaps, tail assemblies, etc. is hot-press phenolic resin-bonded and conforms with Army and Navy Specification AN-NN-P-511a. It is water-, rot-, fungus- and bacteria-proof and has a favorable strength/weight ratio.

A capable technical staff is available for consultation.

*Made by the Vidal Process U.S. Pat. No. 2073290.

UNITED STATES PLYWOOD CORPORATION
World's Largest Producer of Plywood
New York, N. Y.

NEW PLASTIC GLUE

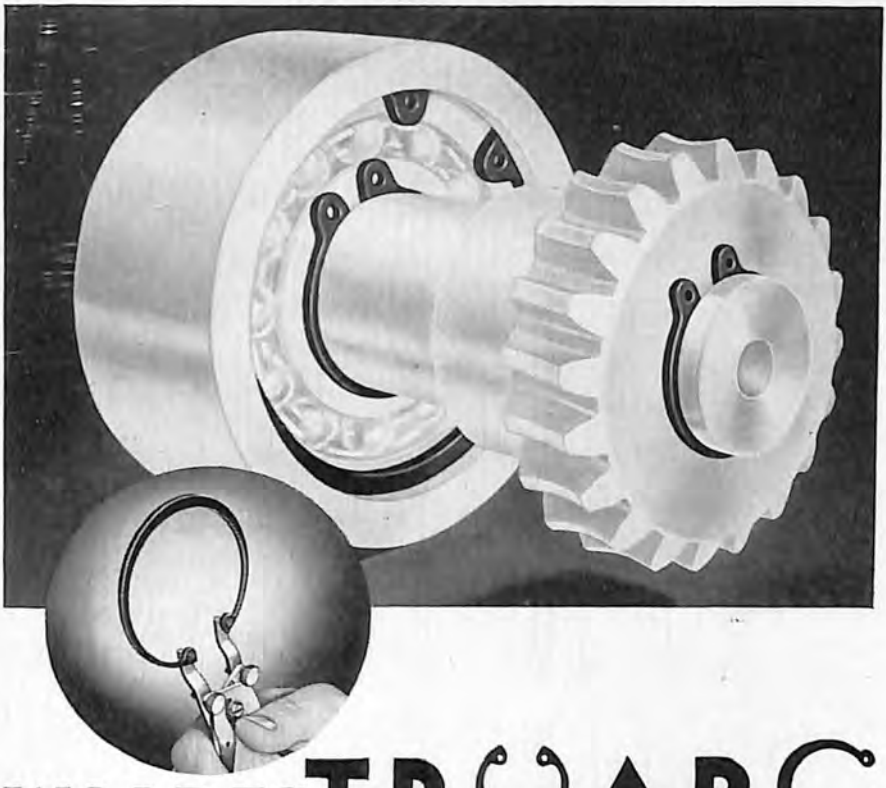
Weldwood Plastic Resin Waterproof Glue . . . makes strong, permanent joints. Readily mixed with cold water. Available in convenient sizes, 1⅛ oz. cans up to 100 lb. drums. Literature, FREE sample on request.

PLASTICS AND WOOD WELDED FOR GOOD

Weldwood is the family name of plywood products made by United States Plywood Corporation. Waterproof Weldwood, so marked, is bonded with phenol formaldehyde synthetic resin. Other types of water resistant Weldwood are manufactured with extended urea resins and other approved bonding agents.

Steel Parts

Ace Manufacturing Corp.
Aero Parts Manufacturing Co., Inc.
Aeronautical Manufacturing Corp.
Aeroproducts Manufacturing Corp.
Aeroquip Corp.
Agawam Aircraft Products, Inc.
Air Associates, Inc.
Airco Tool Co.
Aircraft & Marine Specialty Co.
Aircraft Engineering Products Inc.
Aircraft Hardware Mfg. Co., Inc.
Aircraft Mechanics, Inc.
Aircraft Parts Development Corp.
Aircraft Products & Equipment Corp.
Aircraft Specialties Co.
Airsealand Aircraft Inc.
All-Weather Springs
Alofs Manufacturing Co.
Aluminum Industries, Inc.
American Armament Corp.
American Screw Products
Angelus Steel Treating Co.
The Apex Tool Co., Inc.
Associated Foundries & Manufacturers, Inc.
Atlantic Diesel Corp.
The Automatic Electrical Devices Co.
Baltic Metal Products Co.
Bellanca Aircraft Corp.
Jack Best Mfg. Co.
The Bowling Green Rubber Co.
Brasco Manufacturing Co.
Brunner Mfg. Co.
Charles W. Carll Sons
A. T. Case Co.
Cinch Mfg. Corp.
The Cleveland Metal Stamping Co.
Columbia Stamping & Mfg. Corp.
Continental Screw Co.
Cosco Manufacturing Co.
Cunningham-Hall Aircraft Corp.
Dahlstrom Metallic Door Co.
Dayton Tool & Engineering Co.
The Dayton Wheel Co.
De Young Bros. Machine Shop
Doak Aircraft Co., Inc.
Doolittle Radio Inc.
Eaton Manufacturing Co.
Engel Aircraft Specialties
Engis Equipment Co.
Essick Manufacturing Co.
Ex-Cell-O Corp.
Fleetwings, Inc.
Foote Bros. Gear & Machine Corp.
General Aviation Equipment Co., Inc.
Globe Steel Tubes Co.
The Greist Mfg. Co.
The Hamilton Steel Co.
Hardman Aircraft Products, Inc.
The Hardware Specialties Mfg. Co.
Harlow Aircraft Co.
The Heim Co.
The Holo-Krome Screw Corp.
Hyland Machine Co.
International Stacey Corp.
Jessop Steel Co.
The Kawneer Co.
Keystone Tool & Supply Co.
The Knight Screw Products Co.
George Koch Sons, Inc.
E. Konigslow Stamping & Tool Co.
Kropp Forge Aviation Co.
Liberty Aircraft Products Corp.
H. K. Lorentzen, Inc.
Lyon Metal Products, Inc.
The M B Manufacturing Co., Inc.
Manlove & Spaulding Mfg. Co.
Met-L-Wood Corp.
Monarch Metal Weatherstrip Corp.
Monmouth Products Co.
Moore-Eastwood & Co.
The Murray Corp. of America
National Aircraft Equipment Co.
National Machine Products
Northill Co., Inc.
The Ohio Piston Co.
Pacific-Airmax Corp.
The Park Drop Forge Co.
The Parker Stamp Works, Inc.
Perry Aircraft Products Corp.
Precise Tool & Manufacturing Co.
Precision Products, Inc.
Pressed & Welded Steel Products Co., Inc.
Republic Steel Corp.
Roberts & Mander Stove Co.
Rohr Aircraft Co.
Joseph T. Ryerson & Son, Inc.
S & M Lamp Co.
Saylor Beall Mfg. Co.
Southern California Airparts



WALDES TRUARC

Reg. U. S. Pat. Off.

RETAINING RING

Waldes Truarc presents a significant advance in Retaining Rings.

This improved Retaining Ring spreads or contracts without distortion, always retaining its perfectly-fitting circular contour.

For all thrust load fixing and shaft and housing applications, Waldes Truarc offers distinct space-saving and material-saving advantages over nuts and bolts . . . plus a stability and dependability heretofore not obtainable in Retaining Rings.

On request, we will gladly furnish samples and full data for your tests.

WALDES KOH-I-NOOR • INC

LONG ISLAND CITY • NEW YORK

(Steel Parts) *Continued*
Special Machine Tool Engineering Works
Steel Forming Corp.
The Steel Products Engineering Co.
Summerill Tubing Co.
Thompson Aircraft Products Co.
Thompson Products, Inc.
Timm Aircraft Corp.
Tube Turns
Tuthill Spring Co.
Twin City Tool Co.
Tyson Roller Bearing Corp.
Utility Fan Corp.
Voges Mfg. Co., Inc.
Paul G. Wagner Co.
Wallace Engineering Co.
Warman Steel Casting Co.
Worcester Pressed Steel Co.
Worcester Stamped Metal Co.
Worcester Taper Pin Co.
Zierold Metals Co.

Synthetic Parts

Adel Precision Products Corp.
Aeroquip Corp.
American Phenolic Corp.
Armstrong Cork Co.
Associated Rubber Products Co.
Atlantic India Rubber Works, Inc.
Automotive Rubber Co.
Edward F. Aymond Co.
Jack Best Mfg. Co.
The Bowling Green Rubber Co.
Chicago Rawhide Manufacturing Co.
Continental-Diamond Fibre Co.
Detroit Gasket & Mfg. Co.
Felt Products Mfg. Co.
Firestone Aircraft Co.
The Garlock Packing Co.
The B. F. Goodrich Co., Aeronautical Div.
Goodyear Tire & Rubber Co.
Graton & Knight Co.
The Johnson Rubber Co.
Linear Packing & Rubber Co., Inc.
The Manhattan Rubber Mfg. Div. of Raybestos-Manhattan, Inc.
Molded Insulation Co.
The Parker Appliance Co.
Perry Aircraft Products Corp.
Seiberling Rubber Co.
Spaulding Fibre Co., Inc.
Synthane Corp.
Technical Ply-Woods
Tingley Reliance Rubber Corp.
The United States Graphite Co.
United States Rubber Co.
Virginia Rubatex, Div. Salta Corp.
Voges Mfg. Co., Inc.
The Weatherhead Co.
R. D. Werner Co., Inc.
Westinghouse Electric & Manufacturing Co.

Veneer Parts

Burnside Veneer Co. Inc.
National Veneer & Lumber Co.
J. V. G. Posey & Co.

PISTON RINGS

Atlantic Diesel Corp.
General Aircraft Supply Corp.
The International Piston Ring Co.
Koppers Co., American Hammered Piston Ring Div.
McQuay-Norris Mfg. Co.
Muskegon Piston Ring Co.
Karl Ort
Ramsey Accessories Mfg. Corp.
Richmond Ring Co.
St. Louis Spring Co.
Sealed Power Corp.
Simplex Products Corp.
The United States Graphite Co.
Wilkening Manufacturing Co.

PRIMERS (Engine)

Acme White Lead & Color Works
Adel Precision Products Corp.
Associated Foundries & Manufacturers, Inc.
Bendix Products Div., Bendix Aviation Corp.
The Dole Valve Co.
W. P. Fuller & Co.
General Controls Co.
The Imperial Brass Manufacturing Co.
Koehler Aircraft Products Co.

(Engine Primers) *Continued*
Karl Ort
The Parker Appliance Co.
Valentine & Co., Inc.
Wailes Dove-Hermiston Corp.

PROPELLERS & PROPELLER PARTS

Aero Engineering Corp.
Aero Supply Mfg. Co. Inc.
Aeroproducts Div., General Motors Corp.
American Aluminum Ware Co.
American Propeller Corp.
The Aro Equipment Corp.
Atlantic Diesel Corp.
B. H. Aircraft Co.
The Bowling Green Rubber Co.
Curtiss-Wright Corp., Propeller Div.
Eclipse Aviation Div., Bendix Aviation Corp.
Engineering & Research Corp.
Fahlin Manufacturing Co.
Foote Bros. Gear & Machine Corp.
Freedman-Burnham Engineering Corp.
Gardner Propeller Co.
General Aircraft Supply Corp.
Hamilton Standard Propellers, Div. of United Aircraft Corp.
Hardman, Peck & Co.
Hartzell Propeller Co., Div. of Hartzell Industries, Inc.
Harvey Machine Co.
The Heim Co.
Koppers Co., Bartlett Hayward Div.
Lear Avia, Inc.
Lorenzen Industries
McCauley Steel Propeller Co.
The Marquette Metal Products Co.
Muskegon Piston Ring Co.
National Aircraft Materials Corp.
Neu-Bart Stamping & Mfg. Co.
Karl Ort
Perry Aircraft Products Corp.
Pilot Propellers Inc.
Precise Tool & Manufacturing Co.
Precision Products, Inc.
Pump Engineering Service Corp.
Sensenich Brothers
Special Machine Tool Engineering Works
The Steel Products Engineering Co.
Stone Propeller Co.
Summerill Tubing Co.
The Taft-Peirce Mfg. Co.
The Taylor Machine Co.
Thompson Aircraft Products Co.
Thompson Products, Inc.
Tietzmann Engineering Co.
The Toledo Standard Commutator Co.
Troyer Aircraft
Warner Aircraft Corp.
Woodward Governor Co.

PROTECTIVE CLOTHING & EQUIPMENT

Air Associates, Inc.
Bausch & Lomb Optical Co.
E. D. Bullard Co.
Davis Emergency Equipment Co., Inc.
Dura-Products Mfg. Co.
General Aircraft Supply Corp.
John W. Gillette & Co.
The Goggle Parts Co.
Goodyear Tire & Rubber Co.
Industrial Wire Cloth Products Corp.
The H. D. Lee Mercantile Co.
Lite Mfg. Co.
E. B. Meyrowitz Inc.
Mine Safety Appliances Co.
Karl Ort
Owens-Corning Fiberglas Corp.
Pulmosan Safety Equipment Corp.
Rough Wear Clothing Co.
Schlegel Mfg. Co.
M. L. Snyder & Son
United States Rubber Co.
Uxbridge Worsted Co., Inc.
Willis & Geiger, Inc.
Willson Products, Inc.

PUMPS

A C Spark Plug, Div. of General Motors Corp.
Adel Precision Products Corp.
Aero Supply Mfg. Co. Inc.

(Pumps) *Continued*
Air Associates, Inc.
Aircraft Accessories Corp.
Aircraft Accessories Corp. of Mo.
Aircraft Engineering Products, Inc.
Allis-Chalmers Mfg. Co.
The Aro Equipment Corp.
Beckett Electric Co., Inc.
Bendix Aviation, Ltd.
Bertea Products
Candler-Hill Corp.
Chandler-Evans Corp.
Chicago Pneumatic Tool Co.
Dowty Equipment Corp.
Eastern Engineering Co.
Eaton Manufacturing Co.
Eclipse Aviation Div., Bendix Aviation Corp.
Fairbanks, Morse & Co.
Gardner-Denver Co.
Granberg Equipment Inc.
Harvill Corp.
The Hydraulic Press Mfg. Co.
Liberty Aircraft Products Corp.
The Marquette Metal Products Co.
The Nash Engineering Co.
National Machine Products
The Ohio Piston Co.
Karl Ort
Pacific Aviation Inc.
Pacific Scientific Co.
Pioneer Engineering & Mfg. Co.
Pump Engineering Service Corp.
Robbins & Myers, Inc.
Romec Pump Co.
D. B. Smith & Co.
The Steel Products Engineering Co.
Stewart-Warner Corp.
Thompson Aircraft Products Co.
Thompson Products, Inc.
The Toledo Standard Commutator Co.
United Aircraft Products, Inc.
Vickers Inc.
The Yale & Towne Mfg. Co.

RADIATORS

Clifford Manufacturing Co.
Drayer & Hanson, Inc.
The G & O Manufacturing Co.
Harrison Radiator Div., General Motors Corp.
McCord Radiator & Mfg. Co.
Karl Ort
United Aircraft Products, Inc.
Winchester Repeating Arms Co., Div. of Western Cartridge Co.
Young Radiator Co.

RADIOS

Air Associates, Inc.
Aircraft Accessories Corp.
Aircraft Accessories Corp. of Mo.
Aircraft Radio Corp.
Atlantic India Rubber Works, Inc.
Rex Bassett, Inc.
Bendix Aviation, Ltd.
Clarostat Mfg. Co., Inc.
Communications Co., Inc.
Doolittle Radio Inc.
Electronic Laboratories, Inc.
Electronic Specialty Co.
Federal Telephone & Radio Corp.
Federal Telephone & Radio Corp., Radio Div.
Fisher Research Laboratory
Frazar & Co. Ltd.
General Aircraft Supply Corp.
General Electric Co.
Harvey Machine Co.
Harvey Radio Labs. Inc.
Harvey-Wells Communications, Inc.
Heath Co.
Jefferson-Travis Radio Mfg. Corp.
Lear Avia, Inc.
James Millen Mfg. Co., Inc.
Molded Insulation Co.
Karl Ort
Owens-Corning Fiberglas Corp.
Philco Corp.
RCA Victor Div., Radio Corp. of America
Radio Frequency Laboratories, Inc.
Radio Receptor Co., Inc.
Searle Aero Industries, Inc.
Televiso Products, Inc.
Weltronic Co.
Western Electric Co., Inc.
Westinghouse Electric & Manufacturing Co.

Equipment for Combat

TO see in the dark and to see at a greater distance . . . to push back the clouds and fogs of ignorance has been since the beginning of time one of man's greatest aspirations.

Spurred by war, the scientific laboratories of the nation are making tremendous strides toward meeting this aspiration.

In every branch of the services our fighting men are now armed with electrical devices which enable them to pierce the black of night, the depths of the ocean and the clouded skies. Already much of our success over our enemies on land, sea and in the air has been achieved through the use of these "electrical cats."

The peacetime possibilities of these devices which pierce the darkness are limitless.

In the very forefront in the design and manufacture of these developments stand Western Electric and its engineering organization, the Bell Telephone Laboratories.

Western Electric

ARSENAL OF COMMUNICATIONS EQUIPMENT.

RADIO ACCESSORIES & EQUIPMENT

Aeronautical Radio Mfg. Co.
Aircraft Accessories Corp.
Aladdin Radio Industries, Inc.
Automatic Electric Co.
Bendix Radio Div., Bendix Aviation Corp.
Bliley Electric Co.
Dahlstrom Metallic Door Co.
Eitel-McCullough Inc.
General Radio Co.
Gray Radio Co.
Harvey-Wells Communications Inc.
Islip Radio Manufacturing Corp.
H. K. Lorentzen, Inc.
Radio Accessories Mfg. Corp.
Scintilla Magneto Div., Bendix Aviation Corp.
Shure Brothers
Thordarson Electric Mfg. Co.
Triplett Electrical Instrument Co.
Universal Microphone Co. Ltd.
Walker-Turner Co. Inc.
The Ward Products Corp.

RADIO COMPASSES

Aeronautical Radio Mfg. Co.
Aeroproducts Manufacturing Co.
Bendix Radio Div., Bendix Aviation Corp.
Clarostat Mfg. Co., Inc.
Fairchild Aviation Corp.
Federal Telephone & Radio Corp.
Federal Telephone & Radio Corp., Radio Div.
Fisher Research Laboratory
Frazar & Co. Ltd.
Harvey Machine Co.
Islip Radio Manufacturing Corp.
Lear Avia, Inc.
Karl Ort
RCA Victor Div., Radio Corp. of America
Radio Navigational Instrument Corp.
Televiso Products, Inc.

SCALES

The Exact Weight Scale Co.
Fairbanks, Morse & Co.
The Howe Scale Co.
Toledo Scale Co.

SEATS

Aeronca Aircraft Corp.
All American Aircraft Products, Inc.
Art Chrome Co. of America
Bendix Products Div., Bendix Aviation Corp.
Edward G. Budd Manufacturing Co.
California Panel & Veneer Co.
Charles W. Carll Sons
A. T. Case Co.
Cluff Fabric Products
Diebold Safe & Lock Co.
Essick Manufacturing Co.
Firestone Aircraft Co.
Goodyear Tire & Rubber Co.
Hardman Aircraft Products, Inc.
Harvill Corp.
Hayes Manufacturing Corp.
Logan Co.
Lyon Metal Products, Inc.
Warren McArthur Corp.
J. E. Menaugh Co.
Karl Ort
Southern California Airparts
Technical Ply-Woods
Tennessee Aircraft, Inc.
United States Plywood Corp.
United States Rubber Co.
Vega Aircraft Corp.
Weber Showcase & Fixture Co., Inc.

RADIO & IGNITION SHIELDING

Aeronautical Radio Mfg. Co.
Air Associates, Inc.
Air-Shields, Inc.
American Aluminum Ware Co.
American Phenolic Corp.
American Tube Bending Co., Inc.
The B G Corp.
Breeze Corporations, Inc.
Chicago Metal Hose Corp.
H. A. Douglas Mfg. Co.
C. M. Hall Lamp Co.
F. C. Kent Co.
Lyon Metal Products, Inc.
The Manhattan Rubber Mfg. Div. of Raybestos-Manhattan, Inc.

(Radio & Ignition Shielding) *Continued*
Karl Ort
Packard Electric Div., General Motors Corp.
Poulsen & Nardon, Inc.
Precision Tube Co.
Schori Process Corp.
Scintilla Magneto Div., Bendix Aviation Corp.
Searle Aero Industries, Inc.
Titeflex Metal Hose Co.
Union Aircraft Products Corp.
Vega Aircraft Corp.
Walker-Turner Co., Inc.
The Ward Products Corp.

SHIMS

Aircraft & Marine Specialty Co.
Jack Best Mfg. Co.
The Cleveland Metal Stamping Co.
Continental-Diamond Fibre Co.
Detroit Stamping Co.
Dural Rubber Co.
The Johnson Rubber Co.
Laminated Shim Co., Inc.
McCord Radiator & Mfg. Co.
Karl Ort
Perry Aircraft Products Corp.
Tietzmann Engineering Co.
Twin City Tool Co.
Vega Aircraft Corp.
R. D. Werner Co., Inc.
Whitehead Stamping Co.
H. A. Wilson Co.
Worcester Stamped Metal Co.

SHOCK STRUTS & CORD

Aeronca Aircraft Corp.
Associated Foundries & Manufacturers, Inc.
Axelson Manufacturing Co.
Dowty Equipment Corp.
The Gabriel Co.
The B. F. Goodrich Co., Aeronautical Div.
The Hardware Specialties Mfg. Co.
Houdaille-Hershey Corp.
Marman Products Co.
Menasco Manufacturing Co.
Karl Ort
Pacific Aviation Inc.
Perry Aircraft Products Corp.
John A. Roebling's Sons Co.
The Russell Manufacturing Co.
Schlegel Mfg. Co.
J. W. Wood Elastic Web Co.

SHOP EQUIPMENT

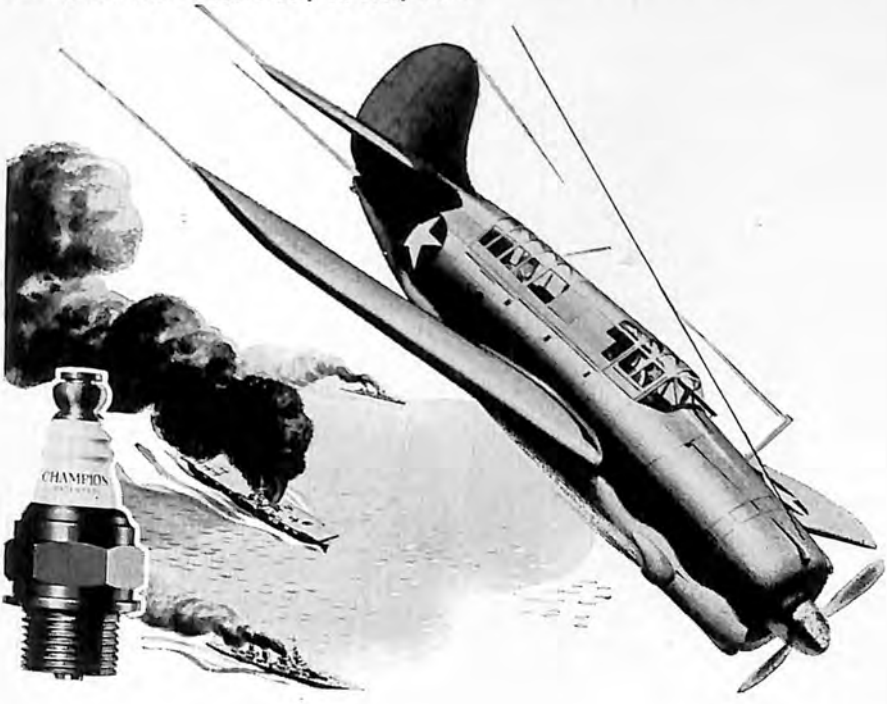
Air Craftsmen, Inc.
Airchox Co. Div. of Joyce Aviation Inc.
Aircraft Engineering Products Inc.
Ajax Electrothermic Corp.
The Alexander Milburn Co.
Baker Industrial Truck Div. of The Baker-Raulang Co.
Darnell Corp., Ltd.
The Duff-Norton Manufacturing Co.
The Elwell-Parker Electric Co.
Federal Aircraft Works
Lake Erie Engineering Corp.
Lamson Corp.
Lea Manufacturing Co.
Reading Chain & Block Corp.
The Strippit Corp.
Union Mfg. Co.
Whiting Corp.

SPARK PLUGS

A C Spark Plug, Div. of General Motors Corp.
Actus Products Corp.
Aero Spark Plug Co., Inc.
Air-Shields, Inc.
The B G Corp.
Champion Spark Plug Co.
The Defiance Stamping Co.
Edison-Splitdorf Corp.
General Aircraft Supply Corp.
J. E. Menaugh Co.
Motor Master Products Corp., Aeronautical Div.
Karl Ort
Scintilla Magneto Div., Bendix Aviation Corp.
Simmonds Aerocessories, Inc.

CHAMPION SPARK PLUGS

are the dependable source of full, flowing engine performance for every aircraft engine because they are backed by exclusive facilities and personnel, without equal in the spark plug industry. Most gratifying reports are continuously flowing into our offices citing service records of the outstanding performance, long-life and extreme dependability of Champion Aircraft Spark Plugs, in engines of every type and size. As proof of these facts, Champions are on active duty on every front.

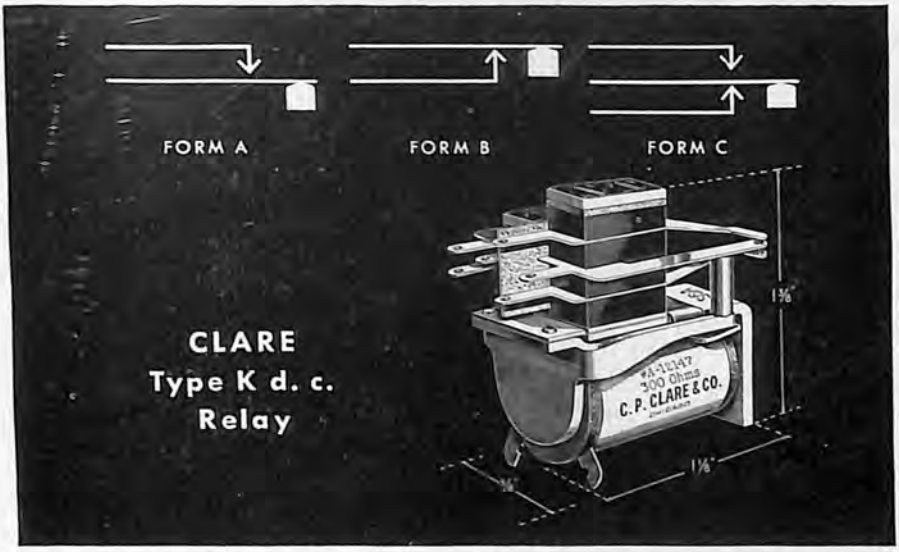


SPRINGS

Advance Spring Corp.
All-Weather Springs
Barnes-Gibson-Raymond Div. of Associated Spring Corp.
California Spring Co., Inc.
M. D. Hubbard Spring Co.
W. B. Jones Spring Co.
Raymond Mfg. Co. Div. Associated Spring Co.
Wichita Wire Products Co.

STAMPINGS

Ace Manufacturing Corp.
Acme Stamping & Mfg. Co.
Advance Spring Corp.
Aero Trades Co.
Aeronca Aircraft Corp.
Aircraft & Marine Specialty Co.
Aircraft Specialties Co.
Airsealand Aircraft Inc.
Alofs Manufacturing Co.
Aluminum Co. of America
American Aluminum Ware Co.
American Central Manufacturing Corp.
American Magnesium Corp.
Andrews & Perillo Inc.
Associated Foundries & Manufacturers, Inc.
Automotive Rubber Co.
Edward F. Aymond Co.
Baltic Metal Products Co.
Berger Brothers Co.
Brasco Manufacturing Co.
Buhl Stamping Co.
Charles W. Carll Sons
A. T. Case Co.
The Cleveland Metal Stamping Co.
Columbia Stamping & Mfg. Corp.
Continental Machines Inc.
Cook Electric Co.
Dahlstrom Metallic Door Co.
The Defiance Stamping Co.
Detroit Stamping Co.
The Dill Mfg. Co.
H. A. Douglas Mfg. Co.
Eaton Manufacturing Co.
The Edwards Manufacturing Co.
Engel Aircraft Specialties
Essick Manufacturing Co.
Forsyth Metal Goods Co.
Fowler Aircraft Co.
General Aircraft Equipment, Inc.
Gilbert & Barker Mfg. Co.
The Greist Mfg. Co.
The Edwin F. Guth Co.
C. M. Hall Lamp Co.
The Hardware Specialties Mfg. Co.
Harvey Machine Co.
Hayes Manufacturing Corp.
Highbridge-International Co.
M. D. Hubbard Spring Co.
Hyland Machine Co.
The Kawneer Co.
Kennedy Name Plate Co.
Keystone Tool & Supply Co.
George Koch Sons, Inc.
E. Konigslow Stamping & Tool Co.
Lansing Stamping Co.
Logan Co.
H. K. Lorentzen, Inc.
Los Angeles Stamp & Stationery Co.
Lyon Metal Products, Inc.
McCord Radiator & Mfg. Co.
Manufacturers Screw Products
Maplewood Machinery Co.
Met-L-Wood Corp.
Monarch Metal Weatherstrip Corp.
Neu-Bart Stamping & Mfg. Co.
Numberall Stamp & Tool Co.
Karl Ort
Pacific-Airmax Corp.
Perry Aircraft Products Corp.
Pneumatic Drop Hammer Co.
Poulsen & Nardon, Inc.
Precision Products, Inc.
Pressed & Welded Steel Products Co., Inc.
Products Engineering Co.
R-B-M Manufacturing Co.
Raymond Mfg. Co. Div. Associated Spring Corp.
Republic Steel Corp.
Revere Copper & Brass Inc.
Reynolds Metals Co.
Roberts & Mander Stove Co.
Rohr Aircraft Corp.
S & M Lamp Co.
A. O. Smith Corp.
Solar Aircraft Co.
Soss Manufacturing Co.



This Relay Laughs at Vibration

THE Clare Type K d.c. Midget Relay pictured above was "custom-built" for mobile applications, such as aircraft, where dwarf-size and feather-weight are imperative; where ability to operate on high frequency circuits is essential; where resistance to constant vibration and severe shock is a "must."

Its construction employs no anti-vibration springs, no loose bearings, no rivets, no gingerbread whatsoever . . . The screws which anchor spring pile-ups to the heelpiece are tightened under pressure and sealed by a coating of Glyptol.

It is extremely small, measuring only 1½" x 1¼" x 13/16" and weighs approximately 1⅔ ounces . . . It can be furnished in the contact forms shown above with any number of springs up to and including 12. Coil voltage range from 1.5 volts to 60 volts d.c. . . . Contacts of either 18 gauge silver, rated one ampere, 50 watts, or 18 gauge palladium, rated 2 amperes, 100 watts. All metal parts of this relay are specially plated to withstand a 200 hour salt spray test.

The size and weight of this relay is a very definite contribution to aircraft design problems. Write us regarding your problems. We will make suggestions. Send for the Clare catalog and data book. C. P. Clare & Company, 4719 West Sunnyside Ave., Chicago, Ill. Sales engineers in all principal cities. Cable address: CLARELAY.

Special Features

1. Spring insulators of ⅛" Mycalex are provided for high frequency circuits.

2. Pile-up screws are enclosed in Polystyrene tubing insulation. Both screws and tubing are completely sealed at head and foot by Glyptol.

3. The armature assembly, heelpiece and coil core are made of magnetic metal, carefully annealed. The armature assembly is available with either single or double arm.

4. The small coil is equipped with a front spool head having a flat side. This locks the entire coil in place against the heelpiece, preventing it from turning or becoming loose.

5. Uniform armature movement is assured by a hinge of "fatigueless" beryllium copper, heat treated and designed to provide a wide margin of safety, insuring long life under vibration.

6. Contact springs are made of nickel silver to the user's specifications. The contacts are over-all welded to these springs by a special process.

7. Spring bushing insulators are made of Bakelite rod under a patented process.

CLARE RELAYS

"Custom-built" Multiple Contact Relays for Electrical, Electronic and Industrial Use

(Stampings) *Continued*
Spriesch Tool & Mfg. Co., Inc.
Steel Forming Corp.
The Steel Products Engineering Co.
Technical Products Co.
Tennessee Aircraft, Inc.
Tietzmann Engineering Co.
Timm Aircraft Corp.
Transue & Williams Steel Forging Corp.
Tubular Rivet & Stud Co.
Twin City Tool Co.
Union Aircraft Products Corp.
United-Carr Fastener Corp.
Universal Fixture Corp.
Utility Fan Corp.
The Variety Aircraft Corp.
Victor Metal Products Corp.
Voges Mfg. Co., Inc.
The John W. Vogler Co., Inc.
E. R. Wagner Manufacturing Co.
Waldes-Koh-I-Noor Inc.
The Ward Products Corp.
Weltronic Co.
Whitehead Stamping Co.
Worcester Pressed Steel Co.
Worcester Stamped Metal Co.
Wrought Washer Mfg. Co.

STARTERS

Champion Aviation Products Co.
Cook Electric Co.
Breeze Corporations, Inc.
Eclipse Aviation Div., Bendix Aviation Corp.
Federal Laboratories, Inc.
General Armature Corp.
The Hart Manufacturing Co.
Jack & Heintz Inc.
P. R. Mallory & Co. Inc.
Karl Ort
Owens-Corning Fiberglas Corp.
Philadelphia Div., Bendix Aviation Corp.
The Toledo Standard Commutator Co.

SUB-ASSEMBLIES

A & F Aluminum Products Co.
Abrams Instrument Co.
Ace Manufacturing Corp.
Aerco Corp.
Aeronautical Manufacturing Corp.
Aeronca Aircraft Corp.
Aircraft Mechanics, Inc.
Aircraft Specialties Co.
The Albano Co. Inc.
All American Aircraft Products, Inc.
American Aluminum Ware Co.
American Central Manufacturing Corp.
American Magnesium Corp.
The Apex Tool Co., Inc.
Armstrong Cork Co.
Associated Foundries & Manufacturers, Inc.
Atlantic Diesel Corp.
Atlantic India Rubber Works, Inc.
The Automatic Electrical Devices Co.
Berger Brothers Co.
Brasco Manufacturing Co.
Briggs Manufacturing Co.
Charles W. Carll Sons
A. T. Case Co.
Century Aircraft Co.
Chicago Metal Hose Corp.
Columbia Stamping & Mfg. Corp.
Cook Electric Co.
Cunningham-Hall Aircraft Corp.
Dayton Tool & Engineering Co.
Doak Aircraft Co., Inc.
Dycer Aviation Supplies
Eaton Manufacturing Co.
Edo Aircraft Corp.
Essick Manufacturing Co.
The Folmer Graflex Corp.
Fowler Aircraft Co.
Julien P. Friez & Sons, Div. Bendix Aviation Corp.
General Aircraft Equipment, Inc.
General Bronze Corp.
Gilbert & Barker Mfg. Co.
The Hardware Specialties Mfg. Co.
Harlow Aircraft Co.
Harvey Machine Co.
Hayes Manufacturing Corp.
Hockaday-Newby Aircraft, Inc.
Hyland Machine Co.
Industrial Wire Cloth Products Corp.
Johnson Tool Co., Inc.
The Kawneer Co.
Kellett Autogiro Corp.

(Sub-Assemblies) *Continued*
Lyon Metal Products, Inc.
Manlove & Spaulding Mfg. Co.
Mercury Aircraft Inc.
The Murray Corp. of America
National Aircraft Equipment Co.
National Machine Products
Neu-Bart Stamping & Mfg. Co.
Pacific-Airmax Corp.
Perry Aircraft Products Corp.
Pittsburgh Plate Glass Co.
Poulsen & Nardon, Inc.
Pressed & Welded Steel Products Co., Inc.
Products Engineering Co.
R-B-M Manufacturing Co.
R E F Aircraft Corp.
Reynolds Metals Co.
Rohr Aircraft Corp.
S & M Lamp Co.
Schlegel Mfg. Co.
Searle Aero Industries, Inc.
South Shore Machine & Tool Works, Inc.
Southern Aircraft Corp.
Southern California Airparts
Special Machine Tool Engineering Works
Speed Way Mfg. Co.
Steel Forming Corp.
The Steel Products Engineering Co.
Surface Combustion, Div. of General Properties Inc.
Thompson Aircraft Products Co.
Thompson Products, Inc.
Tietzmann Engineering Co.
Timm Aircraft Corp.
Vega Aircraft Corp.
Voges Mfg. Co., Inc.
Waldes Koh-I-Noor Inc.
Weber Showcase & Fixture Co., Inc.

SUPERCHARGERS

The Alexander Milburn Co.
General Electric Co.

Engine Superchargers

Turbo Engineering Corp.
Simmonds Aerocessories, Inc.
Wico Electric Co.

Cabin Superchargers

Airesearch Manufacturing Co.
Allis-Chalmers Mfg. Co.
Eclipse Aviation Div., Bendix Aviation Corp.
General Electric Co.
Pacific-Airmax Corp.
Philadelphia Div., Bendix Aviation Corp.
Pump Engineering Service Corp.

TAIL WHEEL ASSEMBLIES

Aerco Corp.
Air Associates, Inc.
Aircraft Mechanics, Inc.
Aircraft Welders Inc.
Bendix Products Div., Bendix Aviation Corp.
Charles W. Carll Sons
Cleveland Pneumatic Tool Co.
Cosco Manufacturing Co.
Diamond Chain & Mfg. Co.
Dowty Equipment Corp.
Essick Manufacturing Co.
Firestone Aircraft Co.
General Aircraft Supply Corp.
Goodyear Tire & Rubber Co.
Heath Co.
Hockaday-Newby Aircraft, Inc.
Houdaille-Hershey Corp.
Kelsey Hayes Wheel Co.
National Aircraft Equipment Co.
Karl Ort
Perry Aircraft Products Corp.
St. Louis Spring Co.
Saylor Beall Mfg. Co.
Scott Aviation Corp.
Timm Aircraft Corp.
United Aircraft Products, Inc.
The Variety Aircraft Corp.

TANKS

Aeronca Aircraft Corp.
Aircraft Components Inc.
Aircraft Welders Inc.
Aluminum Co. of America
American Magnesium Corp.
Associated Foundries & Manufacturers, Inc.

COOLING

of AIRCRAFT ENGINES

SERVING THE AIRCRAFT INDUSTRY WITH BASIC MATERIALS

for **ENGINE COOLING**

HYDRON EXTRUDED TUBING

We manufacture HYDRON thin-wall extruded tubing for aircraft radiators, oil coolers, inter-coolers, and heat inter-changers, for liquid-cooled and air-cooled motors.

for **COOLING CONTROL**

HYDRON METALLIC BELLOWS

HYDRON thin-wall hydraulically-formed metallic bellows are used in all types of temperature and pressure control devices for aircraft engine cooling systems, carburetors and super-chargers.

CLIFFORD MANUFACTURING CO.

564 EAST FIRST STREET. BOSTON

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HYDRON

(Tanks) *Continued*
Bellanca Aircraft Corp.
Briggs Manufacturing Co.
Edward G. Budd Manufacturing Co.
Buick Motor Div.
Columbia Stamping & Mfg. Corp.
The Defiance Stamping Co.
Duramold Div. of Fairchild Engine & Airplane Corp.
Essick Manufacturing Co.
The B. F. Goodrich Co., Aeronautical Div.
Goodyear Tire & Rubber Co.
Hardman Aircraft Products, Inc.
Harvey Machine Co.
Heil Engineering Co.
Highbridge-International Co.
Inglewood Sheet Metal Works
Kelsey Hayes Wheel Co.
Lyon Metal Products, Inc.
McQuay, Inc.
Maplewood Machinery Co.
The Marquette Metal Products Co.
Mercury Aircraft Inc.
Karl Ort
Owens-Corning Fiberglas Corp.
Perry Aircraft Products Corp.
Pittsburgh Plate Glass Co.
Pneumatic Drop Hammer Co.
Pollak Manufacturing Co.
Poulsen & Nardon, Inc.
Reynolds Metals Co.
S & M Lamp Co.
Seiden Pneumatic Tool Co.
Southern California Airparts
Surface Combustion, Div. of General Properties, Inc.
Tennessee Aircraft, Inc.
Timm Aircraft Corp.
United States Plywood Corp.
United States Rubber Co.
Utility Fan Corp.
Vega Aircraft Corp.
Weber Showcase & Fixture Co., Inc.

TESTING & INSPECTION EQUIPMENT

Allen Electric & Equipment Co.
The Brush Development Co.
Denison Engineering Co.
Detroit Rex Products Co.
Fairbanks, Morse & Co.
Kold-Hold Manufacturing Co.
Magnaflux Corp.
The Meriam Co.
Merrill Engineering Laboratories
Mobile Refrigeration, Inc.
P. A. Sturtevant Co.
Toledo Scale Co.
Western Industrial Engineering Co.

TIRES & TUBES

Bacon Vulcanizer Mfg. Co.
Firestone Aircraft Co.
General Aircraft Supply Corp.
The B. F. Goodrich Co., Aeronautical Div.
Goodyear Tire & Rubber Co.
J. E. Menaugh Co.
Karl Ort
United States Rubber Co.

TOOLS

The Acromark Corp.
Adjustable Clamp Co.
Aero Tool Co.
Aeronautical Manufacturing Corp.
Aeronca Aircraft Corp.
Airco Tool Co.
Aircraft Production Engineers
Aircraft Tools, Inc.
Airsealand Aircraft Inc.
Andrews & Perillo Inc.
The Apex Tool Co., Inc.
Armstrong Bros. Tool Co.
Astra Engineering Co.
E. C. Atkins & Co.
The Automatic Electrical Devices Co.
The Automatic Vise Sales Co.
The Bennett Metal Treating Co.
The Black & Decker Mfg. Co.
Blackhawk Mfg. Co.
Bonney Forge & Tool Works
The Bridgeport Hardware Mfg. Corp.
Brown & Sharpe Mfg. Co.
Carboloy Co., Inc.
Cleveland Pneumatic Tool Co.
Columbia Stamping & Mfg. Corp.
The Columbian Vise & Mfg. Co.
Cook Electric Co.

(Tools) *Continued*
Cowles Tool Co.
Crescent Tool Co.
Dayton Tool & Engineering Co.
Denham & Co.
Detroit Broach Co., Inc.
Dix Mfg. Co.
Duro Metal Products Co.
The Elwell-Parker Electric Co.
Engel Aircraft Specialties
Firth-Sterling Steel Co.
General Aircraft Supply Corp.
The Geometric Tool Co.
The Graham Mfg. Co., Inc.
Guiberson Diesel Engine Co.
Hamilton Machinery Builders, Inc.
Henry & Wright Mfg. Co.
The Imperial Brass Manufacturing Co.
Independent Pneumatic Tool Co.
Industrial Grinding Co.
I. Jacoel Cable Splicing Equipment Co.
Kent-Moore Organization Inc.
Keystone Tool & Supply Co.
George Koch Sons, Inc.
The Lufkin Rule Co.
McKenna Metals Co.
Irwin McNiece
The Martindale Electric Co.
Michigan Tool Co.
Millers Falls Co.
Misener Mfg. Co., Inc.
Morse Tool Co.
National Aircraft Equipment Co.
National Broach & Machine Co.
National Twist Drill & Tool Co.
The Nedco Co.
North Bros. Mfg. Co.
The O. K. Tool Co., Inc.
Onsrud Machine Works, Inc.
Karl Ort
The Parker Appliance Co.
The Parker Stamp Works, Inc.
The Paulson Tools, Inc.
The Peck, Stow & Wilcox Co.
Perry Aircraft Products Corp.
Photo Record Equipment Co.
Pioneer Engineering & Mfg. Co.
Plomb Tool Co.
H. K. Porter, Inc.
Prestole Div.
Preston Machine Tool Sales Co.
Procunier Safety Chuck Co.
Production Tool & Die Co., Inc.
Products Engineering Co.
R E F Aircraft Corp.
Reda Mfg. Co.
The Sheffield Corp.
Snap-On Tools Corp.
The L. S. Starrett Co.
Sterling Tool Products Co.
P. A. Sturtevant Co.
Sunnen Products Co.
The Taft-Peirce Mfg. Co.
George A. Terry Co.
M. N. Thackaberry
The Henry G. Thompson & Son Co.
Tietzmann Engineering Co.
The Tobrin Tool Co.
Utica Drop Forge & Tool Corp.
Vega Aircraft Corp.
The Vlchek Tool Co.
The John W. Vogler Co., Inc.
Wilkening Manufacturing Co.
Winter Brothers Co.

TUBING

Aircraft Specialties Co.
Allegheny Ludlum Steel Corp.
Aluminum Co. of America
American Magnesium Corp.
Atlantic India Rubber Works, Inc.
Edward F. Aymond Co.
Baker Steel & Tube Co.
The Beaton & Corbin Mfg. Co.
Beckett Electric Co., Inc.
The Bowling Green Rubber Co.
Brasco Manufacturing Co.
Breeze Corporations, Inc.
Burndy Engineering Co., Inc.
California Panel & Veneer Co.
Chicago Metal Hose Corp.
Corning Glass Works
The Dayton Rubber Mfg. Co.
Federal Metal Hose Corp.
Flex-O-Tube Co.
Forsyth Metal Goods Co.
Globe Steel Tubes Co.
The B. F. Goodrich Co., Aeronautical Div.
Goodyear Tire & Rubber Co.
Henger Seltzer Co.

(Tubing) *Continued*
Irvington Varnish & Insulator Co.
The Johnson Rubber Co.
The Kawneer Co.
F. C. Kent Co.
Lyon Metal Products, Inc.
The Manhattan Rubber Mfg. Div. of Raybestos-Manhattan, Inc.
Metals & Controls Corp., General Plate Div.
The National Copper & Smelting Co.
National Tube Co.
The Ohio Seamless Tube Co.
Karl Ort
Owens-Corning Fiberglas Corp.
Pittsburgh Plate Glass Co.
Precision Tube Co.
Republic Steel Corp.
Resistoflex Corp.
Revere Copper & Brass Inc.
Reynolds Metals Co.
Seamlex Co., Inc.
Searle Aero Industries, Inc.
Seiberling Rubber Co.
Shakespeare Products Co.
M. L. Snyder & Son
Steel & Tubes Div., Republic Steel Corp.
Summerill Tubing Co.
Superior Tube Co.
The Timken Roller Bearing Co.
Tubing Seal-Cap, Inc.
United States Rubber Co.
Vega Aircraft Corp.
Wallace Supplies Mfg. Co.
The Weatherhead Co.
A. H. Wells & Co., Inc.
R. D. Werner Co., Inc.
Winchester Repeating Arms Co., Div. of Western Cartridge Co.
The Wiremold Co.
Wolverine Tube Div. of Calumet & Hecla Consolidated Copper Co.

VALVES (CONTROL)

Adel Precision Products Corp.
Aeronautical Manufacturing Corp.
Air Associates, Inc.
Associated Foundries & Manufacturers, Inc.
Atlantic Diesel Corp.
Barber-Colman Co.
Bendix Aviation, Ltd.
Clayton Manufacturing Co.
Denison Engineering Co.
Diamond Chain & Mfg. Co.
Dix Mfg. Co.
The Dole Valve Co.
Dowty Equipment Corp.
Eclipse Aviation Div., Bendix Aviation Corp.
Eggelhof Engineers
Fleetwings, Inc.
The Fulton Sylphon Co.
General Controls Co.
Harrison Radiator Div., General Motors Corp.
Harvill Corp.
Hoof Products Co.
Houdaille-Hershey Corp.
The Hydraulic Press Mfg. Co.
King-Seeley Corp.
Lorenzen Industries
Milwaukee Valve Co.
Moore-Eastwood & Co.
National Machine Products
Karl Ort
The Parker Appliance Co.
Perry Aircraft Products Corp.
Pump Engineering Service Corp.
Swift Lubricator Co.
C. J. Tagliabue Mfg. Co.
Taylor Instrument Co.
The Taylor Machine Co.
United Aircraft Products, Inc.
Vickers Inc.
Paul G. Wagner Co.
Young Radiator Co.

VALVES (ENGINE) & VALVE PARTS

Aero Supply Mfg. Co., Inc.
Aluminum Industries, Inc.
The American Auto Parts Co.
The Apex Tool Co., Inc.
Burdett Mfg. Co.
The Cooper Alloy Foundry Co.
Eaton Manufacturing Co.
Ertel Machine Co.
The Hartford Machine Screw Co.
Harvill Corp.
Koehler Aircraft Products Co.

STRONG AS A FEATHER . . .

One of nature's masterpieces, the feather, has a weight-strength ratio that remains a challenge to designers. And, of course, the feather's spine is a tube.

Here at Summerill we produce seamless steel tubing, much of which is used in the construction of our birds of war. Not only do we make standard aircraft rounds, streamlines, ovals and squares, but also tapered, swedged and upset sections for special applications. We are always ready to cooperate with aircraft engineers and designers in the solution of problems involving new or special tubing applications.

SUMMERILL TUBING COMPANY

Affiliated with EDGAR T. WARD'S SONS CO. and COLUMBIA STEEL & SHAFTING CO.

BRIDGEPORT · MONTGOMERY COUNTY · PENNSYLVANIA

(Valves (Engine) & Valve Parts) *Continued*
The Manhattan Rubber Mfg. Div. of Raybestos-Manhattan, Inc.
National Machine Products
Karl Ort
The Parker Appliance Co.
Perry Aircraft Products Corp.
The Taylor Machine Co.
Thompson Aircraft Products Co.
Thompson Products, Inc.

VENTILATING & AIR CONDITIONING EQUIPMENT

Aircraft Production Engineers
American Foundry & Furnace Co.
American Foundry Equipment Co.
American Machine & Metals, Inc.
Anemostat Corp. of America
The Automatic Electrical Devices Co.
Barber-Colman Co.
Beckett Electric Co., Inc.
Berger Brothers Co.
Carrier Corp.
Chicago Metal Hose Corp.
Cook Electric Co.
Curtis Mfg. Co.
Detroit Sheet Metal Works
Drayer & Hanson, Inc.
Eggelhof Engineers
Julien P. Friez & Sons, Div. Bendix Aviation Corp.
The Fulton Sylphon Co.
General Controls Co.
The Edwin F. Guth Co.
George Koch Sons, Inc.
McQuay, Inc.
Owens-Corning Fiberglas Corp.
Pacific-Airmax Corp.
Perry Aircraft Products Corp.
B. F. Sturtevant Co.
Surface Combustion, Div. of General Properties, Inc.
United States Plywood Corp.
Utility Fan Corp.
Young Radiator Co.

VIBRATION DAMPERS

Arrowhead Rubber Co.
Associated Rubber Products Co.
Atlantic India Rubber Works, Inc.
The Bowling Green Rubber Co.
Burklyn Co.
The Connecticut Hard Rubber Co.
Cook Electric Co.
The Dayton Rubber Mfg. Co.
The Felters Co., Inc.
The B. F. Goodrich Co., Aeronautical Div.
Goodyear Tire & Rubber Co.
Harris Products Co.
Houdaille-Hershey Corp.
Carl Hussman
Lord Manufacturing Co.
The M B Manufacturing Co.
The Manhattan Rubber Mfg. Div. of Raybestos-Manhattan, Inc.
Packless Metal Products Corp.
Perry Aircraft Products Corp.
Seamlex Co., Inc.
Seiberling Rubber Co.

WELDING EQUIPMENT

The Alexander Milburn Co.
Allen Electric & Equipment Co.
Allis-Chalmers Mfg. Co.
Glenn-Roberts Co.
Krembs & Co.
The Lincoln Electric Co.
Sciaky Bros.
Smith Welding Equipment Corp.
Taylor-Winfield Corp.
Thomson-Gibb Electric Welding Co.
Victor Equipment Co.

WHEELS & BRAKES

Air Associates, Inc.
Bendix Products Div., Bendix Aviation Corp.
Firestone Aircraft Co.
General Aircraft Supply Corp.
The B. F. Goodrich Co., Aeronautical Div.
Goodyear Aircraft Corp.
Goodyear Tire & Rubber Co.
Hayes Industries, Inc.
Kelsey Hayes Wheel Co.
Karl Ort
Pacific Aviation Inc.

AVIATION'S NEW RIGHT HAND . . .

Denison Burst Test Stand for determining burst pressures of devices in hydraulic systems.

Denison electric motor driven HydrOILic Test Stand for testing aircraft hydraulic systems using up to 1500 pound pressures. A similar unit, for 3,000 pound pressures, is also available.

Portable Spark Plug Test Unit for subjecting spark plugs to high pressures.

You'll find Denison HydrOILics producing war material in plants all over the country . . . presses assembling critical parts, valves and controls operating important equipment, and test units assuring safe operation. On these pages are eight examples of why HydrOILics has become the Aviation Industry's New Right Hand . . . a better, faster, and more economical way of solving new problems and improving old methods.

HydrOILic Spark Plug Test Stand, for testing aircraft spark plugs in conjunction with an auxiliary aviation ignition tester.

Magneto Test Stand, for testing airplane magnetos at speeds from 50 to 6500 r.p.m. and at various conditions of heat, humidity and altitude.

Denison Aircraft Fuel Transfer Valve, for manual selection of fuel flow from fuel tanks.

THE DENISON ENGINEERING

(Wheels & Brakes) *Continued*
Scott Aviation Corp.
Taylor Manufacturing Co.
The Variety Aircraft Corp.
Wagner Electric Corp.
Warner Aircraft Corp.

MISCELLANEOUS

A T C Company, Inc.
Ace Manufacturing Corp.
Acme Steel Co.
The Acromark Corp.
The Adams Co.
Adhere, Inc.
Advance Spring Corp.
Aero Research Wind Tunnel Co.
Aero Trades Co.
Aeronautical Manufacturing Corp.
Airchox Co., Div. of Joyce Aviation, Inc.
Aircraft Accessories Corp.
Aircraft Accessories Corp. of Mo.
Aircraft Hardware Mfg. Co., Inc.
Aircraft Mechanics, Inc.
Aircraft Production Engineers
Alfin Corp.
All-Weather Springs
Aluminum Co. of America
Aluminum Ladder Co.
American Armament Corp.
American Central Manufacturing Corp.
American Chain & Cable Co., Inc.
American Oil & Supply Co.
Andrews & Perillo, Inc.
Angier Sales Corp.
R. B. Annis Co.
S. Appel & Co., Inc.
Aqua Systems, Inc.
The Aro Equipment Corp.
Atlantic India Rubber Works, Inc.
Automatic Electrical Devices Co.
The Automatic Vise Sales Co.
Avery Adhesives
Avondale Chemical Co.
The B G Corp.
Barrett-Cravins Co.
The Barrett Div., Allied Chemical & Dye Corp.
Bastian Bros. Co.
Bauer & Black, Div. of The Kendall Co.
Beckett Electric Co., Inc.
The Bell Co., Inc.
Bellanca Aircraft Corp.
Blackhawk Mfg. Co.
Bokelmann Trimming Co., Inc.
S. F. Bowser & Co., Inc.
Briggs Manufacturing Co.
The Carlyle Johnson Machine Co.
Charles W. Carll Sons
Chicago Pneumatic Tool Co.
The Cleveland Graphite Bronze Co.
Cleveland Tungsten, Inc.
Collins-Powell Co.
Columbia Stamping & Mfg. Corp.
Commonwealth Industries, Inc.
Connecticut Telephone & Electric Corp.
Continental Screw Co.
Cook Heat Treating Corp.
Chas. E. Crofoot Gear Corp.
Cunningham-Hall Aircraft Corp.
Cyclone Fence Div., American Steel & Wire Co.
The Davison Chemical Corp.
The Dayton Manufacturing Co.
Detroit Rex Products Co.
Ditto, Inc.
Dodge Cork Co., Inc.
The Dole Valve Co.
E. I. duPont de Nemours & Co., Plastics Dept.
Duramold Div. of Fairchild Engine & Airplane Corp.
Eagle Pencil Co.
The Eastern Machine Screw Corp.
Eastman Kodak Co.
Eclipse Air Brush Co. Inc.
The Electric Auto-Lite Co., Bay Mfg. Div.
The Electric Furnace Co.
Electronic Laboratories, Inc.
Essick Manufacturing Co.
Federal Aircraft Works
Firestone Aircraft Co.
Geo. J. Fix Co.
Flotation Systems, Inc.
Foote Bros. Gear & Machine Corp.
Forsyth Metal Goods Co.
The Gaertner Scientific Corp.
General Abrasive Co., Inc.

(Miscellaneous) *Continued*
General Aircraft Equipment, Inc.
The Geometric Tool Co.
John W. Gillette & Co.
The Glidden Co.
Goodyear Tire & Rubber Co.
Granberg Equipment, Inc.
Great Western Steel Co. Inc.
Guardian Electric Manufacturing Co.
Hamilton Machinery Builders, Inc.
Hardman, Peck & Co.
The Harris Calorific Co.
The Hartford Machine Screw Co.
Hill Aircraft Streamliners Co.
The Holo-Krome Screw Corp.
Hoof Products Co.
Hope Webbing Co.
Carl Hussman Engineers
Hyland Machine Co.
The Imperial Brass Manufacturing Co.
Industrial Grinding Co.
Industrial Sound Control
Industrial Wire Cloth Products Corp.
Inglewood Sheet Metal Works
Intercontinent Aircraft Corp.
Interstate Brake Testing Machine Co.
J.V.W. & Co.
Jack & Heintz Inc.
I. Jacoel Cable Splicing Equipment Co.
Jardur Import Co.
Johns-Manville Sales Corp.
The Johnson Rubber Co.
S. C. Johnson & Son, Inc.
Johnson Tool Co., Inc.
Jones Motrola Sales Co.
Justrite Manufacturing Co.
Kennedy Name Plate Co.
Kent-Moore Organization Inc.
Kester Solder Co.
Keystone Tool & Supply Co.
The Knight Screw Products Co.
E. Konigslow Stamping & Tool Co.
Dave Leahy Co.
The H. D. Lee Mercantile Co.
Libbey-Owens-Ford Glass Co.
Link Aviation Devices Inc.
Link-Belt Co.
David Linzer & Sons, Inc.
Lisle Corp.
Listo Pencil Corp.
Lite Mfg. Co.
Littelfuse Inc.
Longines Wittnauer Watch Co.
H. K. Lorentzen, Inc.
Lorenzen Industries
Los Angeles Stamp & Stationery Co.
The Lufkin Rule Co.
The McKay Co.
Macwhyte Co.
The Manhattan Rubber Mfg. Div. of Raybestos-Manhattan, Inc.
Maplewood Machinery Co.
The Marquette Metal Products Co.
Martin-Decker Corp.
The W. L. Maxson Corp.
Mercury Aircraft Inc.
Metal & Thermit Corp.
Metzgar Co.
Molded Insulation Co.
Monite Waterproof Glue Co.
Monmouth Products Co.
Monsanto Chemical Co., Plastics Div.
Northil Co., Inc.
Norton Co.
Ohio Units
Operadio Manufacturing Co.
Karl Ort
Pacific Gear Works of Los Angeles
Packless Metal Products Corp.
Pannier Bros. Stamp Co.
Paragon-Revolute Corp.
Permatex Co., Inc.
Pittsburgh Plate Glass Co.
Plaskon Co., Inc.
Pollak Manufacturing Co.
Precision Products, Inc.
Pressed & Welded Steel Products Co., Inc.
Prestole Div.
R E F Aircraft Corp.
Radio Accessories Mfg. Co.
Reynolds Metals Co.
Richland Auto Parts Co.
Roberts & Mander Stove Co.
H. H. Robertson Co.
Rochester Ropes Inc.
Rocky Mountain Steel Products, Inc.
Rohr Aircraft Corp.
A. W. Rosen & Co.
The Russell Manufacturing Co.
Russell Uniform Co.
Schlegel Mfg. Co.

(Miscellaneous) *Continued*

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Sellstrom Manufacturing Co.
The Sentry Co.
Sigma Instruments, Inc.
Simons Paint Spraying Equipment Co.
Solar Aircraft Co.
The Sparks-Withington Co.
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Standard Aircraft Products, Inc.
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Templeton, Kenly & Co.
Tennessee Aircraft, Inc.
Thiokol Corp.
Tietzmann Engineering Co.
Tingley Reliance Rubber Corp.
Uniform Hood Lace Co.
United Aircraft Products, Inc.
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United States Rubber Co.
Universal Building Products Corp.
Universal Fixture Corp.
The Variety Aircraft Corp.
Veeder-Root, Inc.
The Vellumoid Co.
Verson Allsteel Press Co.
Vidal Research Corp.
Voges Mfg. Co., Inc.
Charles Wagner Litho Machinery Co., Div. of National-Standard Co.
Walker-Turner Co., Inc.
Wallace Engineering Co.
Weems System of Navigation
R. D. Weiner Co., Inc.
The Wellman Bronze & Aluminum Co.
Wesley Lacquer Co.
The Whitney Chain & Mfg. Co.
Willis & Geiger, Inc.
H. A. Wilson Co.
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A

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PRODUCTS: Aircraft armament; Bearings; Cleaners and cleaning compounds; Controls; Filters and strainers; Instruments; Fuel, air and vacuum pumps; Spark plugs.

A & F ALUMINUM PRODUCTS CO., 3421 E. 22nd St., Los Angeles, Calif.
PERSONNEL: R. M. Allan, Pres., Treas. & Gen. Mgr.; C. R. Fleishman, V. Pres. & Secy.; B. R. Sweany, Pur. Agt.
PRODUCTS: Aluminum castings; Fittings; Hydraulic controls and assemblies; Aluminum parts; Sub-assemblies.

A T C CO., INC., 34 E. Logan St., Philadelphia, Pa.
PERSONNEL: G. H. Johanson, Pres.; J. D. Andrews, V. Pres. & Sales Mgr.; H. E. Kenyon, Secy. & Pur. Agt.; H. Huber, Gen. Mgr.; W. W. Winters, Pub. Dir.; I. G. Johanson, Chief Engr.
PRODUCTS: Temperature and time control equipment.

ABRAMS INSTRUMENT CO., 606 E. Shiawassee St., Lansing, Mich.
PERSONNEL: T. Abrams, Owner, W. S. Karr, Gen. Mgr.
PRODUCTS: Cameras; Controls; Instruments; Sub-assemblies.

ABRASIVE MACHINE TOOL CO., Dexter Rd., E. Providence, R. I.
PERSONNEL: N. D. MacLeod, Pres. & Gen. Mgr.; E. S. Brackett, Jr., V. Pres.; M. E. Young, Secy.; C. G. MacLeod, Treas.; W. Sceeles, Sales Mgr.; H. Hulme, Pur. Agt.; H. A. Patenaude, Pers. Dir.; L. E. Marsh, Chief Engr.
PRODUCTS: Machine tools.

ACE MANUFACTURING CORP., 1205 E. Erie Ave., Philadephia, Pa.
PERSONNEL: G. Jones, Pres.; G. M. Jones, V. Pres., Treas. & Gen. Mgr.; A. W. Engel, Secy. & Pur. Agt.; J. W. Kershaw, Pers. Dir. & Pub. Dir.; F. G. Schutz, Chief Engr.
PRODUCTS: Bushings; Misc. engine equipment; Aluminum and steel parts; Stampings; Sub-assemblies; Miscellaneous.

ACME ELECTRIC HEATING CO., 1217 Washington St., Boston, Mass.
PERSONNEL: H. E. Price, Pres., Treas. & Sales Mgr.; G. A. Rice, V. Pres.
PRODUCTS: Heaters.

ACME STAMPING & MFG. CO., 205 Corliss St., Pittsburgh, Pa.
PERSONNEL: C. A. Kays, Pres. & Gen. Mgr.; T. H. Hunter, V. Pres.; H. J. Wilhelm, Secy., Treas. & Pur. Agt.
PRODUCTS: Stampings.

ACME STEEL CO., 2840 Archer Ave., Chicago, Ill.
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PRODUCTS: Packing materials and supplies.

ACME WHITE LEAD & COLOR WORKS 8250 St. Aubin Ave., Detroit, Mich.
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PRODUCTS: Bearings.

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PERSONNEL: B. Winston, Pres.; H. H. Marshman, V. Pres.; C. A. Robinson, Gen. Mgr.; J. S. McCombe, Sales Mgr.; L. A. Wald, Pur. Agt.; E. F. Kohl, Chief Engr.
PRODUCTS: Switches.

ACTUS PRODUCTS CORP., 10-14 N. Bleeker St., Mt. Vernon, N. Y.
PERSONNEL: C. W. Prochaska, Pres.; Gen. Mgr. & Sales Mgr.; H. McCahan, V. Pres. & Pur. Agt.; J. M. Regan, Secy.; H. McCarthy, Treas.
PRODUCTS: Hose clamps and hose fittings; Spark plugs.

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PRODUCTS: Clamps; Tools.

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PRODUCTS: Hose assemblies and fittings.

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PRODUCTS: Misc. hardware.

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PRODUCTS: Spark plugs.

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PRODUCTS: Misc. engine equipment.

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PRODUCTS: Bushings; Forgings; Steel parts; Tools.

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PRODUCTS: Hydraulic controls and assemblies; Pumps; Radios; Transmitters; Piazzo crystals.

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PRODUCTS: Ammunition boxes and counters; Collector rings, cowls, streamlines; Cowlings; De-icer equipment; Engine mounts; Exhaust manifolds; Hose clamps and hose fittings; Manifolds; Tanks.

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PRODUCTS: Bushings; Misc. engine equipment; Studs; Cap screws; Inserts; Bolts, nuts.

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PRODUCTS: Cleaners and cleaning compounds; Control sticks and wheels; De-icer equipment; Hydraulic controls and assemblies; Aluminum and steel parts; Stampings; Sub-assemblies; Tubing.

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PRODUCTS: Tools.

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PERSONNEL: O. A. Sutton, Pres. & Treas.; W. P. Innes, Jr., V. Pres.; P. R. Kitch, Secy.; W. L. Henry, Gen. Mgr. & Sales Mgr.; J. Kuhlmann, Pur. Agt.; J. Ware, Pers. Dir. & Pub. Dir.; C. A. Bradford, Chief Engr.
PRODUCTS: Engine mounts; Exhaust manifolds; Nacelle frames; Landing gears; Tail wheel assemblies; Welded fittings; Tanks.

AIRESEARCH MANUFACTURING CO., 9851 Sepulveda Blvd., Los Angeles, Calif.
PERSONNEL: J. C. Garrett, Pres.; W. C. Brownlee, V. Pres. & Gen. Mgr.; W. C. Whitehead, Secy.; W. D. Morgan, Treas.; R. J. Hostetter, Sales Mgr.; J. B. Meyer, Pur. Agt.; G. D. Bradley, Pers. Dir.; C. W. Reynolds, Pub. Dir.; W. R. Ramsaur, H. E. W. Tinker, Engrs.
PRODUCTS: Cabin superchargers; Misc. engine equipment; Engine cooling systems; Control systems.

AIRSEALAND AIRCRAFT, INC., 25-17 43rd Ave., Long Island City, N. Y.
PERSONNEL: R. Decat, Pres. & Chief Engr.; L. Levez, Secy.; G. Decat, Treas.; G. Becker, Pers. Dir.
PRODUCTS: Instruments; Misc. hardware; Aluminum, magnesium and steel parts; Stampings; Tools; Blind rivet; Blind riveting gun.

AJAX ELECTROTHERMIC CORP., Trenton, N. J.
PERSONNEL: G. H. Clamer, Pres.; R. N. Blakeslee, V. Pres.; F. T. Chesnut, Secy.; A. D. Meyer, Treas.
PRODUCTS: High frequency induction furnaces.

ALADDIN RADIO INDUSTRIES, INC., 501 W. 35th St., Chicago, Ill.
PERSONNEL: V. S. Johnson, Pres.; J. C. McGinley, V. Pres. & Gen. Mgr.; F. N. Jacob, Chief Engr.
PRODUCTS: Radio components.

THE ALBANO CO., INC., 306 E. 47th St., New York, N. Y.
PERSONNEL: P. Albano, Pres. & Treas.; E. Albano, V. Pres. & Secy.
PRODUCTS: Sub-assemblies.

ALFIN CORP., 30 Rockefeller Plaza, New York, N. Y.
PERSONNEL: J. C. Ward, Jr., Pres.; M. F. Markel, D. B. Cox, V. Pres.; W. H. Schwebel, Secy. & Treas.

ALL AMERICAN AIRCRAFT PRODUCTS, INC., 1350 E. Anaheim St., Long Beach, Calif.
PERSONNEL: E. Adler, Pres. & Gen. Mgr.; G. R. Adler, V. Pres.; H. D. Lawrence, Secy.; C. F. Lindquist, Treas.; W. R. Bennet, Sales Mgr.; C. F. Bittel, Pur. Agt.; R. C. Adler, Chief Engr.
PRODUCTS: Bomb racks; Controls; Control sticks and wheels; Cowlings; Exhaust manifolds; Hydraulic controls and assemblies; Manifolds; Aluminum and plywood parts; Seats; Sub-assemblies.

ALL-WEATHER SPRINGS, 140 Cedar St., New York, N. Y.
PERSONNEL: G. Bliss, Gen. Mgr.; J. W. Rockefeller, Jr., Sales Mgr.
PRODUCTS: Misc. engine equipment; Steel parts; Precision instrument springs.

ALLEGHENY LUDLUM STEEL CORP., Oliver Bldg., Pittsburgh, Pa.
PERSONNEL: W. F. Detwiler, Ch.; W. A. Givens, V. Pres.; E. J. Hanley, Secy. & Treas.; R. M. Allen, Sales Mgr.; L. H. Bittner, Pur. Agt.; R. C. Edgar, Pers. Dir.; C. B. Templeton, Pub. Dir.; J. H. Taylor, Chief Engr.
PRODUCTS: Castings and forgings; Electrical, stainless and tool steel; Tubing.

ALLEN ELECTRIC AND EQUIPMENT CO., 2101-29 N. Pitcher St., Kalamazoo, Mich.
PERSONNEL: G. H. Allen, Pres., Gen. Mgr. & Chief Engr.; L. F. Woolman, V. Pres. & Sales Mgr.; M. E. McMartin, Secy.; A. J. Higdon, Treas.; R. H. Aldrich, Pur. Agt.; L. Feltes, Pers. Dir.; K. Fullerton, Pub. Dir.
PRODUCTS: Arc and spot welders; Testing equipment; Misc. engine equipment.

THE ALLEN MANUFACTURING CO., 133 Sheldon St., Hartford, Conn.
PERSONNEL: H. R. Grant, Pres.; E. Dimock, V. Pres.; F. J. Whitney, Secy.; S. K. Dimock, Treas.; J. G. Osmond, Gen. Mgr.; W. C. Waldo, Sales Mgr.; M. C. Uricchio, Pur. Agt.; E. S. Grant, Pers. Dir.; R. W. Bidwell, Pub. Dir.; C. S. Gates, Chief Engr.
PRODUCTS: Hollow screws; Pipe plugs.

ALLIED CONTROL CO., INC., 227 Fulton St., New York, N. Y.
PERSONNEL: E. H. Gillette, Pres. & Treas.; J. F. Ebert, J. M. Coffeen, V. Pres.; H. L. Kircher, Secy.
PRODUCTS: Airport equipment; Controls; Magnetos; Switches; Instruments.

ALLIS-CHALMERS MANUFACTURING CO., Milwaukee, Wisc.
PERSONNEL: W. Geist, Pres.; H. W. Story, J. A. Keogh, L. H. Hill, V. Pres.; E. H. Brown, V. Pres. & Engr.; W. E. Hawkinson, Secy. & Treas.; J. M. White, Works Mgr.; W. C. Johnson, Sales Mgr.; F. E. Haker, Dir. Pur.
PRODUCTS: Tractors; Electronic arc welder; Centrifugal pumps; Rotary vacuum pumps and air compressors; Lubricants; Superchargers.

ALLOYS FOUNDRY, INC., 403 Beacon Bldg., Wichita, Kans.
PERSONNEL: O. A. Sutton, Pres. & Treas.; W. P. Innes, Jr., H. T. Fleeson, V. Pres.; P. R. Kitch, Secy.; W. W. Cunningham, Gen. Mgr., Sales Mgr. & Chief Engr.; E. J. Kuhlmann, Pur. Agt.; J. F. Ware, Pers. Dir. & Pub. Dir.
PRODUCTS: Castings and forgings; Fittings; Misc. hardware.

ALOFS MANUFACTURING CO., 1615 Madison Ave., S. E., Grand Rapids, Mich.
PERSONNEL: H. G. Alofs, Gen. Mgr.; L. Alkema, Pur. Agt.; J. Lindhout, Pers. Dir.
PRODUCTS: Steel parts; Stampings.

ALPHA METAL & ROLLING MILLS, INC., 363 Hudson Ave., Brooklyn, N. Y.
PERSONNEL: I. I. Shonberg, Pres.; H. Shonberg, V. Pres.; H. Drapkin, Secy.
PRODUCTS: Gaskets; Lead parts.

ALUMINUM COMPANY OF AMERICA, 801 Gulf Bldg., Pittsburgh, Pa.
PERSONNEL: K. F. Thornton, Aviation Dept.
PRODUCTS: Basic materials and fabrications; Castings and forgings; Fittings; Aluminum parts; Stampings; Tanks; Tubing; Extruded shapes; Rivets; Welding materials.

ALUMINUM INDUSTRIES, INC., 2416-38 Beekman St., Cincinnati, O.
PERSONNEL: J. Eckerle, Pres.; H. J. Hater, V. Pres. & Gen. Mgr.; R. T. Mesker, Secy.; E. F. Eckerle, Pur. Agt.; J. H. Cuni, Pers. Dir.; B. V. Keller, Pub. Dir.; M. A. Beckmann, Chief Engr.
PRODUCTS: Castings; Paints, varnishes and finishes; Aluminum, magnesium and steel parts; Engine valves and valve parts.

ALUMINUM LADDER CO., Worthington, Pa.
PERSONNEL: S. H. Carbis, Pres. & Gen. Mgr.; E. A. McCarthy, Secy.; J. G. Campbell, Treas.; D. D. Cramer, Pur. Agt.
PRODUCTS: Aluminum and magnesium parts; Miscellaneous.

AMERICAN AIR FILTER CO., INC., 215 Central Ave., Louisville, Ky.
PERSONNEL: W. M. Reed, Pres.; H. C. Murphy, V. Pres.; B. J. Shayer, Treas.; J. Hellstrom, Gen. Mgr.; G. W. Sonntag, Sales Mgr.; L. Greenebaum, Pur. Agt.; B. A. Taylor, Pers, Dir.; J. R. McConnell, Pub. Dir.; C. P. Hegan, Chief Engr.
PRODUCTS: Air cleaners and filters.

AMERICAN AIRPORT EQUIPMENT CO., 5958-60 Washington Blvd., Chicago, Ill.
PERSONNEL: G. F. Kelly, Owner.
PRODUCTS: Cones; Wind boundary marker; Engine overhaul stands; Electric signs; Wind direction indicators.

AMERICAN ALUMINUM WARE CO., 368 Jelliff Ave., Newark, N. J.
PERSONNEL: H. Brucker, Pres.; J. B. Klausmann, V. Pres., Treas. & Sales Mgr.; F. T. Blackely, Secy. & Pur. Agt.; M. H. Klausmann, H. J. Brucker, Engineers.
PRODUCTS: Aluminum clamps, panels, spinners and parts; Cylinder deflectors, baffles, brackets; Radio and ignition shielding; Stampings; Sub-assemblies.

AMERICAN ARMAMENT CORP., 6 E. 45th St., New York, N. Y.
PERSONNEL: A. J. Miranda, Jr., Pres.; W. A. Smith, V. Pres.; I. J. Miranda, V. Pres. & Treas.; F. W. Zelcer, V. Pres. & Sales Mgr.; D. H. Deppen, Secy.; J. Z. Kaplan, Pur. Agt.; J. J. McGann, Pers. Dir.; J. L. Mott, Pub. Dir.; W. S. Haines, Chief Engr.
PRODUCTS: Aircraft armament; Ammunition boxes and counters; Fittings; Aluminum and steel parts; Miscellaneous.

THE AMERICAN AUTO PARTS CO., 919 Bonham Ave., Columbus, O.
PERSONNEL: L. Lewis, Pres.; L. B. Keyser, V. Pres.; W. T. Lewis, Secy., Gen. Mgr., Sales Mgr. & Pur. Agt.; O. L. Gibson, Treas.
PRODUCTS: Bushings; Engine valves and valve parts.

AMERICAN BOSCH CORP., 3664 Main St., Springfield, Mass.
PERSONNEL: D. P. Hess, Pres.; F. N. Perry, E. H. Moll, V. Pres.; R. A. Wickes, Secy. & Treas.; W. T. Barton, Pur. Agt.; A. B. Howe, Pers. Dir.; G. W. Carlson, Pub. Dir.; B. Loeffler, Chief Engr.; T. J. Kiely, Mgr. Aviation Field Engrg.
PRODUCTS: Magnetos; Misc. electrical equipment; Fuel injection equipment.

AMERICAN CENTRAL MANUFACTURING CORP., Connersville, Ind.
PERSONNEL: S. P. Jones, Pres.; E. O. Johnson, N. C. Ferreri, V. Pres.; E. G. Meldrum, Secy.; E. C. Wilkinson, Sales Mgr.; E. G. Husselman, Pur. Agt.; J. Hendrickson, Pub. Dir.; W. L. Foskett, Chief Engr.
PRODUCTS: Bomb racks; Collector rings, cowls; Cowlings; Exhaust manifolds; Filters and strainers; Panels; Stampings; Sub-assemblies; Bombay doors.

AMERICAN CHAIN & CABLE CO., INC., Bridgeport, Conn.
PERSONNEL: W. T. Morris, Pres.; W. F. Wheeler, Exec. V. Pres. & Treas.; G. C. Moon, C. N. Johns, W. D. Kirkpatrick, V. Pres.; D. Fleming, Pur. Agt.; J. O. Lashar, Adv. Mgr.; E. V. Creagh, Sales Mgr.
PRODUCTS: Fence; Service station equipment; Cable controls and assemblies; Cable terminals and fittings; Abrasive cutting machines; Nibbling machines; Welded and weldless chain; Wire rope; Cotter pins; Welding wire; Electrodes; Hoists, trolleys and cranes.

AMERICAN CORD & WEBBING CO., INC., 374 Broadway, New York, N. Y.
PERSONNEL: M. Krauss, Pres.; J. Krauss, V. Pres.; E. Krauss, Secy.; M. Krauss, Treas.; J. L. Bamberger, Sales Mgr.
PRODUCTS: Webbing; Web straps; Tapes.

AMERICAN FOUNDRY & FURNACE CO., Bloomington, Ill.
PERSONNEL: H. A. Soper, Pres., Gen. Mgr. & Sales Mgr.; L. G. Whitmer, V. Pres. & Treas.; R. P. Whitmer, Secy.; E. L. Fox, Pur. Agt.; W. J. Klingberg, Chief Engr.
PRODUCTS: Heaters; Ventilating and air conditioning equipment; Dampers; Fans.

AMERICAN FOUNDRY EQUIPMENT CO., 301 S. Byrkit St., Mishawaka, Ind.
PERSONNEL: O. A. Pfaff, Pres. & Gen. Mgr.; L. L. Andrus, V. Pres. & Sales Mgr.; H. M. Miller, Secy. & Treas.; H. O. Books, Pur. Agt.; A. E. Lenhard, Pub. Dir.; D. C. Turnbull, Chief Engr.
PRODUCTS: Cleaners and cleaning compounds; Machine tools; Ventilating and air conditioning equipment.

AMERICAN GAS ACCUMULATOR CO., 1029 Newark Ave., Elizabeth, N. J.
PERSONNEL: L. M. Merrill, Pres.; J. B. Rhodes, V. Pres.; W. F. Burk, Secy. & Treas.; I. J. Mack, Gen. Mgr.; R. E. Joubert, Pur. Agt.; V. L. Oestnaes, Chief Engr.
PRODUCTS: Beacons; Floodlights.

AMERICAN HAIR & FELT CO., Merchandise Mart, Chicago, Ill.
PERSONNEL: N. S. McKay, Pres. & Treas.; L. C. Scott, V. Pres.; M. A. Kemper, Secy.; C. H. Rayner, Gen. Mgr.; W. J. Berry, Sales Mgr.; W. A. Busch, Pur. Agt.; R. A. Phelps, Pub. Dir.; R. S. Phillips, Chief Engr.
PRODUCTS: Insulating materials.

AMERICAN HAMMERED PISTON RING DIV. KOPPERS CO., Baltimore, Md.
PERSONNEL: P. Williams, Pres.; A. W. Morton, V. Pres. & Gen. Mgr.; J. A. Worthington, Sales Mgr.; L. Palmer, Pur. Agt.; E. B. Whitman, Pers. Dir.; T. L. Ford, Pub. Dir.; E. Stead, Chief Engr.
PRODUCTS: Oil seals; Piston and sealing rings.

AMERICAN HARD RUBBER CO., 11 Mercer St., New York, N. Y.
PERSONNEL: F. D. Hendrickson, Pres.; A. V. Bristol, V. Pres. & Treas.; G. B. Glaenzer, Sales Mgr.; A. P. House, Pur. Agt.; O. B. Carson, Pub. Dir.; S. P. Fisher, Chief Engr.
PRODUCTS: Control sticks and wheels.

AMERICAN INSTRUMENT CO., 8030-8040 Georgia Ave., Silver Spring, Md.
PERSONNEL: L. Freeman, Pur. Agt.; W. H. Reynolds, Chief Engr.; C. L. Schuettler, Sales Mgr. & Pub. Dir.
PRODUCTS: Heaters.

AMERICAN-LAFRANCE-FOAMITE CORP., Elmira, N. Y.
PERSONNEL: E. E. O'Neill, Pres.; C. F. Smith, V. Pres.; C. A. Pettyjohn, Secy. & Treas.; J. O. Binford, Sales Mgr.; F. R. Baker, Pur. Agt.; L. C. Hogg, Pers. Dir.; C. H. Lindsay, Chief Engr.
PRODUCTS: Fire extinguishers.

AMERICAN MACHINE & METALS, INC., East Moline, Ill.
PERSONNEL: P. G. Mumford, Pres.; J. C. Vander Pyl, V. Pres. & Gen. Mgr.; H. T. McMeekin, Secy. & Treas.; W. Mendell, Sales Mgr.; S. H. Dekker, Pur. Agt.; J. Swennumson, Pers. Dir.; R. W. Denman, Pub. Dir.; T. A. Bryson, Chief Engr.
PRODUCTS: Ventilating and air conditioning equipment; Testing machines.

AMERICAN MAGNESIUM CORP.,
2210 Harvard Ave., Cleveland, O.
PERSONNEL: W. Brown, V. Pres. & Gen. Mgr.; W. G. Harvey, Sales Mgr.
PRODUCTS: Basic materials and fabrications; Castings and forgings; Magnesium parts; Stampings; Sub-assemblies; Tanks; Tubing; Magnesium extruded shapes.

AMERICAN NICKELOID CO., Peru, Ill.
PERSONNEL: F. M. Maze, Pres.; C. C. Struever, V. Pres. & Gen. Mgr.; J. Maze, Secy.; H. Maze, Treas.; C. B. Meng, Pur. Agt.
PRODUCTS: Pre-plated metals.

AMERICAN OIL & SUPPLY CO.,
238 Wilson Ave., Newark, N. J.
PERSONNEL: W. Ulrich, Pres.; H. A. Dwyer, V. Pres. & Secy.; E. F. Hoffmann, V. Pres. & Treas.; L. W. Schreihofer, Sales Mgr.; W. M. Hoffmann, Pur. Agt.
PRODUCTS: Rust proofing and protective compounds.

AMERICAN PAULIN SYSTEM,
1847 S. Flower St., Los Angeles, Calif.
PERSONNEL: A. F. Munter, Pres. & Gen. Mgr.; H. A. Munter, V. Pres.; C. J. Petrovich, Secy. & Treas.; E. G. Larson, Chief Engr.
PRODUCTS: Instruments.

AMERICAN PHENOLIC CORP.,
1830 S. 54th Ave., Chicago, Ill.
PERSONNEL: A. J. Schmitt, Pres. & Gen. Mgr.; D. Alexander, V. Pres., C. V. Wisner, Secy.; A. Dushek, Treas.; W. Rous, Sales Mgr.; E. G. Johnson, Pur. Agt.; M. A. Donlon, Pers. Dir.; C. Quackenbush, Chief Engr.
PRODUCTS: Clamps; Misc. electrical equipment; Insulating materials; Plastic and synthetic parts; Radio and ignition shielding.

AMERICAN PROPELLER CORP., Toledo, O.
PERSONNEL: W. F. Wise, Pres.; E. R. Isbell, Asst. to Pres.; I. J. Snader, V. Pres.-Mfg.; W. A. Mogensen, V. Pres. & Treas.; W. N. Wood, Plant Mgr.; R. J. Cowden, Contract & Service Engr.; D. T. Waltz, Pur. Agt.; W. R. Hanna, Pers. Mgr.; D. R. Woolf, Chief Engr.
PRODUCTS: One-piece hollow steel propeller blades.

AMERICAN ROOF TRUSS CO.,
6850 Stony Island Ave., Chicago, Ill.
PERSONNEL: W. H. Waddington, Pres. & Treas.; T. Bensen, V. Pres.; E. F. Waddington, Secy.; W. H. Waddington, Jr., Gen. Mgr.; R. J. Waddington, Sales Mgr.; M. R. Brosius, Pur. Agt.; R. Weber, Pub. Dir.; W. A. Reinert, Chief Engr.
PRODUCTS: Hangar and roof trusses.

AMERICAN SCREW CO.,
21 Stevens St., Providence, R. I.
PERSONNEL: P. C. Nicholson, Pres.; E. E. Clark, V. Pres. & Gen. Mgr.; J. F. Doherty, Secy.; E. W. Lane, Treas.; D. O. Drayton, Sales Mgr.; W. A. Smedley, Pur. Agt.; J. A. Beauregard, Pers. Dir.; H. Mayoh, Pub. Dir.; F. E. Brown, Chief Engr.
PRODUCTS: Fasteners.

AMERICAN SCREW PRODUCTS,
7000 Avalon Blvd., Los Angeles, Calif.
PERSONNEL: A. Deutsch, Pres.; M. Dalton, V. Pres.; I. Raftes, Secy.; R. Rosenow, Gen. Mgr.; R. Cumins, Sales Mgr.; F. Solantay, Pur. Agt.; E. Hart, Pers. Dir.; L. Deutsch, Pub. Dir.; H. Lenz, Chief Engr.
PRODUCTS: Bushings; Fittings; Aluminum and steel parts.

AMERICAN TUBE BENDING CO., INC.,
5 Lawrence St., New Haven, Conn.
PERSONNEL: H. W. Jones, Jr., Pres.; B. Smith, V. Pres.; F. B. Kingsbury, Sales Mgr.; A. F. Cewe, Pur. Agt.; E. Helwig, Chief Engr.
PRODUCTS: Control sticks and wheels; Engine mounts; Exhaust manifolds; Manifolds; Misc. engine equipment; Radio and ignition shielding.

AMPCO METAL, INC.,
1745 S. 38th St., Milwaukee, Wisc.
PERSONNEL: C. J. Zaiser, Pres. & Gen. Mgr.; R. Kunz, V. Pres.; R. W. Uecker, Secy. & Treas.; J. D. Zaiser, Sales Mgr.; C. Dawley, Pur. Agt.; J. McCormick, Pers. Dir.; G. S. Hamilton, Pub. Dir.; O. Frohman, Chief Engr.
PRODUCTS: Bronze bearings, bushings, castings, forgings and parts.

ANDREWS & PERILLO, INC., 39-30 Crescent St., Long Island City, N. Y.
PERSONNEL: F. J. Perillo, Pres., Treas. & Chief Engr.; L. Peirez, Secy.; B. Peirez, Gen. Mgr. & Pur. Agt.; M. Wagner, Pub. Dir.
PRODUCTS: Stampings; Tools; Training equipment.

ANEMOSTAT CORP. OF AMERICA,
10 E. 39th St., New York, N. Y.
PERSONNEL: A. Rust-Oppenheim, Pres.; F. J. Kurth, V. Pres.; J. C. Anderer, Treas.; J. B. Hewett, Sales Mgr.; F. Honerkamp, Chief Engr.
PRODUCTS: Ventilating and air conditioning equipment.

ANGELUS STEEL TREATING CO.,
2229 E. 38th St., Los Angeles, Calif.
PERSONNEL: C. O. Thrasher, Pres.; S. R. Earl, V. Pres.; J. R. Cerato, Secy.
PRODUCTS: Bushings; Castings and forgings; Landing gears; Machine tools; Aluminum and steel parts.

ANGIER SALES CORP., Framingham, Mass.
PERSONNEL: O. Angier, Pres.; A. J. Thiel, V. Pres. & Sales Mgr.; J. M. Angier, Treas.; P. Bowker, Pur. Agt.; N. W. Forrest, Pub. Dir.; E. R. Dearborn, Chief Engr.
PRODUCTS: Miscellaneous.

R. B. ANNIS CO.,
1101 N. Delaware St., Indianapolis, Ind.
PERSONNEL: R. B. Annis, Chief Engr.
PRODUCTS: Misc. electrical equipment; Instruments; Demagnetizers; Etchers; Dynamic balancing machines.

THE APEX MACHINE & TOOL CO.,
1025 S. Patterson Blvd., Dayton, O.
PERSONNEL: C. A. Lange, Pres. & Gen. Mgr.; W. Frank, V. Pres.; E. S. Newlin, Secy. & Treas.; P. R. Baker, Sales Mgr.; H. Fischer, Pur. Agt.; J. Lange, Pers. Dir.; R. V. Huffman, Chief Engr.
PRODUCTS: Controls.

THE APEX TOOL CO., INC.,
325 Cherry St., Bridgeport, Conn.
PERSONNEL: S. W. Swanson, Pres. & Treas.; S. Swanson, V. Pres.; D. Swanson, Secy.; A. W. Anderson, Pur. Agt.; J. Coppola, Chief Engr.
PRODUCTS: Aluminum, magnesium and steel parts; Sub-assemblies; Tools; Engine valves and valve parts.

S. APPEL & COMPANY, INC.,
18 Fulton St , New York, N. Y.
PERSONNEL: G. I. Appel, Pres.; E. M. Bernstein, Secy.; H. Honeystein, Treas.
PRODUCTS: Uniforms.

APPLETON ELECTRIC CO.,
1701 Wellington Ave., Chicago, Ill.
PERSONNEL: A. I. Appleton, Pres. & Treas.; Arthur I. Appleton, H. Schlobaum, V. Pres.; M. J. Whitfield, V. Pres. & Sales Mgr.; J. V. Painter, Secy.; W. A. Robertson, Pur. Agt.; C. A. Bloom, Pub. Dir.; N. Tornblom, Chief Engr.
PRODUCTS: Disconnect plugs; Misc. electrical equipment.

AQUA SYSTEMS INC.,
385 Gerard Ave., New York, N. Y.
PERSONNEL: E. L. Greene, Pres.; W. J. Peter, V. Pres.-Engrg.; A. C. Kaestner, V. Pres.-Sales & Secy.; H. W. Ballantine, Treas.; H. B. Stewart, Pur. Agt.
PRODUCTS: Gasoline storage and dispensing systems.

ARCH ROOF CONSTRUCTION CO., INC.,
55 West 42nd St., New York, N. Y.
PRODUCTS: Hangars.

ARENS CONTROLS, INC.,
2253 S. Halsted St., Chicago, Ill.
PERSONNEL: C. A. Arens, Pres. & Treas.; C. Norton, V. Pres., Secy., Gen. Mgr. & Sales Mgr.; A. Lundgren, Pur. Agt.; R. T. Borcherdt, Pers. Dir. & Plant Mgr.; R. H. Frost, Chief Engr.
PRODUCTS: Controls.

ARMSTRONG BROS. TOOL CO.,
317-357 N. Francisco Ave., Chicago, Ill.
PRODUCTS: Clamps; Tools.

ARMSTRONG CORK CO., Lancaster, Pa.
PERSONNEL: H. W. Prentis, Jr., Pres.; F. L. Suter, V. Pres.; C. D. Armstrong, Secy.; K. Powlison, Treas.; J. J. Fitzpatrick, Gen. Mgr., Munitions Div.; F. E. Stevens, Gen. Mgr., Industrial Div.; W. B. Tucker, Sales Mgr., Industrial Div.; V. R. Despard, Jr., Mgr., Aircraft Dept.; R. A. Barton, Pur. Agt.; J. J. Evans, Jr., Pers. Dir.; W. D. Shilling, Pub. Dir.; C. F. Hawker, Chief Engr.
PRODUCTS: Gaskets; Insulating materials; Oil seals; Aluminum, cork, felt, fibre, rubber and synthetic parts; Wing tips; Tail surfaces; Fuselage sections.

THE ARO EQUIPMENT CORP., Bryan, O.
PERSONNEL: J. C. Markey, Pres.; J. E. Allen, Asst. to Pres.; J. P. Johnson, V. Pres.; E. G. Davies, Secy.; L. L. Hawk, Treas.; C. H. Rice, Pur. Agt.; C. W. Ginter, Works Mgr.
PRODUCTS: De-icer equipment; Hydraulic controls and assemblies; Industrial pneumatic tools; Propellers and propeller parts; Pumps; Lubricating equipment.

ARROW BRASS FOUNDRY,
733 New High St., Los Angeles, Calif.
PERSONNEL: D. E. Gilbert, Owner; E. F. Snowden, Supt. & Pur. Agt.
PRODUCTS: Brass and bronze castings.

ARROWHEAD RUBBER CO.,
2244 E. 37th St., Vernon, Calif.
PERSONNEL: H. Franklin, Pres. & Gen. Mgr.; L. W. Winship, V. Pres.; D. Proud, Secy. & Treas.; A. Barth, Sales Mgr.; E. See, Pur. Agt.; H. Davis, Pers. Dir.; V. Nechke, Chief Engr.
PRODUCTS: Oil seals; Rubber parts; Vibration dampers.

ART CHROME CO. OF AMERICA,
141 Malden St., Boston, Mass.
PERSONNEL: E. Reiss, Pres. & Gen. Mgr.; A. Reiss, V. Pres. & Sales Mgr.
PRODUCTS: Seats.

ARTER GRINDING MACHINE CO.
15 Sagamore Rd., Worcester, Mass.
PERSONNEL: W. A. Arter, Pres.; H. Arter, V. Pres. & Treas.; H. Tattersall, Secy. & Pur. Agt.; A. B. O'Donnell, Sales Mgr.; W. F. Fraser, Chief Engr.
PRODUCTS: Machine tools.

ASSOCIATED FOUNDRIES & MANUFACTURERS, INC., 503-507 W. 56th St., New York, N. Y.
PERSONNEL: J. L. Hutchinson, Pres.; A. I. Berger, V. Pres. & Chief Engr.
PRODUCTS: Ammunition boxes and counters; Bushings; Fittings; Flares; Floats, skiis; Hydraulic controls and assemblies; Aluminum, magnesium, plastic and steel parts; Primers; Shock struts and cord; Stampings; Sub-assemblies; Tanks; Control valves.

ASSOCIATED RUBBER PRODUCTS CO.,
1219 Springfield Ave., Irvington, N. J.
PERSONNEL: A. N. Shea, Pres. & Sales Mgr.; J. A. Guthrie, Secy. & Pur. Agt.; A. R. Berman, Gen. Mgr. & Chief Engr.
PRODUCTS: Bushings; Engine mounts; Gaskets; Oil seals; Rubber and synthetic parts; Vibration dampers.

ASTRA ENGINEERING CO.,
911 Raymond Lane, S. Pasadena, Calif.
PERSONNEL: W. Griffith, Owner, Gen. Mgr. & Chief Engr.
PRODUCTS: Precision tools.

E. C. ATKINS & CO.,
402 S. Illinois St., Indianapolis, Ind.
PERSONNEL: H. C. Atkins, Pres. & Gen. Mgr.; E. C. Atkins, W. A. Atkins, V. Pres.; K. W. Atkins, V. Pres. Sales; D. H. Potter, Secy. & Treas.; G. W. Dunnington, R. F. Ellis, Sales Mgrs.; F. McCormick, Chief Engr.
PRODUCTS: Band and circular saws; Hacksaw blades and frames; Files; Grinding wheels; Machine knives; Armor plate.

ATLANTIC DIESEL CORP.,
Sandford St. & Jersey Ave., New Brunswick, N. J.
PERSONNEL: J. S. Johnson, Pres. & Gen. Mgr.; J. G. McCarthy, V. Pres. & Sales Mgr.; K. Perry, Secy.; F. A. Cosgrove, Treas.; F. Mather, Pur. Agt.; A. H. Merritt, Pers. Dir.; C. B. Kirkham, Chief Engr.
PRODUCTS: Hydraulic controls and assemblies; Landing gears; Aluminum, magnesium and steel parts; Piston rings; Propellers and propeller parts; Sub-assemblies; Control valves.

ATLANTIC INDIA RUBBER WORKS, INC.,
1453 W. Van Buren St., Chicago, Ill.
PERSONNEL: C. O. Moore, Pres.; R. V. Kline, V. Pres.; M. E. Moore, Treas.; O. Kayser, Office Mgr.; S. R. Flett, Sales Mgr.; W. G. Linard, Pur. Agt., Pers. Dir. & Pub. Dir.; D. B. Tipton, Chief Engr.
PRODUCTS: Rubber and synthetic rubber parts.

THE ATLANTIC REFINING CO.,
260 S. Broad St., Philadelphia, Pa.
PERSONNEL: R. H. Colley, Pres.; W. D. Anderson, E. J. Henry, A. A. Garrabrant, V. Pres.; W. M. O'Connor, V. Pres. & Secy.; W. C. Yeager, V. Pres. & Sales Mgr.; P. Shuman, Treas.; J. S. Parks, Pur. Agt.; H. W. Jones, Pers. Dir.; R. Rollins, Pub. Dir.; L. M. Goldsmith, Chief Engr.
PRODUCTS: Fuels and lubricants.

ATLAS DROP FORGE CO., Lansing, Mich.
PERSONNEL: R. H. Scott, Pres. & Gen. Mgr.; J. W. Hubbard, V. Pres.; L. G. Reutter, Secy.; E. L. Cooley, Treas.; N. R. Buckingham, Sales Mgr. & Chief Engr.; A. O. Peterson, Pur. Agt.; F. H. Rowden, Pers. Dir.
PRODUCTS: Forgings.

ATLAS PRESS CO., Kalamazoo, Mich.
PERSONNEL: J. H. Penniman, Pres. & Gen. Mgr.; G. C. Nancarrow, V. Pres. & Sales Mgr.; A. R. Eichelberg, Secy. & Treas.; J. G. Collins, Pers. Dir.; H. J. Steele, Pur. Agt.; H. G. Dykhouse, Pub. Dir.; H. M. Musselman, Chief Engr.
PRODUCTS: Machine tools.

AULT & WIBORG CORP.,
75 Varick St., New York, N. Y.
PERSONNEL: J. R. Esposito, Pres.; J. G. Morris, Exec. V. Pres.; M. W. Frishkorn, V. Pres.; W. W. Wright, Secy.; H. A. Dunne, Treas.; W. H. Dernell, Sales Mgr., Aeronautical Div.; G. Welp, Pub. Dir.
PRODUCTS: Paints, varnishes and finishes; Cable lacquers for aircraft wiring systems.

THE M. B. AUSTIN CO.,
108-116 S. Desplaines St., Chicago, Ill.
PERSONNEL: M. B. Austin, Jr., Pres.; W. W. Kingsbury, V. Pres.; L. J. Peckham, Secy.; A. H. Friend, Treas. & Sales Mgr.; R. E. Van Natta, Pur. Agt.; T. Heether, Chief Engr.
PRODUCTS: Clamps; Terminals; Misc. electrical equipment; Bolt locking plates.

AUTOMATIC ELECTRIC CO.,
1033 W. Van Buren St., Chicago, Ill.
PERSONNEL: P. W. Conrad, Pres.; C. S. Cadwell, Sales Mgr.; K. W. Graybill, Chief Engr.
PRODUCTS: Controls; Relays; Stepping switches; Solenoids; Condensers; Resistors; Cords; Connecting plugs and jacks; Radios and radio equipment.

AUTOMATIC ELECTRICAL DEVICES CO.,
324 E. Third St., Cincinnati, O.
PERSONNEL: C. E. Ogden, Pres., Treas., Gen. Mgr.; Sales Mgr. & Pub. Dir.; H. F. Smith, V. Pres. & Chief Engr.; A. H. Ewald, Secy.; W. H. Hirschire, Pur. Agt.
PRODUCTS: Ammunition boxes and counters; Auxiliary power plants; Basic materials and fabrications; Battery chargers; Cleaners and cleaning compounds; De-icer equipment; Misc. electrical equipment; First aid equipment; Gaskets; Landing and navigation lights; Cork, felt, fibre, and steel parts; Sub-assemblies; Special tools, Ventilating and air conditioning equipment; Miscellaneous.

THE AUTOMATIC VISE SALES CO.,
2845 Sunset Pl., Los Angeles, Calif.
PERSONNEL: R. C. Andrus, Pres. & Gen. Mgr.
PRODUCTS: Airport equipment; Tools; Automatic bench vise.

AUTOMOTIVE RUBBER CO.,
8601 Epworth Blvd., Detroit, Mich.
PERSONNEL: R. L. Redmond, Pres.; T. G. Meulenberg, Gen. Mgr.; F. Kurt, Sales Mgr.; F. D. Wressell, Pur. Agt.
PRODUCTS: Clamps; Hose clamps and hose fittings; Aluminum, felt, fibre, rubber and synthetic parts; Stampings.

AVERY ADHESIVES,
451-453 E. Third St., Los Angeles, Calif.
PERSONNEL: R. S. Avery, Gen. Mgr.; M. McDougal, Sales Mgr.; R. W. Morris, Pur. Agt.; C. Stentz, Chief Engr.
PRODUCTS: Removable labels.

THE AVEY DRILLING MACHINE CO.,
25 E. Third St., Covington, Ky.
PERSONNEL: L. B. Patterson, Pres.; D. A. Patterson, Secy.; G. K. McKee, Gen. Mgr.; J. E. Shriver, Sales Mgr.
PRODUCTS: Machine tools.

AVONDALE CHEMICAL CO.,
1030 N. Cleveland Ave., Chicago, Ill.
PERSONNEL: H. N. Limback, Pres. & Pur. Agt.; P. Kania, Gen. Mgr.
PRODUCTS: Insulating materials; Paints, varnishes and finishes; Adhesives.

AXELSON MANUFACTURING CO.,
P. O. Box 98, Vernon Station, os Angeles, Calif.
PERSONNEL: J. C. Axelson, Pres. & Gen. Mgr.; D. F. Axelson, V. Pres. & Pub. Dir.; L. E. Hogsett, Secy.; E. E. Kerfoot, Treas.; A. T. Jenkins, Pur. Agt.; C. D. Sills, Pers. Dir.; E. W. Ostrom, Chief Engr.
PRODUCTS: Landing gears; Machine tools; Shock struts and cord.

EDWARD F. AYMOND CO.,
3750 Urban Ave., Dallas, Tex.
PERSONNEL: E. F. Aymond, Owner.
PRODUCTS: Disconnect plugs; Insulating materials; Misc. hardware; Fibre, plastic and synthetic parts; Stampings; Tubing.

B

THE B G CORP.,
136 W. 52nd St., New York, N. Y.
PRODUCTS: Spark plugs, elbows and terminal sleeves; Spark plug service and test equipment; Ignition harnesses; Ignition harness test equipment.

B. H. AIRCRAFT CO., 27-01 Bridge Plaza North, Long Island City, N. Y.
PRODUCTS: Cowls; Wing tip floats; Manifolds; Collector Rings; Tanks; Engine mounts; Collapsible oars; Life raft pumps; Smoke grenade clamps; Propeller cuffs.

SEMON BACHE & CO.,
636 Greenwich St., New York, N. Y.
PERSONNEL: J. Dreyfuss, Pres.; D. Hirsch, V. Pres.; R. M. Dreyfuss, Secy.; E. O. Salman, Treas.; M. Mariani, Gen. Mgr.; B. Newton, Sales Mgr. & Pub. Dir.; M. S. Goodman, Pur. Agt.; H. DelTosto, Pers. Dir.; E. Avalone, Chief Engr.
PRODUCTS: Glass; Lens; Mirrors.

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AIRCRAFT PLYWOOD

(PRODUCTION-RESEARCH)

HASKELITE PLYMOLD

Plymold is a new technique in the mass production of molded plywood. Wood veneers are laminated over easily fabricated dies, in small sizes or in sections as large as a bomber fuselage. To meet stress requirements, thickness variations can be accurately molded into any section —ribs or other reinforcing members may be incorporated as an integral part of the structure in a single molding operation. Haskelite's Plymolding capacity is the largest in the United States.

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The Haskelite used in today's planes is a functional product—produced to conform to specifications and perform as the plane designer demands. Since World War I, when Haskelite was a prime source of aircraft plywood, engineering research has created new uses for Haskelite materials by constantly improving their quality and uniformity.

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To provide extra strength at the areas of concentrated stress in wood planes, such as points where fastenings are made, compressed Walnut Bearing Blocks have been developed by Haskelite. They are more easily machined and glued than other denser materials serving the same purpose. (Where still higher strength is required, Haskelite Compressed and Impregnated wood is specified).

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HASKELITE MANUFACTURING CORPORATION

Grand Rapids, Mich.
Chicago, Ill. · New York, N. Y. · Detroit, Mich.

BACKSTAY WELT CO., Union City, Ind.
PRODUCTS: Basic materials and fabrications; Felt, leather and rubber parts.

BACON VULCANIZER MFG. CO., 1267-67th St., Oakland, Calif.
PERSONNEL: T. P. Bacon, Sr., Pres. & Gen. Mgr.; T. P. Bacon, Jr., V. Pres. & Chief Engr.; P. P. Marion, Secy., Treas. & Sales Mgr.; A. Fassero, Pur. Agt.
PRODUCTS: Tires and tubes.

THE BAIRD MACHINE CO., Bridgeport, Conn.
PERSONNEL: L. A. Warner, Pres., Treas. & Gen. Mgr.; B. C. Warner, V. Pres.; A. J. Lewis, Sr., Secy. & Chief Engr.; A. Pott, Sales Mgr.; J. E. Reynolds, Pur. Agt.
PRODUCTS: Machine tools.

BAKER & CO., INC. 113 Astor St., Newark, N. J.
PERSONNEL: C. Engelhard, Pres., Treas. & Gen. Mgr.; A. M. Williams, V. Pres.; K. Huber, Secy.; D. P. FitzGerald, Pur. Agt.
PRODUCTS: Electrical contact material.

BAKER INDUSTRIAL TRUCK DIV. THE BAKER-RAULANG CO., 2149, West 25th St., Cleveland, O.
PERSONNEL: E. J. Bartlett, Pres. & Gen. Mgr.; E. J. Stahl, V. Pres.; J. W. Moran, Secy. & Treas.; D. L. Darnell, Sales Mgr.; E. W. Sankey, Pur. Agt.; W. F. Parsons, Pers. Dir.; M. W. McMillan, Pub. Dir.; B. F. Stoner, Chief Engr.
PRODUCTS: Cranes; Trucks; Tractors.

BAKER STEEL & TUBE CO., 955 S. Alameda St., Los Angeles, Calif.
PERSONNEL: R. Mulholland, Pres.; M. J. Baker, V. Pres.; W. F. Fahs, Secy. & Treas.; J. P. Boore, Gen. Mgr. & Sales Mgr.
PRODUCTS: Chrome molybdenum and low carbon steel tubing.

BAKEWELL MANUFACTURING CO., 2023 Santa Fe Ave., Los Angeles, Calif.
PERSONNEL: H. F. Bakewell, Owner & Gen. Mgr.; N. C. Nourse, Sales Mgr.; J. Kuhn, Pur. Agt.; L. McKenzie, Pers. Dir.; R. S. Arnold, Pub. Dir.; J. Goodwin, Chief Engr.
PRODUCTS: Machine tools.

BALDOR ELECTRIC CO., 4351-69 Duncan Ave., St. Louis, Mo.
PERSONNEL: E. Ballman, Pres., Gen. Mgr. & Chief Engr.; F. B. Rogers, V. Pres.; O. A. Baumann, Secy.; E. Doerr, Treas.; E. W. Bruce, Sales Mgr.; E. Reinagel, Pur. Agt.; O. A. Life, Pub. Dir.
PRODUCTS: Airport equipment; Auxiliary motors; Misc. electrical equipment.

BALDWIN-DUCKWORTH DIV. OF CHAIN BELT CO., Springfield, Mass.
PERSONNEL: F. J. Weschler, V. Pres. & Gen. Mgr.
PRODUCTS: Chain controls; Turnbuckles; Sprockets.

BALTIC METAL PRODUCTS CO., 366 Butler St., Brooklyn, N. Y.
PERSONNEL: S. L. Schlanger, Pres. & Chief Engr.; L. Levine, Secy.
PRODUCTS: Ammunition boxes and counters; Bomb racks; Cylinder deflectors, baffles, brackets; Steel parts; Stampings.

BANTAM BEARINGS CORP., South Bend, Ind.
PERSONNEL: F. W. Deming, Pres.; R. B. Nichols, V. Pres. & Gen. Mgr.; W. T. Bell, Secy. & Treas.; J. F. Oehlhoffen, Sales Mgr.; E. A. Olson, Pur. Agt.; J. Barber, Pers. Dir.; S. R. Thomas, Chief Engr.
PRODUCTS: Bearings.

BARBER-COLMAN CO., Rockford, Ill.
PERSONNEL: H. A. Severson, Pres.; J. G. Jones, Secy.; O. O. Smith, Treas.; E. D. Parker, Gen. Mgr.; C. J. Braatz, Sales Mgr.; H. W. Bails, Pur. Agt.; A. M. Monks, Pers. Dir.; H. E. Shugars, Pub. Dir.; T. K. Greenlee, Chief Engr.
PRODUCTS: Controls; Control valves; Auxiliary motors; Machine tools; Ventilating and air conditioning equipment.

BARBOUR STOCKWELL CO., 205 Broadway, Cambridge, Mass.
PERSONNEL: E. F. Stockwell, Pres.
PRODUCTS: Tachometers.

BARDCO MANUFACTURING & SALES CO., 2450 E. 23rd St., Los Angeles, Calif.
PERSONNEL: F. Jervis, Pres.; L. Jervis, V. Pres.; E. F. Brown, Gen. Mgr.; W. J. Ashton, Pur. Agt.; E. C. Ball, Pers. Dir.; J. Netherly, Production Mgr.
PRODUCTS: Auxiliary power plants; Castings and forgings.

BARNES-GIBSON-RAYMOND DIV. OF ASSOCIATED SPRING CORP., 6400 Miller Ave., Detroit, Mich.
PERSONNEL: L. D. Adams, V. Pres. & Gen. Mgr.; W. J. Black, Sales Mgr.; C. W. Naas, Factory Mgr.; L. E. Hilts, Pur. Agt.; F. P. Zimmerli, Chief Engr.
PRODUCTS: Coiled and flat springs; Wire forms; Small stampings.

BARRETT-CRAVENS CO., 3255 W. 30th St., Chicago, Ill.
PERSONNEL: A. M. Barrett, Pres. & Treas.; E. J. Heimer, V. Pres., Gen. Mgr. & Sales Mgr.; O. M. Lund, Secy. & Chief Engr.; G. Collinet, Pur. Agt.; W. J. Kennedy, Pub. Dir.
PRODUCTS: Elevators; Cranes; Hand trucks.

THE BARRETT DIV., ALLIED CHEMICAL & DYE CORP., 40 Rector St., New York, N. Y.
PRODUCTS: Rock wool; Bituminous paints; Miscellaneous.

BARTLETT HAYWARD DIV. KOPPERS CO., 200 Scott St., Baltimore, Md.
PERSONNEL: W. F. Perkins, V. Pres.; J. E. Tellman, Secy. & Treas.; E. R. Hall, Gen. Mgr.; S. H. Fedan, Sales Mgr.; J. E. Aldridge, Pur. Agt.; W. Ortman, Pers. Dir.; P. F. Hackethal, Chief Engr.
PRODUCTS: Propellers and propeller parts.

REX BASSETT, INC., 500 S. E. Second St., Ft. Lauderdale, Fla.
PERSONNEL: R. E. Bassett, Jr., Pres. & Treas.; M. E. Bassett, V. Pres.; W. B. Giles, Secy.; R. E. Bassett, Sr., Gen. Mgr., Sales Mgr. & Pur. Agt.; J. Street, Pers. Dir.; E. Jones, Chief Engr.
PRODUCTS: Radios.

BASTIAN BROS. CO.,
1600 Clinton Ave., N., Rochester, N. Y.
PERSONNEL: W. J. Wolf, Pres. & Gen. Mgr.; F. J. Brown, V. Pres.; J. H. Mahoney, Secy.; F. J. Temmerman, Treas.; L. W. Shanley, Pur. Agt.
PRODUCTS: Dials; Instruction and name plates.

BAUER & BLACK, DIV. OF THE KENDALL CO., 2500 S. Dearborn St., Chicago, Ill.
PRODUCTS: First aid equipment; Masking tape.

BAUSCH & LOMB OPTICAL CO.,
St. Paul St., Rochester, N. Y.
PERSONNEL: H. Eisenhart, Pres. & Gen. Mgr.; C. S. Hallauer, V. Pres. & Sales Mgr.; W. W. McQuilkin, Secy.; J. F. Taylor, Treas.; J. E. Hansen, Pur. Agt.; R. B. Welch, Pers. Dir.; M. C. Williamson, Pub. Dir.; C. L. Bausch, Chief Engr.
PRODUCTS: Lenses; Bubble sextants; Goggles; Binoculars; Gun sights.

BAY MFG. DIV., THE ELECTRIC AUTO-LITE CO., Bay City, Mich.
PERSONNEL: C. M. Adams, V. Pres. & Gen. Mgr.; J. P. Kelso, Sales Mgr.; B. D. Kimerer, Pur. Agt.; L. M. Reynolds, Pers. Dir.
PRODUCTS: Controls; Control sticks and wheels; Magnetos; Terminals; Misc. electrical equipment; Fittings; Name plates; Plastic parts; Miscellaneous.

BEARIUM METALS CORP.
258 State St., Rochester, N. Y.
PERSONNEL: E. Langworthy, Pres.; G. P. Palma, V. Pres.; A. E. Zielke, Pur. Agt.
PRODUCTS: Bearings; Bushings.

THE BEATON & CORBIN MFG. CO.,
Southington, Conn.
PERSONNEL: A. R. Wells, Pres.; C. W. Rush, V. Pres. & Pur. Agt.; A. E. Ralston, Secy.; H. B. Armstrong, Treas. & Gen. Mgr.
PRODUCTS: Exhaust manifolds; Intake manifolds; Tubing.

BECKETT ELECTRIC CO., INC.,
1101-7 McKinney Ave., Dallas, Tex.
PERSONNEL: T. G. Beckett, Pres.; T. G. Beckett, Jr., V. Pres.; E. T. Summers, Treas. & Sales Mgr.
PRODUCTS: Batteries; Bearings; Bushings; Auxiliary motors; Disconnect plugs; Switches; Terminals; Misc. electrical equipment; Indirect lighting systems; Insulating materials; Pumps; Tubing; Ventilating and air conditioning equipment; Vibration dampers; Miscellaneous.

BELDEN MANUFACTURING CO.,
4647 W. Van Buren St., Chicago, Ill.
PERSONNEL: W. Jacobs, Pres.; C. S. Craigmile, Exec. V. Pres.; H. W. Clough, V. Pres.; A. Beutler, Secy.; A. L. Wanner, Treas.; H. A. Neil, Sales Mgr.; W. A. Sandy, Pur. Agt.; S. F. Kiss, Pers. Dir.; B. Rogers, Pub. Dir.; H. H. Wermine, Chief Engr.
PRODUCTS: Wire; Cables; Terminals.

BELDING HEMINWAY CO.,
119 W. 40th St., New York, N. Y.
PERSONNEL: J. P. T. Armstrong, Pres.; F. D. Levi, V. Pres.; F. L. Johnson, V. Pres. & Sales Mgr.; H. A. Johnson, V. Pres. & Chief Engr.; C. G. Heinrich, Secy. & Treas.
PRODUCTS: Silk and nylon threads for parachutes.

THE BELL CO., INC.
411 N. Wolcott Ave., Chicago, Ill.
PERSONNEL: J. M. Bell. Pres.; N. B. Belsky, V. Pres.; C. J. Bell, Secy. & Treas.; C. E. Allderdice, Jr., Gen. Mgr.; G. E. Kugelman, Pur. Agt.
PRODUCTS: De-icer fluid; Fire extinguisher fluid; Fuels and lubricants; Hydraulic and landing gear fluid.

BELL & HOWELL CO.,
1801-15 Larchmont Ave., Chicago, Ill.
PERSONNEL: J. H. McNabb, Pres. & Treas.; A. S. Howell, V. Pres.; C. A. Ziebarth, Secy.; J. H. Booth, Sales Mgr. & Pub. Dir.; H. R. Cleland, Pur. Agt.; K. R. Wood Pers. Dir.; B. E. Stechbart, Chief Engr.
PRODUCTS: Cameras.

BELLANCA AIRCRAFT CORP.,
New Castle, Del.
PERSONNEL: J. S. Wilson, Pres.; L. C. Milburn, V. Pres. & Gen. Mgr.; J. R. Morford, Secy.; W. R. Yarnall, Treas.; H. L. Thompson, Sales Mgr. & Pub. Dir.; R. F. Wright, Pur. Agt.; I. H. Brinton, Pers. Dir.; A. F. Haiduck, Chief Engr.
PRODUCTS: Aircraft armament; De-icer equipment; Floats; Panels; Aluminum, plastic, plywood and steel parts; Tanks; Miscellaneous.

BELLOIL PAINT PRODUCTS CO.,
547 W. Lake St., Chicago, Ill.
PERSONNEL: A. M. Craig, Secy.; J. O. Clark, Sales Mgr.; P. N. Belleisle, Chief Engr.
PRODUCTS: Paints, varnishes and finishes

BENDIX AVIATION CORP.,
1104 Fisher Bldg., Detroit, Mich.
PERSONNEL: E. R. Breech, Pres.; H. A. Gossner, Secy.; H. L. Sharlock, Pub. Dir.

BENDIX AVIATION, LTD.,
11600 Sherman Way, N. Hollywood, Calif.
PERSONNEL: E. R. Breech, Pres.; P. Nicholls, V. Pres. & Gen. Mgr.; M. M. Burns, V. Pres.; R. L. Galbraith, Pur. Agt.; J. M. White, Chief Engr.
PRODUCTS: Clamps; Hydraulic controls and assemblies; Pumps; Radios; Control valves.

BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., 401 Bendix Dr., South Bend, Ind.
PERSONNEL: E. R. Breech, Pres.; M. P. Ferguson, V. Pres.; H. A. Gossner, Secy.; E. R. Palmer, Treas.; T. W. Tinkham, Gen. Mgr.; F. B. Willis, Sales Mgr.; J. R. Cautley, Landing Gear Sales Mgr.; C. D. Manhart, Carburetor Sales Mgr.; R. Ledbetter, Armament Sales Mgr.; C. E. Budd, Pur. Agt.; M. Stone, Pers. Dir.; H. L. Sharlock, Pub. Dir.; K. M. Wise, Chief Engr.
PRODUCTS: Aircraft armament; Carburetors; Landing gears; Engine primers; Seats; Tail wheel assemblies; Wheels and brakes.

BENDIX RADIO DIV., BENDIX AVIATION CORP., Baltimore, Md.
PERSONNEL: H. Benet, Gen. Mgr.; F. S. Gutekunst, Div. Compt.; J. H. Hammond, Sales Mgr.; G. M. Hafner, Pur. Agt.; J. H. Kahlert, Pers. Dir.; W. L. Webb, Chief Engr.; W. P. Hilliard, Dir. Sales & Engrg.
PRODUCTS: Transmitters and receivers; Radio compasses.

THE BENNETT METAL TREATING CO.,
1045 New Britain Ave., Elmwood, Conn.
PERSONNEL: A. J. German, Pres.; J. P. German, Secy.; A. L. Davis, Treas.
PRODUCTS: Aircraft armament; Bearings; Castings and forgings; Machine tools; Misc. hardware; Tools.

BENRUS WATCH CO.,
200 Hudson St., New York, N. Y.
PERSONNEL: B. Lazrus, O. M. Lazrus, S. R. Lazrus, Partners.
PRODUCTS: Instruments.

THE BENSON MANUFACTURING CO.,
3001-15 E. 18th St., Kansas City, Mo.
PERSONNEL: A. J. Benson, Pres.; E. H. Benson, V. Pres.; E. L. Benson, Secy.; E. A. Benson, Treas.; R. F. Bullock, Pur. Agt.; L. C. Campbell, Chief Engr.
PRODUCTS: Ammunition boxes and counters; Collector rings, cowls, streamlines; Cowlings; De-icer equipment; Engine mounts; Exhaust manifolds.

THE BENWOOD LINZE CO.,
1815 Locust St., St. Louis, Mo.
PERSONNEL: H. J. Wrape, Pres.; C. E. Peters, V. Pres.; I. W. Veigel, Secy. & Treas.; N. Beerend, Sales Mgr.; A. R. Kieffer, Jr., Pur. Agt.
PRODUCTS: Electrical rectifiers.

BERGER BROTHERS CO.,
229-237 Arch St., Philadelphia, Pa.
PERSONNEL: H. E. Usinger, Pres.; H. B. Feltman, Secy.; R. H. Hoffman, Treas.; R. S. Brown, Sales Mgr.; C. C. Beez, Pur. Agt.
PRODUCTS: Stampings; Sub-assemblies; Ventilating and air conditioning equipment.

BERRY BROTHERS,
211 Leib St., Detroit, Mich.
PERSONNEL: A. Kiernan, Pres. & Gen. Mgr.; T. B. Colby, R. Y. Cutler, V. Pres.; F. L. Colby, Jr., Secy.; E. H. Dunn, Treas.; C. E. Spooner, Sales Mgr.; H. A. Dedenback, Pur. Agt.; J. D. Greene, Pub. Dir.; G. Smith, Chief Engr.
PRODUCTS: Paints, varnishes and finishes.

BERTEA PRODUCTS,
1450 N. Lake Ave., Pasadena, Calif.
PERSONNEL: Alex Bertea, Gen. Mgr. & Chief Engr.; C. Sorenson, Sales Mgr.; Ann Bertea, Pur. Agt.; H. G. Williams, Pers. Dir.
PRODUCTS: De-icer equipment; Auxiliary motors; Anti-icing pumps.

JACK BEST MFG., CO.,
2128 S. Los Angeles St., Los Angeles, Calif.
PERSONNEL: G. J. Anderson, Gen. Mgr.
PRODUCTS: Engine mounts; Gaskets; Oil seals; Aluminum, cork, felt, fibre, leather, rubber, steel and synthetic parts; Shims.

THE BILLINGS & SPENCER CO.,
1 Laurel St., Hartford, Conn.
PERSONNEL: W. A. Purtell, Pres., Treas. & Gen. Mgr.; H. E. Oberg, V. Pres.; R. J. Ahern, V. Pres. & Secy.; W. D. Endres, Sales Mgr.; W. Blackburn, Pur. Agt.; R. H. Young, Pub. Dir.
PRODUCTS: Forgings.

BLACK BEAR CO., INC.,
44-45 23rd St., Long Island City, N. Y.
PERSONNEL: R. A. Schleicher, Pres.; S. R. Towles, V. Pres. & Chief Engr.; M. E. Bingham, Secy.; F. G. Schleicher, Treas.; F. G. Kacmer, Production Mgr.; A. de Goll, Sales Mgr.; R. H. Ellis, Pur. Agt.; J. R. Boyd, Tech. Dir.; M. Phillips, Pub. Dir.
PRODUCTS: Graphited lubricants; Anti-corrosive compounds.

THE BLACK & DECKER MFG. CO.,
E. Pennsylvania Ave., Towson, Md.
PERSONNEL: S. D. Black, Pres.; A. G. Decker, V. Pres.; & Gen. Mgr.; C. A. Sacra, Secy.; F. J. Nagell, Treas.; R. D. Black, Sales Mgr.; C. B. Mann, Pur. Agt.; H. T. Douglas, Pers. Dir.; J. F. Apsey, Jr., Pub. Dir.; G. C. Wilhide, Chief Engr.
PRODUCTS: Portable electric tools.

BLACKER ENGINEERING CORP.,
136 Liberty St., New York, N. Y.
PERSONNEL: E. B. Cooke, Pres., Gen. Mgr., Sales Mgr., Pub. Dir. & Chief Engr.; L. B. Dexter, V. Pres.; W. F. Shorter, Secy.; C. H. Cooke, Treas.; R. C. Wilson, Pur. Agt. & Pers. Dir.
PRODUCTS: Helve and power hammers.

BLACKHAWK MFG. CO.,
5325 W. Rogers, Milwaukee, Wisc.
PERSONNEL: H. P. Brumder, Pres.; J. C. Merker, V. Pres. & Gen. Mgr.; G. H. Goehrig, V. Pres. & Sales Mgr.; E. M. Pfauser, V. Pres. & Chief Engr.; L. E. Bertane, Treas.; G. Cremer, Pur. Agt.; P. J. Spielmann, Pers. Dir.; B. E. Hotvedt, Pub. Dir.
PRODUCTS: Airport equipment; Hydraulic controls and assemblies; Tools; Miscellaneous.

BLANCHARD BROS. & LANE
408 Frelinghuysen Ave., Newark, N. J.
PERSONNEL: J. H. Gay, Pres.; W. G. Ressland, V. Pres. & Sales Mgr.; H. G. Crawford, Secy.; S. B. Gay, Treas.; K. W. Koeinger, Pur. Agt.
PRODUCTS: Leather parts.

BLILEY ELECTRIC CO.,
Union Station, Erie, Pa.
PERSONNEL: F. D. Bliley, Pres. & Gen. Mgr.; C. C. Collman, V. Pres.; O. Horsman, Treas.; G. E. Wright, Sales Mgr.; J. Reigelman, Pur. Agt.; A. Pero, Pers. Dir.; J. M. Wolfskill, Chief Engr.
PRODUCTS: Radio quartz crystals and holders.

E. W. BLISS CO.,
53rd St. & Second Ave., Brooklyn, N. Y.
PERSONNEL: H. H. Pinney, Pres.; H. U. Herrick, V. Pres.; E. S. McClary, Secy. & Treas.; R. Biggane, Sales Mgr.; F. B. Smith, Pur. Agt.; H. F. Smith, Pers. Dir.; M. Stumm, Adv. Mgr.; I. Patrick, Chief Engr.
PRODUCTS: Mechanical power presses; Hydraulic presses; Die cushions; Automatic feeds; Special machinery.

SIDNEY BLUMENTHAL & CO., INC.,
1 Park Ave., New York, N. Y.
PERSONNEL: H. H. Schell, Pres.; J. J. Hoyne, V. Pres.; J. Fenske, Secy.; G. Beisheim, Treas.; W. P. Mimnagh, Sales Mgr.; E. S. Cobb, Pur. Agt.; E. S. Evans, Pers. Dir.
PRODUCTS: Rugs and carpets.

BODINE ELECTRIC CO.,
2254 W. Ohio St., Chicago, Ill.
PERSONNEL: C. D. Bodine, Pres.; E. W. Larson, V. Pres. & Pur. Agt.; P. J. Bodine, Secy. & Treas.; W. M. Yogerst, Sales Mgr.; J. W Towle, Pers. Dir.; C. A. Rall, Chief Engr.
PRODUCTS: Auxiliary motors.

BOKELMANN TRIMMING CO., INC.,
45 E. 53rd St., New York, N. Y.
PERSONNEL: L. F. Timmerman, Pres.; B. H. Andrews, V. Pres.; M. King, Secy.; H. E. Dunn, Treas.
PRODUCTS: Webbing.

BONNEY FORGE & TOOL WORKS,
Allentown, Pa.
PERSONNEL: F. S. Durham, Pres. & Gen. Mgr.; J. E. Durham, Jr., V. Pres.; A. J. Male, Secy., Treas. & Sales Mgr.; W. F. Herbst, Jr., Pur. Agt.; S. R. Robinson, Pub. Dir.
PRODUCTS: Tools.

THE BOOTH FELT CO.,
463 19th St., Brooklyn, N. Y.
PERSONNEL: E. W. Booth, Owner, Treas., Gen. Mgr. & Pur. Agt.; L. D. Croninger, V. Pres.; J. H. Murray, Secy.; R. S. Stevens, Sales Mgr.
PRODUCTS: Felt parts.

BOOTS AIRCRAFT NUT CORP.,
New Canaan, Conn.
PERSONNEL: N. J. Boots, Pres.; R. W. Johnson, V. Pres. & Gen. Mgr.; R. W. Luce, V. Pres.; O. Schell, Jr., Secy.; C. A. Milton, Treas.; R. F. Hibbert, Sales Mgr.; W. C. Wooton, Chief Engr.
PRODUCTS: Airport equipment; Clamps; Cowlings; Fasteners.

BOSTITCH, INC., E. Greenwich, R. I.
PERSONNEL: J. D. A. Whalen, Pres., Treas. & Gen. Mgr.; F. I. Brown, V. Pres. & Sales Mgr.; E. C. Mowry, Secy.; J. E. Scully, Pur. Agt.; S. L. Smith, Pub. Dir.
PRODUCTS: Fasteners; Metal stitchers.

THE BOSTON AUTO GAGE CO.,
Pittsfield, Mass.
PERSONNEL: T. C. Nelson, Pres., Secy. & Sales Mgr.; H. MacKelvie, V. Pres. & Pur. Agt.; H. J. Martin, Treas.; R. Gage, Chief Engr.
PRODUCTS: De-icer equipment; Quantity gages.

BOSTON INSULATED WIRE & CABLE CO.,
75 Bay St., Dorchester, Mass.
PERSONNEL: H. B. Burley, Pres. & Treas.; J. C. Burley, V. Pres., Sales Mgr. & Chief Engr.; M. G. Fitsgerald, Secy.; H. B. Burley, Jr., Gen. Mgr.
PRODUCTS: Wire; Cable.

BOUND BROOK OIL-LESS BEARING CO.,
Bound Brook, N. J.
PERSONNEL: W. F. Jennings, Pres. & Treas.; H. O. Johnson, V. Pres., Secy. & Sales Mgr.; D. H. Carhart, Pur. Agt.; C. Claus, Chief Engr.
PRODUCTS: Bearings, Bushings.

BOWER ROLLER BEARING CO.,
3040 Hart Ave., Detroit, Mich.
PERSONNEL: S. A. Strickland, Pres.; W. S. Bennett, V. Pres. & Sales Mgr.; T. C. Dye, Secy. & Treas.; G. F. Johnson, Gen. Mgr.; E. M. Pratt, Pur. Agt.; M. J. Olson, Pers. Dir.; E. Wooler, Chief Engr.
PRODUCTS: Bearings; Bushings.

THE BOWLING GREEN RUBBER CO.,
Prospect & NYCRR, Toledo, Ohio
PERSONNEL: S. Roberts, Pres. & Treas.; R. Roberts, V. Pres., Secy., Gen. Mgr. & Pur. Agt.; I. F. Zarobsky, Chief Engr.
PRODUCTS: Rubber bushings; Gaskets; Misc. engine equipment; Oil seals; Rubber, steel, and synthetic parts; Propellers and propeller parts; Rubber tubing; Vibration dampers.

S. F. BOWSER & CO., INC.,
1302 E. Creighton Ave., Ft. Wayne, Ind.
PERSONNEL: R. H. Damon, Pres.; E. D. Eggimann, V. Pres.; J. F. Bartels, Secy. & Treas.; E. C. Marsh, Sales Mgr.; E. A. Steinhauser, Pur. Agt.; H. J. Slack, Pub. Dir.; C. P. Griffith, Chief Engr.
PRODUCTS: Airport equipment; Filters and strainers; Fueling systems; Instruments; Fuel consumption meters.

BRASCO MANUFACTURING CO.,
Harvey, Ill.
PERSONNEL: L. Barton, Pres.; M. J. Rosenfeld, V. Pres., Treas. & Gen. Mgr.; C. B. Hess. Secy.; A. W. Sorenson, Pur. Agt.; E. Roach, Pers. Dir.; J. J. Arnsfield, Pub. Dir.; J. J. Bosshard, Chief Engr.
PRODUCTS: Ammunition boxes and counters; Basic materials and fabrications; Panels; Aluminum, magnesium, plastic and steel parts; Stampings; Sub-assemblies; Tubing.

BREEZE CORPORATIONS, INC.,
41 S. Sixth St., Newark, N. J.
PERSONNEL: J. T. Mascuch, Pres.; J. F. Lucas, V. Pres. & Sales Mgr.; A. T. Burleigh, Secy.; F. G. Shupp, Treas.; G. C. Braumuller, Pur. Agt.; J. B. Keating, Pers. Dir.; A. E. Calkins, Pub. Dir.; K. G. Strunk, Chief Engr.
PRODUCTS: Aircraft armament; Ammunition boxes and counters; Controls; Fittings; Instruments; Manifolds; Radio and ignition shielding; Starters; Flexible tubing.

THE BREWER-TITCHENER CORP.,
117 Port Watsen St., Cortland, N. Y.
PERSONNEL: E. A. Brewer, Pres. & Treas.; D. A. Brewer V. Pres. & Pur. Agt.; J. Greene, Secy.; J. Dwyer, Gen. Mgr.; M. E. Maxson, Sales Mgr.; F. Fiske, Pers. Dir.; W. A. Bruce, Pub. Dir.; U. Johansen, Chief Engr.
PRODUCTS: Forgings.

BRIDGEPORT FABRICS, INC.,
Bridgeport, Conn.
PERSONNEL: H. B. Naramore, Pres.; R. W. Naramore, V. Pres.; E. J. Morrell, Secy.; T. N. Wakeman, Treas.; H. A. Hubbell, Pur. Agt.; L. Spraragen, Chief Engr.
PRODUCTS: Rubber parts; Cords and fabrics.

THE BRIDGEPORT HARDWARE MFG. CORP., 461 Iranistan Ave., Bridgeport, Conn.
PERSONNEL: H. B. Curtis, Pres.; A. G. Ryan, Secy.; J. F. Windsor, Treas.
PRODUCTS: Forgings, Tools.

THE BRIDGEPORT SAFETY EMERY WHEEL CO., INC., 1299 W. Broad St., Stratford, Conn.
PERSONNEL: L. Wallace, Jr., Pres.; deB. K. Seeley, V. Pres.; A. H. Kean, Treas.
PRODUCTS: Machine tools.

BRIGGS & STRATTON CORP., 2711 N. 13th St., Milwaukee, Wisc.
PERSONNEL: C. L. Coughlin, Pres.; E. V. Oehler, R. W. Griffith, V. Pres.; L. G. Regner, Secy.; E. M. Bodendoerfer, Treas.; R. W. Randall, O. L. Sicker, Sales Mgrs.; J. F. Bode, Pur. Agt.; H. S. Brown, Chief Engr.
PRODUCTS: Switches.

BRIGGS MANUFACTURING CO., 11631 Mack Ave., Detroit, Mich.
PERSONNEL: W. P. Brown, Pres. & Gen. Mgr.; W. D. Robinson, V. Pres.; A. D. Blackwood, Secy.; W. O. Briggs, Jr., Treas.; A. J. Wettlaufer, Sales Mgr.; W. J. Cleary, Pur. Agt.; F. H. Taylor, Pers. Dir.; J. Lee, II, Pub. Dir.; E. E. Lundberg, Chief Engr.
PRODUCTS: Tank hulls; Air frame parts and assemblies; Gun turrets; Searchlights; Heat exchangers; Shells.

BRIGGS-WEAVER MACHINERY CO., Dallas, Tex.
PERSONNEL: J. B. Dale, Pres., Gen. Mgr. & Sales Mgr.; R. B. Young, V. Pres.; D. C. Dale, Secy. & Treas.; W. C. Jaschob, Pur. Agt.
PRODUCTS: Machine tools; Misc. hardware.

BROOKLYN VARNISH MFG. CO., INC., 35 Nostrand Ave., Brooklyn, N. Y.
PERSONNEL: W. J. Anderson, Pres.; D. C. Anderson, V. Pres.; R. B. Anderson, Secy.; C. Engelhardt, Gen. Mgr.; J. W. Wilson, Sales Mgr.
PRODUCTS: Paints, varnishes and finishes.

ANDREW BROWN CO., 5431 S. Riverside Dr., Los Angeles, Calif.
PERSONNEL: A. Brown, Pres. & Gen. Mgr.; W. E. Moore, V. Pres. & Chief Engr.; A. M. Roberts, Secy. & Treas.; O. C. Pumphrey, Sales Mgr.; N. Bergeron, Pur. Agt.; J. Franks, Pers. Dir.
PRODUCTS: Fuels and lubricants; Paints, varnishes and finishes.

THE BROWN INSTRUMENT CO., Wayne & Roberts Ave., Philadelphia, Pa.
PERSONNEL: C. B. Sweatt, Pres.; E. B. Evleth, V. Pres. & Gen. Mgr.; J. P. Goheen, Secy.; W. Huff, Treas.; L. M. Morley, Sales Mgr.; J. W. Weingartner, Pur. Agt.; P. L. Goldstrohm, Pers. Dir.; J. F. Sullivan, Pub. Dir.; G. M. Muschamp, Chief Engr.
PRODUCTS: Flight test recorder.

BROWN & SHARPE MFG. CO., 235 Promenade St., Providence, R. I.
PERSONNEL: H. D. Sharpe, Pres. & Treas.; P. C. DeWolf, J. S. Chafee, R. Viall, A. K. Brown, V. Pres.; J. A. Newton, Secy.; A. H. Bainton, Works Mgr.; C. W. Machon, Sales Mgr.; R. W. Dixon, Pur. Agt.; J. J. Hall, Pers. Dir.; J. P. Burdick, Pub. Dir.; B. P. Graves, Chief Engr.
PRODUCTS: Machine tools; Precision tools.

BRUNNER MFG. CO., 1821 Broad St., Utica, N. Y.
PERSONNEL: G. L. Brunner, Pres.; G. L. Brunner, Jr., V. Pres. & Secy.; A. G. Zumbrun, Treas.; B. J. Scholl, Sales Mgr.; E. A. Schiller, Pur. Agt.; O. R. McDonald, Pub. Dir.; S. R. Hirsch, Chief Engr.
PRODUCTS: Airport equipment; Steel parts.

THE BRUSH DEVELOPMENT CO., 3311 Perkins Ave., Cleveland, O.
PERSONNEL: A. L. Williams, Pres.; V. B. Phillips, V. Pres. & Sales Mgr.; W. L. Flory, Secy.; C. B. Sawyer, Treas.; E. R. Parker, Pur. Agt.; W. H. Shelton, Pers. Dir. & Pub. Dir.; C. K. Gravley, Chief Engr.
PRODUCTS: Pickups; Oscillographs; Surface analyzers.

THE BRYANT ELECTRIC CO., 1421 State St., Bridgeport, Conn.
PERSONNEL: H. E. Seim, V. Pres. & Gen. Mgr.; S. Booth, Treas.; H. Hey, Sales Mgr.; F. C. Esser, Pur. Agt.; C. L. Sundine, Pers. Dir.; F. F. Herold, Pub. Dir.; C. H. Hodgkins, Chief Engr.
PRODUCTS: Disconnect plugs; Switches; Plastic parts.

BUCKEYE TOOLS CORP., 29 W. Apple St., Dayton, O.
PERSONNEL: M. J. McCombs, Pres. & Gen. Mgr.; H. O. Gummere, Secy., Sales Mgr. & Pub. Dir.; A. G. Lauzon, Treas.; E. E. Reeves, Pur. Agt.; E. B. Hamilton, Chief Engr.
PRODUCTS: Portable machine tools.

EDWARD G. BUDD MANUFACTURING CO., 25th & Hunting Park Ave., Philadelphia, Pa.
PERSONNEL: E. G. Budd, Sr., Pres.; E. W. Budd, Jr., D. Alexander, V. Pres.; H. A. Coward, Secy.; P. Zens, Treas.; S. A. Mahan, Works Mgr.; H. P. Curtis, Sales Mgr.; F. S. White, Pur. Agt.; E. H. McIlvain, Pers. Dir.; H. D. Leopold, Pub. Dir.; M. Watter, Aircraft Engr.
PRODUCTS: Ammunition boxes and counters; Collector rings, cowls, streamlines; Exhaust manifolds; Seats; Tanks.

BUHL STAMPING CO., 2730 Scotten Ave., Detroit, Mich.
PERSONNEL: L. D. Buhl, Pres.; H. S. Finkenstaedt, V. Pres. & Gen. Mgr.; H. E. Ryan, Treas.; E. F. Rickelman, Aviation Sales Mgr.; A. W. Gies, Pur. Agt.; D. Warner, Pers. Dir.; C. D. LaFond, Chief Engr.
PRODUCTS: Clamps; Collector rings, cowls, streamlines; Cowlings; Cylinder deflectors, baffles, brackets; Exhaust manifolds; Manifolds; Aluminum parts; Stampings.

BUHR MACHINE TOOL CO., 839 Green St., Ann Arbor, Mich.
PERSONNEL: J. F. Buhr, Pres. & Gen. Mgr.; T. H. L. Backus, V. Pres.; J. F. Haarer, Secy. & Treas.; C. P. Roth, Sales Mgr.; J. H. Buhr, Jr., Pur. Agt.; M. A. Morice, Pers. Dir.; W. J. Mattson, Pub. Dir.; G. D. Evans, Chief Engr.
PRODUCTS: Machine tools.

BUICK MOTOR DIV., Flint, Mich.
PERSONNEL: H. H. Curtice, Pres., I. L. Wiles, Treas.; W. F. Hufstader, Sales Mgr.; L. A. Stewart, Pur. Agt.; R. F. Thalner, Pers. Dir.; F. Webb, Pub. Dir.; C. A. Chayne, Chief Engr.
PRODUCTS: Castings and forgings; Cylinder deflectors, baffles, brackets; Aluminum and magnesium parts; Tanks.

THE BULLARD CO.,
286 Canfield Ave., Bridgeport, Conn.
PERSONNEL: E. P. Bullard, Pres.; E. C. Bullard, V. Pres. & Gen. Mgr.; A. E. North, Secy. & Treas.; E. P. Blanchard, Sales Mgr.; R. T. Phipps, Pur. Agt.; F. H. Somers, Pers. Dir.; R. C. Bullard, Pub. Dir.; V. J. Elsenboss, Chief Engr.
PRODUCTS: Machine tools.

E. D. BULLARD COMPANY,
275 Eighth St., San Francisco, Calif.
PERSONNEL: E. W. Bullard, Pres. & Gen. Mgr.; A. Bull, V. Pres. & Sales Mgr.; R. C. Mills, Pur. Agt.; M. E. Wank, Pub. Dir.
PRODUCTS: First aid equipment; Protective clothing and equipment.

THE BUNTING BRASS & BRONZE CO.,
715 Spencer St., Toledo, O.
PERSONNEL: C. E. Bunting, Pres. & Treas.; G. H. Adams, Exec. V. Pres. & Sales Mgr.; D. McKercher, V. Pres. & Gen. Mgr.; W. F. Volk, Secy.; J. Frautschi, Pur. Agt.; G. Yager, Chief Engr.
PRODUCTS: Bearings; Bushings.

BURDETT MFG. CO.,
19 N. Loomis St., Chicago, Ill.
PERSONNEL: J. B. Burdett, Pres.; J. H. Burdett, V. Pres.; J. E. Veihl, Secy., Treas. & Gen. Mgr.
PRODUCTS: Airport equipment; Engine valves and valve parts.

BURGESS BATTERY COMPANY,
Freeport, Ill.
PERSONNEL: D. W. Hirtle, Pres.; A. M. Dobbs, V. Pres.; O. W. Storey, Secy.; D. J. Teare, Treas.; L. J. Lockwood, Plant Supt.; J. A. McIlnay, Sales Mgr.; C. A. Butcher, Pur. Agt.; W. C. Morse, Pers. Dir.; C. E. Balz, Pub. Dir.; J. J. Coleman, Chief Engr.
PRODUCTS: Dry batteries.

BURKLYN COMPANY,
3429 Glendale Blvd., Los Angeles, Calif.
PERSONNEL: E. Burke, T. Lynn, Partners.
PRODUCTS: Aircraft armament; Ammunition boxes and counters; Controls; Fasteners; Hydraulic controls and assemblies; Vibration dampers.

BURNDY ENGINEERING COMPANY, INC.,
107 Eastern Boulevard, New York, N. Y.
PERSONNEL: P. Fried, Pres.; B. Dibner, V. Pres.; M. Lee, Secy.; Gen. Mgr. & Chief Engr.; F. E. L. Whitesell, Sales Mgr.; S. Wolberg, Pur. Agt.; J. Morrison, Pers. Dir.; T. Gravenson, Pub. Dir.
PRODUCTS: Terminals; Misc. electrical equipment; Insulating materials; Tubing.

BURNSIDE VENEER CO., INC.,
Burnside, Ky.
PERSONNEL: R. Kreamer, Pres. & Sales Mgr.; M. C. Wilkinson, V. Pres. & Secy.; F. Smith, Treas.
PRODUCTS: Single ply-rotary cut poplar aircraft veneer; Plywood and veneer parts.

BURROUGHS WELLCOME & CO., INC.,
9 East 41st St., New York, N. Y.
PERSONNEL: T. Nevin, Pres.; G. S. Dunbar, V. Pres.; W. F. Weber, Secy.; R. C. Ralphs, Treas.; M. S. Smith, Pur. Agt.
PRODUCTS: First aid equipment.

BURTON-ROGERS CO., SALES DIV., HOYT ELECTRICAL INSTRUMENT WORKS, 857 Boylston St., Boston, Mass.
PERSONNEL: C. W. Burton, Pres. & Treas.; E. L. Chase, V. Pres.; V. S. Church, Secy. & Chief Engr.
PRODUCTS: Instruments.

BUSSMANN MANUFACTURING CO.,
University at Jefferson, St. Louis, Mo.
PERSONNEL: A. B. Bussmann, Pres. & Gen. Mgr.; H. T. Bussmann, V. Pres. & Sales Mgr.; J. A. Bussmann, Secy., Treas. & Pers. Dir.; L. J. Bussmann, Pur. Agt.; H. Thomas, Pub. Dir.; J. Lebens, Chief Engr.
PRODUCTS: Fuses.

BYRNE DOORS, INC.,
1150 Griswold St., Detroit, Mich.
PERSONNEL: J. I. Byrne, Pres.; G. M. Bolton, V. Pres. & Gen. Mgr.; B. C. Walsh, Secy.; R. Ballantyne, Treas.; E. F. Dunkle, Sales Mgr.; W. B. Lyons, Pur. Agt.; N. E. Colburn, Sr., Chief Engr.
PRODUCTS: Airport equipment.

C

C-O-TWO FIRE EQUIPMENT CO.,
U. S. Highway No. 1, Newark, N. J.
PERSONNEL: S. E. Allen, Pres. & Chief Engr.; M. A. Laswell, V. Pres. & Sales Mgr.; E. A. Clapp, Treas.; E. D. Wolf, Pur. Agt.; H. A. Gorman, Pers. Dir.; T. Young, Pub. Dir.
PRODUCTS: Fire extinguishers.

C & W TOOL CO.,
19 Chestnut St., Cambridge, Mass.
PERSONNEL: A. H. Avery, Pres. & Treas.; J. A. Long, V. Pres., Sales Mgr. & Pers. Dir.; J. B. Harrington, Pur. Agt. & Chief Engr.; R. C. Crichton, Pub. Dir.
PRODUCTS: Cutting tools.

CALIFORNIA PANEL & VENEER CO.,
955 S. Alameda St., Los Angeles, Calif.
PERSONNEL: M. J. Baker, Pres.; G. R. Stratemeyer, V. Pres.; W. F. Fahs, Secy., Treas., Pur. Agt., Pers. Dir. & Pub. Dir.; R. Mulholland, Gen. Mgr. & Sales Mgr.; B. Ostlind, Chief Engr.
PRODUCTS: Plywood parts; Seats; Tubing.

CALIFORNIA SPRING CO., INC.,
1746 S. Los Angeles St., Los Angeles, Calif.
PERSONNEL: J. H. Neuhart, Gen. Mgr.
PRODUCTS: Springs.

THE CALIFORNIA WIRE CLOTH CORP.,
1001-22nd Ave., Oakland, Calif.
PERSONNEL: S. C. Pohlman, V. Pres. & Gen. Mgr.; G. T. Stockfleth, Secy. & Treas.; H. R. Merriam, Sales Mgr.; F. Kelleway, Pur. Agt.; W. de Poy, Chief Engr.
PRODUCTS: Basic materials and fabrications.

CAMBRIDGE INSTRUMENT CO., INC.,
3732 Grand Central Terminal, New York, N. Y.
PERSONNEL: R. H. Kruse, Pres. & Gen. Mgr.; H. N. Packard, V. Pres. & Treas.; W. H. Jefferson, Secy.; B. O. Watkins, Aircraft Sales Mgr.; L. Birdsall, Pur. Agt.; R. Rick, Pub. Dir.; U. O. Hutton, Chief Engr.
PRODUCTS: Instruments.

CAMLOC FASTENER CO.,
420 Lexington Ave., New York, N. Y.
PERSONNEL: J. M. Summers, Managing Partner; A. W. Faber, Controller & Pur. Agt.; D. S. Kane, Gen. Mgr.; R. W. Allen, Pub. Dir.; S. W. Hennessey, Jr., Chief Engr.
PRODUCTS: Fasteners.

CANDLER-HILL CORP.,
405 Midland Ave., Detroit, Mich.
PERSONNEL: J. B. Candler, Pres.; E. J. Hill, V. Pres.; G. E. Runyeon, Secy.; B. Ferris, Pur. Agt.; A. G. Schlosser, Chief Engr.
PRODUCTS: Pumps.

CANNON ELECTRICAL DEVELOPMENT CO., 3209 Humboldt St., Los Angeles, Calif.
PERSONNEL: J. H. Cannon, Pres.; R. J. Cannon, V. Pres. & Gen. Mgr.; G. Taylor, Secy.; D. H. Loukota, M. F. Gillern, Sales Mgrs.; R. L. Rowan, Pur. Agt.; A. S. Wilcox, Pers. Dir.; F. G. Hobart, Pub. Dir.; E. Neifing, Chief Engr.
PRODUCTS: Disconnect plugs; Terminals; Misc. electrical equipment.

THE CANTON DROP FORGING & MFG. CO., Canton, O.
PERSONNEL: C. A. Brauchler, Pres., Gen. Mgr. & Sales Mgr.; C. H. Brauchler, V. Pres. & Chief Engr.; K. S. Goodin, Secy. & Treas.
PRODUCTS: Drop forgings.

CARBOLOY CO., INC.,
1177 E. 8 Mile Rd., Detroit, Mich.
PERSONNEL: W. G. Robbins, Pres.; A. MacKenzie, V. Pres.; K. R. Oberle, Treas.; J. R. Longwell, Gen. Mgr.; K. R. Beardslee, Sales Mgr.; A. DeCarlo, Pur. Agt.; F. C. Ritner, Pers. Dir.; E. C. Howell, Pub. Dir.; P. Miller, Chief Engr.
PRODUCTS: Cemented carbide tools.

CHARLES W. CARLL SONS,
Cole St. & Reading R. R., Trenton, N. J.
PERSONNEL: C. M. Carll, Pres. and Chief Engr.; J. W. Carll, Pur. Agt.
PRODUCTS: Ammunition boxes and counters; Bomb racks; Cowlings; Engine mounts; Exhaust manifolds; Aluminum and steel parts; Seats; Stampings; Sub-assemblies; Tail wheel assemblies; Miscellaneous.

THE CARLYLE JOHNSON MACHINE CO.,
52 Main St., Manchester, Conn.
PERSONNEL: S. H. Simon, Pres. & Gen. Mgr.; A. R. Coe, V. Pres., Pur. Agt. and Chief Engr.; J. M. Miller, Treas.; J. Furey, Sales Mgr.
PRODUCTS: Friction clutches.

E. W. CARPENTER MFG. CO.,
1565 Railroad Ave., Bridgeport, Conn.
PERSONNEL: H. C. Wheeler, Pres.; A. A. Lincoln, V. Pres. & Gen. Mgr.; D. W. Clark, Secy.; R. T. Davis, Treas.; W. A. Patterson, Jr., Pur. Agt.; P. D. Thomas, Pers. Dir.; J. W. Adams, Chief Engr.
PRODUCTS: Aircraft armament; Misc. hardware.

THE CARPENTER STEEL CO.,
101 W. Bern St., Reading, Pa.
PERSONNEL: J. H. Parker, Pres.; F. R. Palmer, E. J. Poole, Jr., V. Pres.; J. S. Pendleton, Secy. & Treas.; R. V. Mann, Sales Mgr.; R. P. Freehafer, Pur. Agt.; C. F. Weaver, Pers. Dir.; A. E. Keller, Pub. Dir.; C. M. Jones, Chief Engr.
PRODUCTS: Stainless, alloy and matched tool steels; Ferro and high nickel alloys.

CARRIER CORP., Syracuse, N. Y.
PERSONNEL: E. C. Wampler, Pres.; E. T. Murphy, V. Pres. & Sales Mgr.; M. E. Snyder, Secy. & Treas.; F. Hubbard, Pur. Agt.; R. Ebbert, Pers. Dir.; W. A. Bowe, Pub. Dir.; L. L. Lewis, Chief Engr.
PRODUCTS: Heaters; Ventilating and air conditioning equipment.

CARTER MOTOR COMPANY,
1608 Milwaukee Ave., Chicago, Ill.
PERSONNEL: A. J. Carter, Pres.; R. W. Carter, V. Pres. & Chief Engr.; E. J. Detsch, Secy.; B. R. Carter, Treas.; J. M. Mattheis, Pur. Agt.
PRODUCTS: Dynamotors; Auxiliary motors; Generators.

A. T. CASE CO.,
6100 Avalon Blvd., Los Angeles, Calif.
PERSONNEL: A. T. Case, Pres.; J. G. Campazzie, Secy. & Gen. Mgr.; J. K. Doan, Treas.; E. A. Evans, Sales Mgr.; L. Inman, Pur. Agt.; H. Derner, Pers. Dir.; H. Childers, Chief Engr.
PRODUCTS: Ammunition boxes and counters; Basic materials and fabrications; Bomb racks; Collector rings, cowls, streamlines; Cowlings; Engine mounts; Aluminum and steel parts; Seats; Stampings; Sub-assemblies.

CASTALLOY CO., INC.,
220 Sixth St., Cambridge, Mass.
PERSONNEL: F. Hengesch, Pres.; F. McConville, Treas.
PRODUCTS: Castings and forgings.

CATALIN CORP.,
One Park Ave., New York, N. Y.
PERSONNEL: W. Theile, Pres.; H. Krehbiel, V. Pres.; E. S. Horsman, Adv. Mgr.
PRODUCTS: Plastic materials; Phenolics; Compounds; Resins.

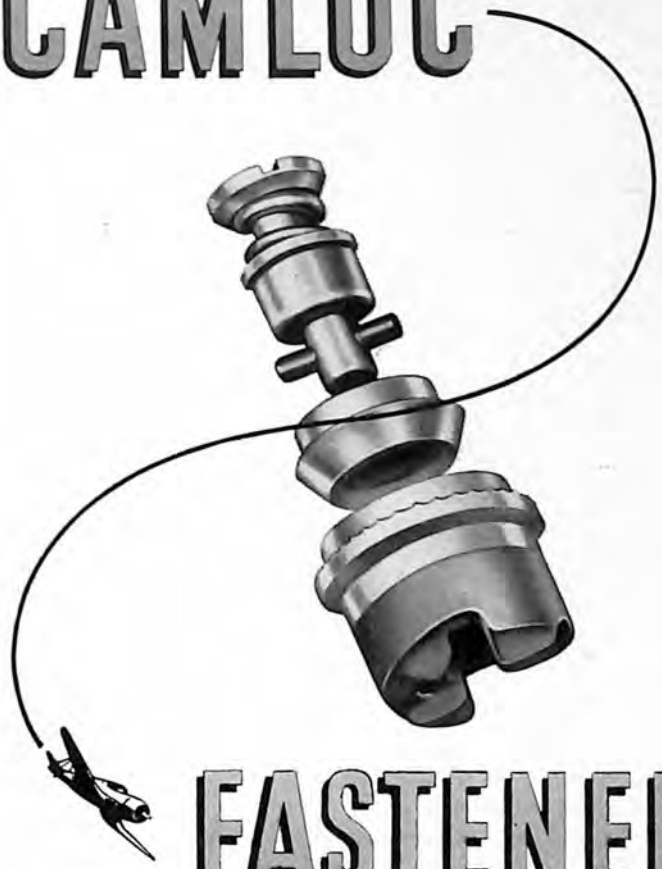
CEE BEE CHEMICAL CO., INC.,
655 E. Gage Ave., Los Angeles, Calif.
PERSONNEL: S. C. Black, Pres.; C. D. Black, Secy. & Treas.; D. Wright, Asst. Gen. Mgr.
PRODUCTS: Engine carbon remover.

CELANESE CELLULOID CORP.,
180 Madison Ave., New York, N. Y.
PERSONNEL: W. S. Landes, V. Pres.-Plastics; G. H. Richards, Gen. Mgr.; E. W. Ward, Gen. Sales Mgr.; J. G. Thomas, Pur. Agt.; H. E. Raymond, Adv. Mgr.; R. G. Piperoux, Chief Engr.
PRODUCTS: Basic materials and fabrications; Fuels and lubricants; Insulating materials; Dopes; Plastic parts.

CENTRAL SCREW COMPANY,
3501 Shields Ave., Chicago, Ill.
PERSONNEL: H. F. Kellogg, Pres., Treas. & Pur. Agt.; D. S. Jennings, V. Pres., Secy. & Gen. Mgr.; E. Payne, Sales Mgr.; M. Colombo, Pers. Dir.; R. B. Warren, Pub. Dir.; W. Roche, Chief Engr.
PRODUCTS: Fasteners.

CENTURY AIRCRAFT COMPANY,
5601 Century Blvd., Los Angeles, Calif.
PERSONNEL: J. M. Henry, Gen. Mgr.
PRODUCTS: De-icer equipment; Hydraulic controls and assemblies; Landing gears; Subassemblies.

CAMLOC



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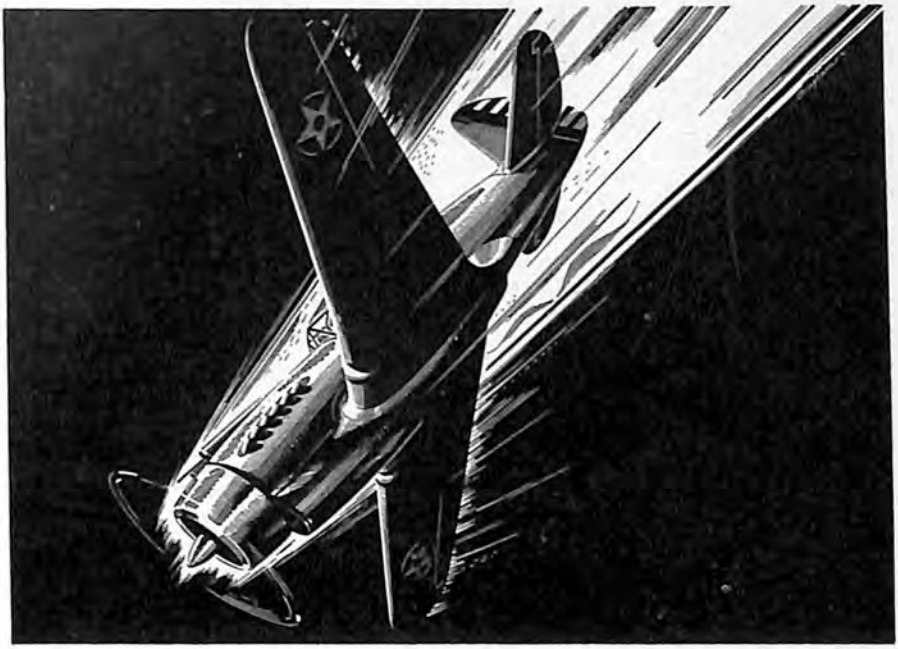

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PRODUCTS: Electrical relays; Timing devices; Solenoids.

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PRODUCTS: Basic materials and fabrications; Insulating materials; Paints, varnishes and finishes; Plastic parts.

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PRODUCTS: Fasteners.

E

EAGLE PARACHUTE CORP.,
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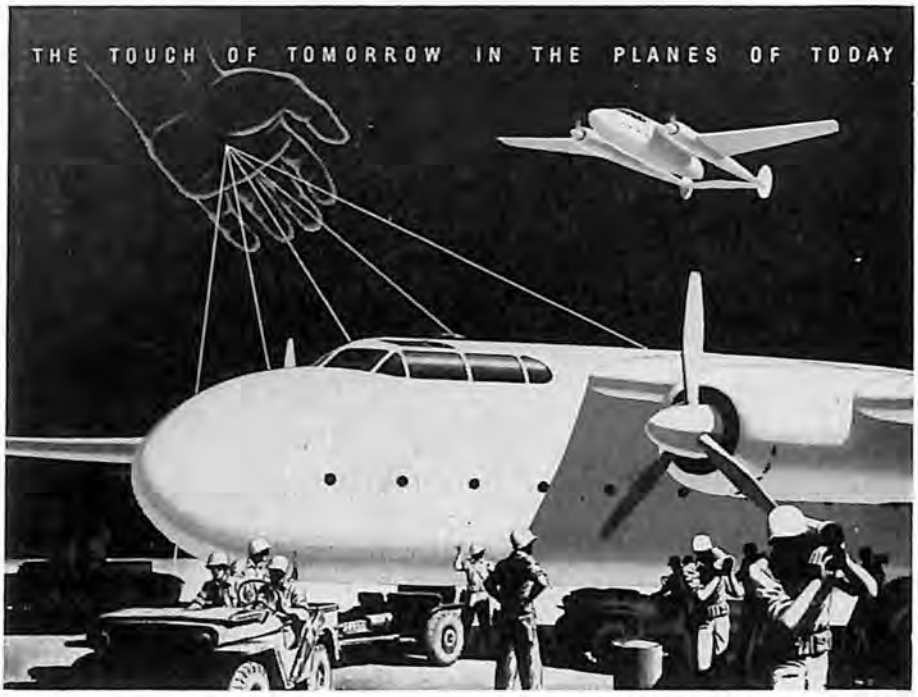
PRODUCTS: Flares; Life saving equipment Parachutes.



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PRODUCTS: Cowlings; Floats, skiis; Aluminum alloy parts; Sub-assemblies.

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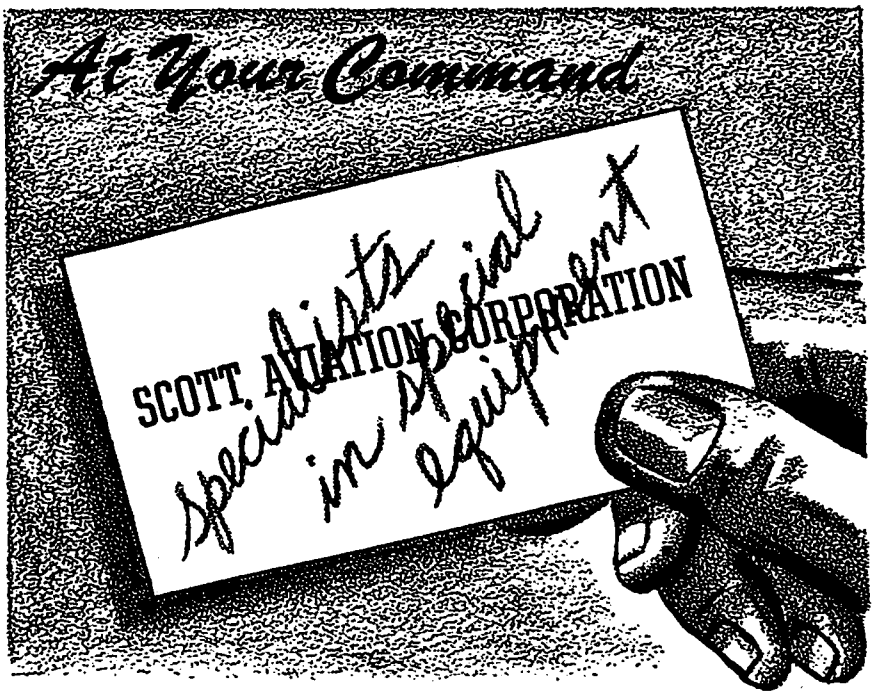
PRODUCTS: Terminals; Wire; Cable.



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PRODUCTS: Scales.

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PRODUCTS: Airport equipment; Radios; Radio compasses.

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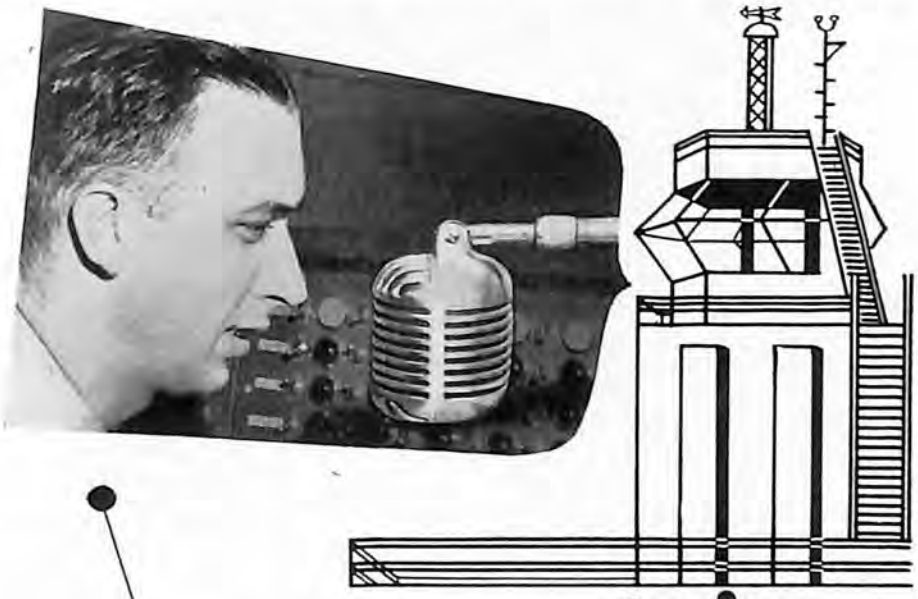
PERSONNEL: L. H. Hansel, Pres. & Gen. Mgr.; G. H. Wood, V. Pres.; W. C. King, Secy., Sales Mgr. & Pub. Dir.; E. M. Guillaume, Treas.; C. V. S. Purdy, Pur. Agt.
PRODUCTS: Insulating materials; Felt parts; Vibration dampers.



Clearer Transmission

Clear, penetrating signals that command attention! The Shure Super-Cardioid Communications Microphone makes this possible. Its Cardioid pickup pattern, sensitive at the front—dead at the rear, rejects 73% of all unwanted sounds. Its special Speech Response increases intelligibility of signals. At Airports where background noise and other acoustic interference is present—use a Shure Super-Cardioid for the traffic control tower and paging systems.

Shure Brothers are manufacturing Microphones for the armed forces of the United Nations. Every effort is being put forth in engineering and production to hasten the day of final victory for the democratic forces.

SHURE

SHURE BROTHERS

Designers and Manufacturers of Microphones and Acoustic Devices

225 West Huron Street, Chicago

FENWAL, INC., Ashland, Mass.
PERSONNEL: T. L. Fenn, Pres.; W. J. Turenne, V. Pres.
PRODUCTS: Controls; Fire detector; Thermostitches.

FERRACUTE MACHINE CO., Bridgeton, N. J.
PERSONNEL: G. E. Bass, Pres.; H. Janvier, V. Pres.; P. Meyers, Secy.; L. Meyers, Treas., Gen. Mgr. & Chief Engr.; C. M. Hobson, Jr., Sales Engr.; G. Smith, Pur. Agt.; A. T. Bayley, Pers. Dir.
PRODUCTS: Presses and press brakes.

FIBRE CONDUIT CO., Orangeburg, N. Y.
PERSONNEL: H. J. Robertson, Jr., Pres.; J. R. Connell, V. Pres. & Sales Mgr.; F. G. Wehman, Secy. & Treas.; G. Allen, Pur. Agt.; B. G. LeMieux, Chief Engr.
PRODUCTS: Fibre conduit; Underground conduit; Underfloor duct.

FIRESTONE AIRCRAFT CO., Firestone Pkwy., Akron, O.
PERSONNEL: H. S. Firestone, Jr., Pres.; J. L. Cohill, V. Pres.; W. Shaw, Sales Mgr.
PRODUCTS: Motor mounts; Oil seals; Rubber accessories; Synthetic rubber parts; De-icer shoes for propellers; Wood and metal seats; Air springs; Tail wheel assemblies; Tires and tubes; Wheels and brakes; Miscellaneous.

FIRST AID SUPPLY CO., 32 W. 22nd St., New York, N. Y.
PERSONNEL: J. Maslan, Pres.; R. Rudin, Secy.; G. Wishny, Gen. Mgr.; P. Baer, Chief Engr.
PRODUCTS: First aid equipment.

FIRTH-STERLING STEEL CO., McKeesport, Pa.
PERSONNEL: L. G. Firth, Pres. & Gen. Mgr.; D. G. Clark, V. Pres.; C. G. Krapf, Secy.; H. R. Huemme, Treas.; A. B. Corbin, Sales Mgr.; H. K. Stern, Pur. Agt.; W. F. Rechter, Pers. Dir.; C. F. Hoffman, Pub. Dir.; M. F. Judkins, Chief Engr. Firthite Div.
PRODUCTS: Cutting tools; Carbides; Sintered, high speed, stainless and tool steel.

FISCHER SPECIAL MFG. CO., 446 Morgan St., Cincinnati, O.
PERSONNEL: F. H. Fischer, H. F. Fischer, Partners; C. H. Gross, Sales Mgr.; F. Wehking, Pur. Agt.
PRODUCTS: Screw machine products.

FISCHER'S SURFA-SAVER, INC., Paddock Rd., & B & O R. R., Cincinnati, O.
PERSONNEL: H. Fischer, Pres. & Gen. Mgr.; H. D. Fischer, V. Pres.; E. B. Fischer, Secy. & Treas.
PRODUCTS: Cleaning solvents.

FISHER FURNACE CO., 5535 N. Wolcott Ave., Chicago, Ill.
PERSONNEL: W. P. Martin, Jr., Pres. & Treas.; K. D. Hoke, V. Pres. & Gen. Mgr.; E. Pankratz, Secy. & Pur. Agt.; P. J. Myall, Sales Mgr.; B. Bell, Chief Engr.
PRODUCTS: Furnaces; Blowers; Burners.

FISHER RESEARCH LABORATORY, 1961 University Ave., P. O. Box 356, Palo Alto, Calif.
PERSONNEL: G. R. Fisher, Owner; T. Brown, Treas.; C. Fisher, Gen. Mgr.; R. Adams, Sales Mgr.; O. M. McCoy, Pur. Agt.; C. Soderquist, Chief Engr.
PRODUCTS: Radios; Radio compasses.

FITCHBURG GRINDING MACHINE CORP. Falulah Rd., Fitchburg, Mass.
PERSONNEL: G. S. Gould, Pres., Gen. Mgr. & Pub. Dir.; J. Cushing, Sales Mgr.; J. J. Healey, Pur. Agt.; C. A. Hall, Chief Engr.
PRODUCTS: Machine tools.

GEORGE J. FIX CO., 2413 Commerce St., Dallas, Tex.
PERSONNEL: G. J. Fix, Sr., Pres. & Gen. Mgr.; L. M. Dorman, Sales Mgr.; G. J. Fix, Jr., Chief Engr.
PRODUCTS: Bearings; Bushings; Chains; Gears; Sprockets; Universal joints.

FLEETWINGS, INC., Bristol, Pa.
PERSONNEL: F. deGanahl, Pres.; C. deGanahl, I. S. Wilson, V. Pres.; C. Nielsen, Compt.; A. Thompson, Contracts Mgr.; W. E. Strang, Pers. Dir.; P. F. Biklen, Pub. Dir.; R. W. Ayer, Chief Engr.
PRODUCTS: Hydraulic controls and assemblies; Aluminum, plywood and steel parts; Control valves.

FLEX-O-TUBE CO., 750 14th St., Detroit, Mich.
PERSONNEL: J. L. Ward, Pres. & Sales Mgr.; R. DeTamble, V. Pres.; J. H. Conn, Secy. & Treas.; B. T. Shute, Gen. Mgr.; A. Wyka, Pur. Agt.; G. Fredericks, Pers. Dir.; N. Couty, Chief Engr.
PRODUCTS: Hydraulic controls and assemblies; Flexible oil and fuel tubing.

FLOTATION SYSTEMS, INC., 4031 Goodwin Ave., Los Angeles, Calif.
PERSONNEL: J. Q. Henry, Pres.; F. E. Kalte, V. Pres. & Pers. Dir.; H. D. Dargert, Secy. & Treas.; L. E. Sowden, Pur. Agt.; T. Gregory, Chief Engr.
PRODUCTS: Airport equipment; Fueling systems.

THE FOLMER GRAFLEX CORP., Rochester, N. Y.
PERSONNEL: N. L. Whitaker, Pres. & Gen. Mgr.; C. H. Harper, V. Pres. & Treas.; H. A. Schumacher, V. Pres. & Sales Mgr.; G. C. Whitaker, V. Pres.; J. E. B. Murphy, Secy.; C. J. Krembel, Pur. Agt.; M. S. Murphy, Pers. Dir.; W. H. Field, Pub. Dir.; V. E. Whitman, Chief Engr.
PRODUCTS: Aerial cameras; Misc. hardware; Sub-assemblies.

FOOTE BROS. GEAR & MACHINE CORP., 5225 S. Western Blvd., Chicago, Ill.
PERSONNEL: W. A. Barr, Pres. & Gen. Mgr.; R. G. Davis, V. Pres. & Pub. Dir.; A. Mackman, V. Pres.; J. R. Fagan, Secy. & Treas.; R. B. Moir, Sales Mgr. & Chief Engr.; W. H. Johnson, Pur. Agt.; R. Mathers, Pub. Dir.
PRODUCTS: Landing gears; Misc. engine equipment; Steel parts; Propellers and propeller parts; Miscellaneous.

THE FOOTE-BURT CO., Cleveland, O.
PERSONNEL: T. H. Doan, Pres.; W. F. Babcock, V. Pres.; S. E. Gross, Secy. & Treas.; W. G. Winship, Pur. Agt.; M. C. Wickham, Pub. Dir.
PRODUCTS: Machine tools.

THE J. B. FORD SALES CO., Biddle Ave., Wyandotte, Mich.
PERSONNEL: C. B. Robinson, Pres. & Gen. Mgr.; W. F. Torrey, V. Pres.; W. M. Cole, Sales Mgr.
PRODUCTS: Cleaners and cleaning compounds.

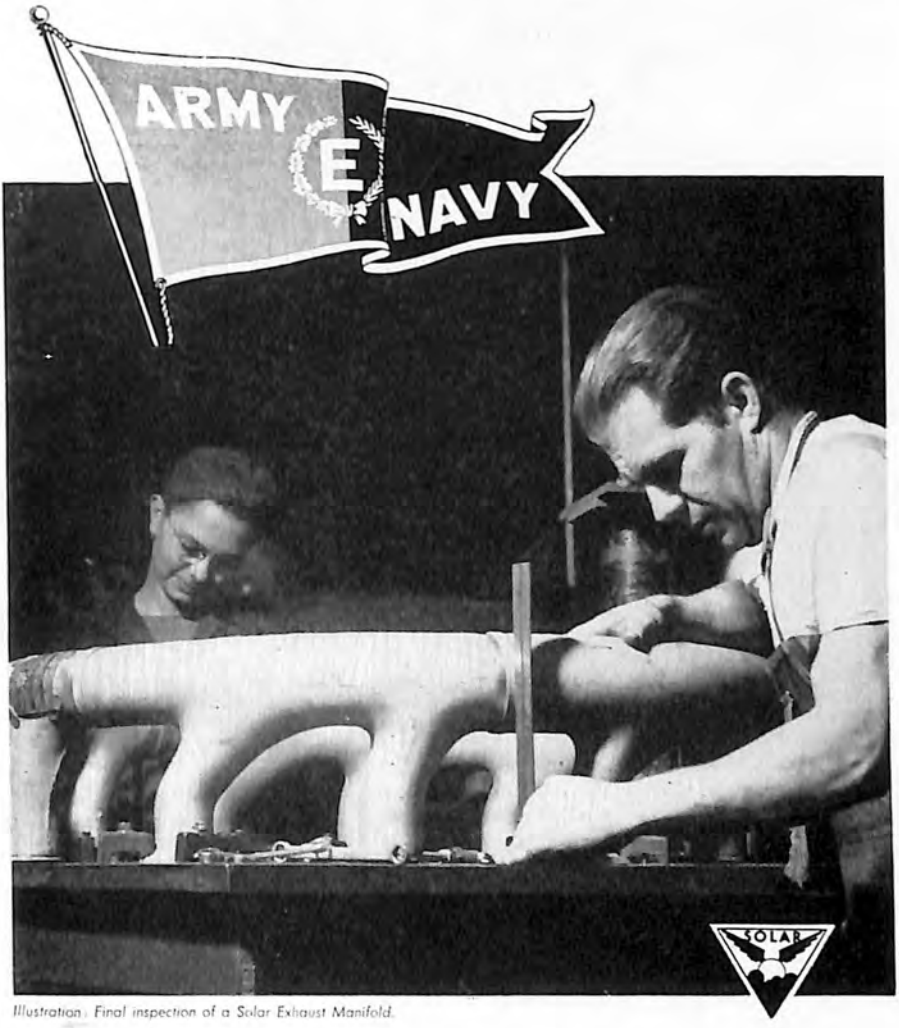


Illustration: Final inspection of a Solar Exhaust Manifold.

"—for accomplishing more than seemed reasonable or possible a year ago"—the men and women of Solar Aircraft have received the Army-Navy Production Award. Proudly will this pennant fly—an inspiration to greater achievement.

ARMY E NAVY

SOLAR

EXHAUST SYSTEMS—

SOLAR AIRCRAFT COMPANY • SAN DIEGO, CALIFORNIA

THE FORMICA INSULATION CO., 4614 Spring Grove Ave., Cincinnati, O.
PERSONNEL: D. J. O'Conor, Pres. & Secy.; W. J. Gebhart, Treas.; J. R. White, Sales Mgr.; J. H. Heitbrink, Pur. Agt.; G. H. Clark, Chief Engr.
PRODUCTS: Plastic parts.

FORSYTH METAL GOODS CO., 129 Elm St., East Aurora, N. Y.
PERSONNEL: W. H. Blake, Pres.; G. E. Blake, Treas.
PRODUCTS: Exhaust manifold flanges; Stampings; Flexible tubing.

THE FOSTORIA PRESSED STEEL CORP., Fostoria, O.
PERSONNEL: R. J. Carter, Pres., Treas. & Gen. Mgr.; C. W. McDaniel, V. Pres., Secy. & Pub. Dir.; E. L. Bates, Sales Mgr.; R. L. Hill, Pur. Agt.; W. S. Crandall, Chief Engr.
PRODUCTS: Airport drying and lighting equipment; De-icer equipment; Non-magnetic plane lights.

THE FOUR WHEEL DRIVE AUTO CO., Clintonville, Wisc.
PERSONNEL: W. A. Olen, Pres. & Gen. Mgr.; J. D. Cotton, V. Pres.; S. H. Sanford, Secy.; D. J. Rohrer, Treas.; R. H. Schmidt, Sales Mgr.; L. Pinkowsky, Pur. Agt.; F. Dana, Pers. Dir.; F. M. Higgins, Pub. Dir.; H. B. Dodge, Chief Engr.
PRODUCTS: Refueling units; Crash trucks; Airport maintenance and snow removal units.

FOWLER AIRCRAFT CO., 4642 Cass Blvd., San Diego, Calif.
PERSONNEL: H. D. Fowler, Owner; Mrs. H. D. Fowler, Treas.; S. Kousens, Supt.; J. Fischer, Pur. Agt.
PRODUCTS: Fittings; Machine tools; Parachute frames; Stampings; Sub-assemblies.

S. G. FRANTZ CO., INC., 161 Grand St., New York, N. Y.
PERSONNEL: S. G. Frantz, Pres. & Treas.; F. H. Boyd, V. Pres. & Sales Mgr.; G. E. Gibson, Secy.
PRODUCTS: Filters.

FRAY MACHINE TOOL CO., 515 W. Windsor Rd., Glendale, Calif.
PERSONNEL: J. H. Richards, Pres. & Gen. Mgr.; L. Hales, V. Pres.; O. W. Weyman, Secy. & Treas.; R. W. Wollard, Pur. Agt.; F. Pollon, Chief Engr.
PRODUCTS: Machine tools.

FRAZAR & CO., LTD., 301 Clay St., San Francisco, Calif.
PERSONNEL: E. W. Frazar, Pres.; O. C. Hansen, V. Pres.; B. Hassler, Sales Mgr.
PRODUCTS: Cleaners and cleaning compounds; Radios; Radio compasses.

FREEDMAN BURNHAM ENGINEERING CORP., 659 E. Sixth St., Cincinnati, O.
PERSONNEL: G. L. Freedman, Pres.; B. M. Wallenstein, V. Pres. & Pur. Agt.; W. E. Burnham, V. Pres. & Chief Engr.; S. S. Freedman, Secy. & Treas.
PRODUCTS: Propellers and propeller parts.

JULIEN P. FRIEZ & SONS, DIV. BENDIX AVIATION CORP., Taylor Ave., Towson, Md.
PERSONNEL: B. A. Best, Asst. Secy.; L. L. Friez, Div. Gen. Mgr.; D. McCormack, Sales Mgr.; W. C. Curran, Pur. Agt.; R. R. Chappell, Chief Engr.
PRODUCTS: Aircraft armament; Airport equipment; Cameras; Controls; Instruments; Sub-assemblies; Ventilating and air conditioning equipment.

FUEL INJECTION CORP., Getty at Keating, Muskgon, Mich.
PERSONNEL: L. Wegusen, Pres.; G. L. Lundborg, V. Pres., Secy. & Gen. Mgr.; C. F. High, V. Pres., Sales Mgr. & Chief Engr.; H. W. Harper, Treas.
PRODUCTS: Carburetors.

W. P. FULLER & CO., 135 N. Los Angeles St., Los Angeles, Calif.
PERSONNEL: H. B. Wilson, Gen. Mgr.; M. G. McKinlay, Sales Mgr.; H. L. Acker, Chief Engr.
PRODUCTS: Paints, varnishes and finishes. Engine primers.

THE FULTON SYLPHON CO., Knoxville Tenn.
PERSONNEL: J. V. Giesler, Pres.; C. N. Mynderse, V. Pres. & Gen. Mgr.; W. S. D. Woods, Secy.; R. S. Reynolds, Jr., Treas.; F. C. Cross, Sales Mgr.; E. C. Silver, Pur. Agt.; W. S. Fowler, Pers. Dir.; E. D. Rogers, Pub. Dir.; W. L. Chandler, Chief Engr.
PRODUCTS: Aircraft armament; Controls; Instruments; Misc. engine equipment; Control valves; Ventilating and air conditioning equipment.

G

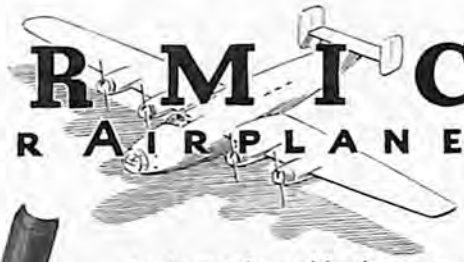
THE G & O MANUFACTURING CO., 138 Winchester Ave., New Haven, Conn.
PERSONNEL: A. J. Verdi, Pres.; V. Carangelo, V. Pres.; F. I. Newton, Secy.; C. Oppe, Treas. & Gen. Mgr.; H. E. Benevento, Pur. Agt.
PRODUCTS: Oil coolers; Radiators.

THE GABRIEL CO., 1407 E. 40th St., Cleveland, O.
PERSONNEL: J. H. Briggs, Pres. & Gen. Mgr.; L. W. Klein, V. Pres., Sales Mgr. & Pub. Dir.; C. R. Wefler, Secy. & Treas.; G. E. McAllister, Pur. Agt.; C. B. Kurtz, Jr., Pers. Dir.; E. L. Beecher, Chief Engr.
PRODUCTS: Hydraulic controls & assemblies; Landing Gears; Shock struts and cord.

THE GAERTNER SCIENTIFIC CORP. 1201 Wrightwood Ave., Chicago, Ill.
PERSONNEL: W. Gaertner, Pres., Treas., Gen. Mgr. & Sales Mgr.; S. Jacobsohn, V. Pres.; J. Mandel, Secy.; V. DeCancq, Pur. Agt.; L. W. Higgins, Pub. Dir.; P. F. Meyn, Chief Engr.
PRODUCTS: Oxygen regulators; Flowmeters; Masks; Oxygen tanks; Bail-out cylinders; High altitude testing equipment; Toolmaker microscopes; Micrometer slides.

FORMICA

FOR AIRPLANES



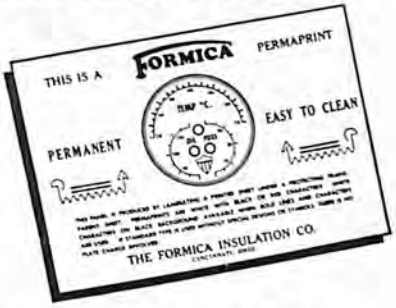
Light weight, stable dimensions, resistance to corrosion, make Formica an important material in airplane construction: Insulation for electrical circuits, pulleys, bushings and spools for cable control, instrument panels and identification plates, and in the Pregwood grade, for propeller parts and air frame members.

CONTROL PULLEYS

The largest single item in Formica production for the aviation industry is control pulleys. These are made in the complete range of standard sizes according to Army and Navy specifications, and in types with anti-friction and plain bearings.

INSTRUMENT PANELS

Formica instrument panels may be printed, engraved, stamped or printed with fluorescent inks which are brightly legible in black or invisible light. Instruction and identification plates may be produced in black lettering on a white background or vice-versa.



PREGWOOD PROPELLER BLADES

Pregwood is a special grade of Formica made by impregnating thin plywood with thermosetting resins and vulcanizing it into a strong, hard, homogeneous material, from blocks of which propeller blades and propeller parts are machined. The material is also used for edge strips to hold fastenings, where one section of a plywood structure butts up against the next.

THE FORMICA INSULATION COMPANY
CINCINNATI, OHIO

GALENA OIL CORP.,
440 Culvert St., Cincinnati, O.
PERSONNEL: H. M. Hart, Pres.; B. H. Morris, V. Pres.; E. H. Shepherd, Pur. Agt.; G. L. Service, Pub. Dir.; L. A. Calkins, Chief Engr.
PRODUCTS: Lubricating oils and greases.

GARDNER-DENVER CO., Quincy, Ill.
PERSONNEL: H. G. Myers, Pres. & Gen. Mgr.; E. F. Schaefer, V. Pres.; G. H. Gubbins, Secy.; L. H. Stout, Treas.; R. J. MacFarland, Sales Mgr. & Chief Engr.; E. J. Maloney, Pur. Agt.; B. B. Gooch, Pers. Dir.; B. P. Spann, Pub. Dir.
PRODUCTS: Air compressors; Pumps.

GARDNER MACHINE CO., Beloit, Wisc.
PERSONNEL: W. P. Leishman, Pres., Pers. Dir. & Sales Mgr.; I. R. Shue, V. Pres.; C. W. Thompson, Secy.; F. V. Halstead, Pur. Agt.; H. B. Nielsen, Pub. Dir.
PRODUCTS: Machine tools.

GARDNER PROPELLER CO.,
215 Harlem Ave., Forest Park, Ill.
PERSONNEL: W. H. Gardner, Chief Engr.
PRODUCTS: Propellers and propeller parts.

THE GARLOCK PACKING CO.,
Palmyra, N. Y.
PERSONNEL: G. L. Abbott, Pres., Treas. & Gen. Mgr.; C. R. Hubbard, V. Pres.; R. M. Waples, Secy.; G. W. Cadwallader, Pur. Agt.; P. Arnold, Sales Mgr.; R. J. Hinkle, Pub. Dir.; J. B. McClain, Chief Engr.
PRODUCTS: Gaskets; Oil seals; Aluminum, leather, rubber and synthetic packings.

THE GASKET MANUFACTURING CO.,
324 Venice Blvd., Los Angeles, Calif.
PERSONNEL: L. B. Van De Car, Gen. Mgr.; E. A. Kellenberger, Sales Mgr.
PRODUCTS: Gaskets.

GEAR GRINDING MACHINE CO.,
3901 Christopher, Detroit, Mich.
PERSONNEL: C. N. Macdonald, Pres.; D. W. R. Macdonald, V. Pres.; M. Scheimer, Secy. & Treas.; A. W. Rudel, Sales Mgr.; M. R. King, Pur. Agt.; I. Gruenberg, Chief Engr.
PRODUCTS: Machine tools.

GEM SHINE PRODUCTS CO.,
1213 W. 59th St., Chicago, Ill.
PERSONNEL: G. E. Mortenson, Pres.; A. Stake, V. Pres.; O. Stake, Secy.
PRODUCTS: Cleaners and cleaning compounds.

GENERAL ABRASIVE CO., INC.,
Niagara Falls, N. Y.
PERSONNEL: A. V. Parker, Pres., Gen. Mgr. & Pers. Dir.; R. Macdonald, Jr., V. Pres.; C. Lockwood, Secy.; H. A. Richmond, Treas.; A. J. Sandorff, Sales Mgr.; E. J. Nicholson, Pur. Agt.; R. P. Trott, Chief Engr.
PRODUCTS: Abrasive grains for blasting and polishing.

GENERAL AIRCRAFT EQUIPMENT, INC.,
South Norwalk, Conn.
PERSONNEL: C. M. Torrey, Pres. & Gen. Mgr.; C. B. H. Deller, V. Pres.; S. M. Loomis, Secy. & Treas.
PRODUCTS: Aircraft armament; Ammunition boxes and counters; Bomb racks; Collector rings, cowls, streamlines; Cowlings; Stampings; Sub-assemblies; Oxygen and electrical systems; Gun controls; Flame damping exhausts.

GENERAL AIRCRAFT SUPPLY CORP.,
Detroit City Airport, Detroit, Mich.
PERSONNEL: L. F. Zygmunt, Pres.; P. Altman, V. Pres.; H. L. Mitchell, Secy. & Treas.; G. Reidy, Gen. Mgr.
PRODUCTS: Airport equipment; Basic materials and fabrications; Batteries; Clamps; Cleaners and cleaning compounds; Control sticks and wheels; Covers; Fasteners; Fire extinguishers; First aid equipment; Flares; Gaskets; Landing and naviagation lights; Paints, varnishes and finishes; Parachutes; Plastic parts; Piston rings; Propellers and propeller parts; Protective clothing and equipment; Radios; Spark plugs; Tail wheel assemblies; Tires and tubes; Tools; Wheels and brakes.

GENERAL ARMATURE CORP.,
Lock Haven, Pa.
PERSONNEL: Lou Mervis, Pres., Treas. & Gen. Mgr.; M. B. Mervis, V. Pres.; M. G. Mervis. Secy.; Leonard Mervis, Sales Mgr.; A. C. Potratz, Pur. Agt.; J. A. Petrunak, Pers. Dir.; G. K. Warner, Pub. Dir.; J. F. Cullin, Chief Engr.
PRODUCTS: Dynamotors; Generators.

GENERAL AVIATION EQUIPMENT CO., INC., 61-73 Mary St., Ashley, Pa.
PERSONNEL: V. C. Bell, Pres.; J. M. Faehndrich, V. Pres., Treas. & Gen. Mgr.; H. W. Conroy, Secy.; C. P. Elliott, Pur. Agt.
PRODUCTS: Aluminum, fibre, plastic and steel parts; Control pulleys.

GENERAL BRONZE CORP., 24-19 Tenth St., Long Island City, N. Y.
PERSONNEL: W. P. Jacob, Pres.; E. Peremi, V. Pres.; I. L. Martin, Secy. & Treas.; C. C. Moran, Sales Mgr.; H. Meyer, Pur. Agt.; C. Samson, Pers. Dir.; H. L. King, Pub. Dir.; A. Danielsen, Chief Engr.
PRODUCTS: Aluminum and bronze castings; Sub-assemblies.

GENERAL CONTROLS CO.,
801 Allen Ave., Glendale, Calif.
PERSONNEL: W. A. Ray, Pres. & Chief Engr.; A. W. Ray, V. Pres.; E. T. Howard, Sales Mgr.; H. E. Callahan, Pur. Agt.; C. E. Wilson, Pub. Dir.
PRODUCTS: Controls; De-icer equipment; Hydraulic controls and assemblies; Engine primers; Control valves; Ventilating and air conditioning equipment.

THE GENERAL DETROIT CORP.,
2272 E. Jefferson Ave., Detroit, Mich.
PERSONNEL: C. K. Huthsing, Pres. & Treas.; E. A. Warren, V. Pres.; R. L. Braden, Secy.; A. A. Morris, Plant Supt. & Pers. Dir.; F. D. Bacon, Sales Mgr. & Pub. Dir.; C. J. Thoman, Pur. Agt.; C. W. Floss, Chief Engr.
PRODUCTS: Fire extinguishers.

GENERAL DROP FORGE DIV. OF BROWN-LIPE GEAR CO., 1738 Elmwood Ave., Buffalo, N. Y.
PERSONNEL: C. A. Dana, Pres.; W. B. Breyley, V. Pres.; J. V. Melick, Secy. & Treas.; W. B. Breyley, Jr., Plant Mgr.; B. Herman, Pur. Agt.; J. Gallagher, Pers. Dir.; J. H. Chandler, W. Hopson, Chief Engrs.
PRODUCTS: Castings and forgings.

GENERAL ELECTRIC CO.,
Schenectady, N. Y.
PERSONNEL: G. Swope, Pres.; E. O. Shreve, V. Pres.; C. H. Lang, V. Pres. & Apparatus Sales Mgr.; J. C. Miller, Mgr. Aviation Div.; R. S. Peare, Pub. Mgr.
PRODUCTS: Generators; Motors; Switches; Controls; Radios; Voltage regulators and relays; Instruments; Magnetos; Armament; Cabin superchargers; Superchargers.

GENERAL ENGINEERING CO.,
785 Hertel Ave., Buffalo, N. Y.
PERSONNEL: W. Johndrew, T. H. Speller, Partners; O. F. Johndrew, Sales Mgr.; E. D. Williams, Pur. Agt.; J. A. Randolph, Chief Engr.
PRODUCTS: Machine tools.

GENERAL MANUFACTURING CO.,
6430 Farnsworth Ave., Detroit, Mich.
PERSONNEL: F. C. Hossie, Pres. & Gen. Mgr.; H. F. Marsh, Secy. & Sales Mgr.; I. A. Unger, Treas.
PRODUCTS: Machine tools.

GENERAL RADIO CO.,
30 State St., Cambridge, Mass.
PERSONNEL: M. Eastham, Pres.; E. H. Locke, V. Pres. & Pers. Dir.; H. B. Richmond, Treas.; A. E. Thiessen, Sales Mgr.; W. H. Sherwood, Pur. Agt.; C. E. Worthen, Pub. Dir.; C. T. Burke, Engrg. Mgr.
PRODUCTS: Noise and vibration meters; Stroboscopes; Radio test equipment.

THE GEOMETRIC TOOL CO.,
New Haven, Conn.
PERSONNEL: G. S. Tracy, Asst. Sales Mgr.
PRODUCTS: Die heads; Taps; Threading machines.

E. A. GERLACH CO.,
3567-71 Sepviva St., Philadelphia, Pa.
PERSONNEL: R. G. Gerlach, Pres. & Treas.; T. W. Cleeland, Sales Mgr.
PRODUCTS: Engine point stripping and decarbonizing compounds.

GILBERT & BARKER MFG. CO.,
W. Springfield, Mass.
PERSONNEL: S. C. Hope, Pres. & Gen. Mgr.; T. C. O'Donnell, V. Pres.; P. H. Bills, V. Pres. & Treas.; G. MacDonald, Secy.; W. C. Leitch, Sales Mgr.; H. D. Foss, Pur. Agt.; C. Umla, Pers. Dir.; R. B. White, Pub. Dir.; H. O. Grimmeisen, Chief Engr.
PRODUCTS: Fueling for airport equipment; Filters and strainers; Stampings; Sub-assemblies.

OHN W. GILLETTE & CO.,
901 Stephenson Bldg., Detroit, Mich.
PERSONNEL: J. W. Gillette, Jr., Pres.
PRODUCTS: Protective clothing and equipment; Sound deadening materials; Upholstery; Instrument coverings.

GISHOLT MACHINE CO., 1399 E. Washington Ave., Madison, Wisc.
PERSONNEL: G. H. Johnson, Pres.; H. S. Johnson, Jr., A. B. Morey, V. Pres.; G. M. Class, V. Pres.-Engrg.; G. E. Gernon, Secy.; H. J. Homewood, Treas.; C. K. Swafford, Gen. Mgr.; F. L. Chapman, Sales Mgr.; R. K. Newton, Pur. Agt.; J. Tooney, Pers. Dir.; J. Hazlewood, Pub. Dir.
PRODUCTS: Balancing machines; Turret and automatic lathes.

GLENN-ROBERTS CO.,
1009 Fruitvale Ave., Oakland, Calif.
PERSONNEL: G. G. Glenn, Pres.; P. A. Carrothers, Secy.; J. E. Vosburgh, Sales Mgr.; J. C. Weaver, Pur. Agt.; D. C. Girard, Chief Engr.
PRODUCTS: Transformer type arc welders.

THE GLIDDEN CO.,
11001 Madison Ave., Cleveland, O.
PERSONNEL: A. D. Joyce, Pres.; R. H. Horsburgh, V. Pres.; C. M. Kolb, Secy.; J. A. Peters, Treas.; D. P. Joyce, Gen. Mgr.; J. L. Noon, Sales Mgr.; J. M. Stadter, Pur. Agt.; C. L. Cole, Pers. Dir.; P. L. Lotz, Pub. Dir.; O. F. Shobe, Chief Engr.
PRODUCTS: Cleaners and cleaning compounds; Insulating materials; Paints, varnishes and finishes; Dopes; Lacquers; Thinners.

GLOBE STEEL TUBES CO.,
Milwaukee, Wisc.
PERSONNEL: W. C. Buchanan, Pres. & Gen. Mgr.; F. J. O'Brien, V. Pres. & Sales Mgr.; G. O. Ross, Secy. & Treas.; A. Korsan, Pur. Agt.; G. W. Walzer, Pers. Dir.; H. K. Ihrig, Chief Engr.
PRODUCTS: Steel parts: Tubing.

GODDARD-JACKSON CO.,
935 Santa Fe Ave., Los Angeles, Calif.
PERSONNEL: A. C. Goddard, Pres. & Gen. Mgr.; A. E. Fouts, V. Pres. & Sales Mgr.; M. L. Hilands, Secy. & Treas.; P. E. Boyd, Pur. Agt.
PRODUCTS: Bearings; Roller chain and sprockets; Hose clamps and hose fittings.

THE GOGGLE PARTS, CO.,
Blackstone Bldg., Cleveland, O.
PERSONNEL: W. R. Paterson, J. D. Hill, Partners.
PRODUCTS: First aid equipment; Protective clothing and equipment.

THE B. F. GOODRICH CO., AERONAUTICAL DIV., Akron, O.
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PRODUCTS: De-icer equipment; Gaskets; Oil seals; Rubber and synthetic parts; Shock struts and cord; Tanks; Tires and tubes; Tubing; Vibration dampers; Wheels and brakes.

GOODYEAR AIRCRAFT CORP., Akron, O.
PERSONNEL: P. W. Litchfield, Pres.; E. J. Thomas, P. E. H. Leroy, R. DeYoung, K. Arnstein, V. Pres.; H. E. Blythe, V. Pres. & Gen. Mgr.; Z. C. Oseland, Treas.; H. L. Hyde, Secy.; L. A. Murphy, Pur. Agt.
PRODUCTS: Airplane parts; Wheels and brakes.

Aircraft Lighting and Controls

RUNNING LAMP ASSEMBLY
TYPE A-8
SINGLE CONTACT
Air Corps Drawing
3784962
Air Corps Specification
94-32116
Weight—.188 lbs. complete (without bulb)
Overall size—
length 3 1/8";
width 1 7/8";
height 2 1/2".

DOME LAMP ASSEMBLY
TYPE A-2
Air Corps Drawing
34B2946
Air Corps Specification
94-32015
Weight—.516 lbs. complete (without bulb)
Overall size—
length 6 1/16" approx.;
diam. 4 7/8"; depth 2 5/32".

SIGNAL LAMP ASSEMBLY
DOUBLE CONTACT—
Air Corps Drawing
39A2822
SINGLE CONTACT—
Air Corps Drawing
39A2823
Weight—.0625 lbs. complete (without bulb)
Overall size—
length 2 7/8";
diameter 1 3/16".

OIL TANK VENT VALVE
To impose pressure in oil tank and prevent air laden oil from returning to system. After desired pressure built up in tank, excess is returned to crank case for venting through crank case breather system. Return valve prevents vacuum developing in oil tank. Wt. 14 oz.—2 1/4" diam. x 5 1/2" length overall.

OIL DILUTION VALVE
Electro-magnetic valve designed primarily for dilution of engine oil with gasoline for instant starting in cold climates. Available for 12 to 24 volt systems. Wt. 12 1/2 oz.—1 9/16" diam. x 3 5/8" length overall.

ANEROID VALVE
To eliminate fuel cavitation by maintaining the correct pressure in the fuel system for all flight conditions. Wt. 1 lb., 2 oz. — 4 1/4" x 5" overall size.

We make many other precision instruments, lamps, and accessories for all types aircraft. Write for data, prices.

STANDAIR

STANDARD AIRCRAFT PRODUCTS, Inc., Dayton, Ohio

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Hartwell Aviation Supply Co., 3417 Crenshaw Blvd., Los Angeles, Calif.
L. M. Payne Company, Inc., 417 Curtis Building, Detroit, Michigan

GOODYEAR TIRE & RUBBER CO.,
Akron, O.
PERSONNEL: E. J. Thomas, Pres.; R. S. Wilson, P. E. H. Leroy, C. Slusser, H. E. Blythe, J. M. Linforth, J. E. Mayl, V. Pres.; W. D. Shilts, Secy.; Z. C. Oseland, Treas.; V. R. Jacobs, Mgr. Aeronautics Dept; R. S. Wilson, Sales Mgr.; E. H. Brooks, Pur. Agt.; R. S. Pope, Pers. Dir.; L. E. Judd, Pub. Dir.; H. A. Planner, Chief Engr.
PRODUCTS: Barrage balloons; Flotation gear; Rubber boats and rafts; Life vests; Parachute pack boats; Bullet seal fuel and oil tanks; Hose; Engine mounts; Floats, skiis; Gaskets; Hose clamps and hose fittings; Landing gears; Life saving equipment; Rubber and synthetic parts; Protective clothing and equipment; Seats; Tail wheel assemblies; Tires and tubes; Tubing; Vibration dampers; Wheels and brakes; Miscellaneous.

GEORGE GORTON MACHINE CO.,
1331 Racine St., Racine, Wisc.
PERSONNEL: F. C. Kinney, Pub. Dir.
PRODUCTS: Machine tools.

GOULD & EBERHARDT, INC.,
433 Fabyan Place, Newark, N. J.
PERSONNEL: F. L. Eberhardt, Pres. & Gen. Mgr.; U. Eberhardt, V. Pres. & Treas.; H. Eberhardt, Secy. & Pur. Agt.; G. E. Spies, Sales Mgr.; W. F. Zimmermann, Chief Engr.
PRODUCTS: Machine tools.

GOULD STORAGE BATTERY CORP.,
35 Neoga St., Depew, N. Y.
PERSONNEL: A. H. Daggett, Pres.; H. G. Barnes, V. Pres. & Gen. Mgr.; C. R. Bachman, Secy.; E. F. Cary, Treas.; J. C. Sykora, Sales Mgr.; E. J. Suttell, Pur. Agt.; R. D. Thomas, Pers. Dir.; R. C. Cragg, Pub. Dir.; J. L. Rupp, Chief Engr.
PRODUCTS: Batteries.

THE GOVRO-NELSON CO.,
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PERSONNEL: V. Gauvreau, Gen. Mgr.
PRODUCTS: Aircraft engine parts; Drilling units.

THE GRAHAM MFG. CO., INC.,
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PERSONNEL: J. C. B. Washburn, Pres., Treas. &. Gen. Mgr.; K. R. Dunnell, Secy.
PRODUCTS: Tools.

L. F. GRAMMES & SONS, INC.,
Allentown, Pa.
PERSONNEL: F. Weindel, Jr.; Pres. & Treas.; R. Lamont, V. Pres.; W. G. J. Baur, Secy.; L. D. Kiechel, Sales Mgr.; J. A. Schaefer, Pur. Agt.
PRODUCTS: Fasteners; Misc. hardware; Instrument dials and panels; Radio panels; Instruction plates.

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PRODUCTS: Oil seals; Leather and synthetic parts.

G. A. GRAY CO.,
3611 Woodburn Ave., Cincinnati, O.
PERSONNEL: H. Marx, Pres.; A. Marx, V. Pres. & Gen. Mgr.; A. Zuest, Secy. & Treas.; J. E. Doran, Sales Mgr.; R. Jeggle, Pur. Agt.; E. Henke, Pers. Dir.; J. Walter, Chief Engr.
PRODUCTS: Machine tools.

GRAY RADIO CO., West Palm Beach, Fla.
PERSONNEL: F. E. Gray, Owner & Chief Engr.; G. H. De Shazo, Gen. Mgr. & Pur. Agt.
PRODUCTS: Radio telephone equipment.

GREAT WESTERN STEEL CO., INC.,
1011 E. 61st St., Los Angeles, Calif.
PERSONNEL: C. G. Hoyland, Pres.; F. X. Moore, V. Pres.; R. A. Moore, Secy. & Treas.
PRODUCTS: Tool and special steels.

THE GREIST MFG. CO.,
Blake St., New Haven, Conn.
PRODUCTS: Steel parts; Stampings.

GRIMES MFG. CO.,
515 N. Russell St., Urbana, O.
PERSONNEL: W. G. Grimes, Pres. & Treas.; C. Grimes, V. Pres.; N. Black, Secy.; D. O. Printz, Gen. Mgr.; L. B. Moore, Sales Mgr. & Chief Engr.; K. Durnell, Pur. Agt.; J. Davis, Pers. Dir.
PRODUCTS: Landing and navigation lights.

GRINNELL CO., INC.,
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PRODUCTS: Castings and forgings; Fittings.

GROB BROTHERS, Grafton, Wisc.
PERSONNEL: B. Grob, T. Grob, Partners & Gen. Mgrs.; L. W. Rothe, Pur. Agt.
PRODUCTS: Machine tools.

GUARDIAN ELECTRIC MANUFACTURING CO., 1621 W. Walnut St., Chicago, Ill.
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PRODUCTS: Collector rings, cowls, streamlines; Cowlings; Cylinder deflectors, baffles, brackets; Exhaust manifolds; Manifolds; Tools.

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PRODUCTS: Navigation instruments.

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PRODUCTS: Airport equipment; Ammunition boxes and counters; Indirect lighting systems; Landing and navigation lights; Stampings; Ventilating and air conditioning equipment.

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PRODUCTS: Airport equipment; Ammunition boxes and counters; Clamps; Cylinder deflectors, baffles, brackets; Disconnect plugs; Terminals; Misc. electrical equipment; Flares; Indirect lighting systems; Landing and navigation lights; Panels; Radio & ignition shielding; Stampings.

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PRODUCTS: Valve and valve seat grinding equipment.

HAMILTON STANDARD PROPELLERS, DIV. OF UNITED AIRCRAFT CORP., 362 S. Main St., E. Hartford, Conn.
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PRODUCTS: Propellers.

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PRODUCTS: Plywood parts.

HARDMAN AIRCRAFT PRODUCTS, INC., 12324 Center St., South Gate, Calif.
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PRODUCTS: Ammunition boxes and counters; Bomb racks; Clamps; Collector rings, cowls, streamlines; Cowlings; Cylinder deflectors, baffles, brackets; Engine mounts; Exhaust manifolds; Aluminum, magnesium and steel parts; Seats; Tanks.

HARDMAN, PECK & CO., 524-542 W. 52nd St., New York, N. Y.
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PRODUCTS: Plywood parts; Propellers and propeller parts; Laminated wood parts for planes or gliders.

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PRODUCTS: Basic materials and fabrications; Controls; Control sticks and wheels; Covers; Cowlings; Engine mounts; Fittings; Landing gears; Misc. hardware; Aluminum, magnesium and steel parts; Shock struts and cord· Stampings; Sub-assemblies.

HALL ECCENTRIC VALVE SEAT GRINDING
UNIVERSALLY ADOPTED
FOR PRODUCTION AND MAINTENANCE

In airplane engine production and maintenance HALL ECCENTRIC Valve Seat Grinders have been adopted because of the finer precision and finish obtained with greater speed. Here is a partial list of HALL users: FORD (Pratt & Whitney Engines), PACKARD (Rolls-Royce and Marine Engines), BUICK (P. & W. Engines), CHEVROLET (P. & W Engines), ELECTRO-MOTIVE CORP., PRATT & WHITNEY (Canada), PRATT & WHITNEY (Australia), WRIGHT (Canada), GUIBERSON Diesel Engine Co., LYCOMING, RANGER, MENASCO, CONTINENTAL, PAN-AMERICAN AIRWAYS, PENNSYLVANIA CENTRAL AIRLINES, ROLLS-ROYCE (England), ARMSTRONG-SIDDELEY (England), DeHAVILAND (England), U. S. AIR CORPS, U. S. NAVY, U. S. TANK CORPS, R. A. F., R. C. A. F.

Below: Part of a battery of AWA Grinders shipped to Ford for P. & W. engine production.

Left: AW wet type ECCENTRIC Grinder. Made in production and service types. Operator can "blind" grind valve seats to finest precision and finish without losing time by repeated grinding and gauging operations.

At right: HALL AWA Universal Dual type ECCENTRIC Grinder set up for wet grinding valve seats in Allison engine.

At left: HALL AWA Universal Dual type Grinder shown above set up for wet grinding of seats in radial cylinders.

Right: HALL ECCENTRIC Grinder as built for Packard airplane and marine engine production.

Left: E. J. A. ECCENTRIC Grinder for production or service of valve seats located deep in in-line cylinders.

Right: HALL Model 80A Wet Type Valve Refacer. Has dual motors with rheostat control for work head motor. Has Micrometer Feed. Provides finish and precision to match HALL-ground valve seats.

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Write for catalog or put your particular grinding problem up to HALL Engineers as scores of others have done.

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PRODUCTS: Covers; Cowlings; Engine mounts; Aluminum and steel parts; Sub-assemblies.

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PRODUCTS: Bearings; Rubber bushings; Vibration dampers.

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PERSONNEL: R. N. Hartzell, Pres. & Gen. Mgr.; G. W. Hartzell, V. Pres.; R. Reck, Secy.; R. V. Hartzell, Treas.; R. W. Zimmerlin, Sales Mgr.; M. C. Wright, Pur. Agt.; W. E. Balliet, Pers. Dir.; F. J. Charavay, Chief Engr.
PRODUCTS: Propellers and propeller parts.

HARVEY MACHINE CO.,
6200 Avalon Blvd., Los Angeles, Calif.
PERSONNEL: L. M. Harvey, Pres.; L. A. Harvey, V. Pres.; H. Gratz, Secy.; A. Grossman, Treas.; E. W. Forrow, Sales Mgr.; R. Wolff, Pur. Agt.; D. Coleman, Pers. Dir.; E. Casler, L. Stearman, G. Greene, Engrs.
PRODUCTS: Aircraft armament; Ammunition boxes and counters; Bomb racks; Collector rings, cowls, streamlines; Control sticks and wheels; Cowlings; Misc. electrical equipment; Engine mounts; Exhaust manifolds; Engine pre-heaters; Instruments; Machine tools; Aluminum parts; Propeller parts; Radios; Radio compasses; Stampings; Sub-assemblies; Tanks.

HARVEY RADIO LABS. INC.,
447 Concord Ave., Cambridge, Mass.
PERSONNEL: F. Lyman, Jr., Pres.; R. H. Vacca, V. Pres. & Chief Engr.; G. E. Moorehouse, Secy.; G. J. Gregory, Pers. Dir.
PRODUCTS: Radios.

HARVEY-WELLS COMMUNICATIONS, INC., North St., Southbridge, Mass.
PERSONNEL: J. M. Wells, Pres. & Treas.; C. A. Harvey, V. Pres.; R. A. Mahler, Secy. & Gen. Mgr.; D. W. Vecchia, Pur. Agt.; J. K. Edwards, Pers. Dir.; H. E. Allen, Chief Engr.
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PERSONNEL: F. M. Hoefler, Pres.; W. G. Stratton, Secy. & Treas.; D. R. Taylor, Pur. Agt.; G. C. Jaynes, Pers. Dir.; P. R. Jordan, Pub. Dir.; A. A. Turton, Chief Engr.
PRODUCTS: Castings and forgings; Controls; Fittings; Hydraulic controls and assemblies; Misc. hardware; Misc. engine equipment; Aluminum, magnesium, plastic and plywood parts; Pumps; Seats; Control valves; Engine valves and valve parts.

HASKELITE MANUFACTURING CORP.,
208 W. Washington St., Chicago, Ill.
PERSONNEL: G. R. Meyercord, Jr., Pres. & Gen. Mgr.; F. M. Curran, V. Pres.; V. S. Barnes, V. Pres. & Sales Mgr.; O. H. Basquin, V. Pres. & Chief Engr.; J. Harrington, Secy. H. B. Dunton, Treas.; P. V. Atkinson, Pur. Agt.
PRODUCTS: Plywood parts.

JOHN HASSALL, INC.,
394 Oakland St., Brooklyn, N. Y.
PERSONNEL: T. B. Smith, Pres.; J. Smith, V. Pres.; W. W. Smith, Secy. & Pur. Agt.; J. H. Hassall, Treas.; E. F. Karnes, Pub. Dir.
PRODUCTS: Rivets; Nails.

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PRODUCTS: Aircraft armament; Ammunition boxes and counters; Bomb racks; Cowlings; De-icer equipment; Engine mounts; Exhaust manifolds; Floats, skiis; Parachutes; Seats; Stampings; Sub-assemblies.

THE HEALD MACHINE CO.,
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PRODUCTS: Machine tools.

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PRODUCTS: Covers; Floats, skiis; Aluminum, plastic plywood and rubber parts; Radios; Tail wheel assemblies; Windshields.

HEIL ENGINEERING CO.,
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THE HEIM CO.,
46 Sanford St., Fairfield, Conn.
PERSONNEL: L. R. Heim, Pres. & Chief Engr.; A. E. Heim, V. Pres.; C. R. Heim, Secy., Treas., Gen. Mgr. & Pur. Agt.; E. Hildes-Heim, Sales Mgr.; N. Schollin, Pers. Dir.
PRODUCTS: Spherical rod ends; Bushings; Steel parts; Propeller parts.

HEINEMANN CIRCUIT BREAKER CO.,
Trenton, N. J.
PERSONNEL: B. S. Berlin, Pres.; K. W. Wilckens, Secy. & Chief Engr.; H. W. Haenni, Gen. Mgr. & Pur. Agt.; E. Bromberg, Sales Mgr.
PRODUCTS: Circuit breakers.

THE HENDEY MACHINE CO.,
105 Summer St., Torrington, Conn.
PERSONNEL: D. Ayr, Pres. & Gen. Mgr.; E. J. Seybold, V. Pres.; J. H. Markham, Secy. & Treas.; F. J. McCarty, Sales Mgr.; F. N. McKenzie, Pur. Agt. & Pub. Dir.; H. H. Fuessenich, Pers. Dir.; C. Bouillon, Chief Engr.
PRODUCTS: Machine tools.

HENGER SELTZER CO.,
130 S. Hewitt St., Los Angeles, Calif.
PERSONNEL: I. R. Seltzer, Pres.; E. W. Henger, Treas.; C. R. Henger, Gen. Mgr. & Sales Mgr.; P. Hough, Pur. Agt.; R. Barkelew, Chief Engr.
PRODUCTS: Basic materials and fabrications; Bomb racks; Switches; Misc. electrical equipment; Aluminum and magnesium parts; Tubing.

HENRY & WRIGHT MFG. CO.,
Hartford, Conn.
PERSONNEL: F. K. Simmons, Pres. & Gen. Mgr.; C. F. Sherman, V. Pres.-Sales; H. H. Hilliard, Treas.; R. Whittier, Pur. Agt.; A. E. Caserta, Chief Engr.
PRODUCTS: Machine tools; Tools.

HERRICK IRON WORKS,
18th & Campbell Sts., Oakland, Calif.
PERSONNEL: S. G. Herrick, Secy.; M. S. Herrick, Treas.; L. A. Peck, Sales Mgr.; E. G. Herman, Pur. Agt.; C. Kehrlein, Pers. Dir.; E. O. Rosberg, Chief Engr.
PRODUCTS: Hangar doors.

ROBERT HETHERINGTON & SON, INC.,
Sharon Hill, Pa.
PERSONNEL: C. F. Benzel, Pres. & Treas.; R. Hetherington, Sr., V. Pres., Sales Mgr. & Pub. Dir.; J. D. Cox, Secy., Gen. Mgr. & Pers. Dir.; R. Hetherington, Jr., Pur. Agt.; J. H. Schellman, Chief Engr.
PRODUCTS: Controls; Switches.

HEVI DUTY ELECTRIC CO.,
Milwaukee, Wisc.
PERSONNEL: H. E. Koch, Pres.; N. Bloye, G. A. Chutter, V. Pres.; D. C. Hinstorff, Pur Agt.; A. H. Oberndorfer, Pub. Dir.
PRODUCTS: Heat treating furnaces.

HIGHBRIDGE-INTERNATIONAL CO.,
Morris Heights Station, New York, N. Y.
PERSONNEL: W. J. Stolz, Prop.
PRODUCTS: Castings and forgings; Clamps; Misc. hardware; Stampings; Developing and processing tanks.

HILL AIRCRAFT STREAMLINERS CO.,
700 W. Sixth St., Cincinnati, O.
PERSONNEL: J. A. Hill, Pres.; F. K. Hill, Secy. & Treas.; K. W. Abbott, Gen. Mgr.; W. A. Sundquist, Chief Engr.
PRODUCTS: Cowlings; Wheel pants; Nacelles.

HILO VARNISH CORP.,
42 Stewart Ave., Brooklyn, N. Y.
PERSONNEL: C. J. Schumann, Pres. & Gen. Mgr.; A. G. Schumann, V. Pres.; W. L. Schwalb, Secy., Pur. Agt. & Chief Engr.; F. M. Schumann, Treas.; J. J. Mattiello, Sales Mgr.
PRODUCTS: Paints, Varnishes and finishes.

HOCKADAY-NEWBY AIRCRAFT, INC.
68 E. Orange Grove, Burbank, Calif.
PERSONNEL: N. R. Hockaday, Pres.; H. L. Newby, Secy. & Treas.
PRODUCTS: Engine mounts; Sub-assemblies; Tail wheel assemblies.

HOLE ENGINEERING SERVICE,
5901 Fourth Ave., Detroit, Mich.
PERSONNEL: H. C. Satterthwaite, Gen. Mgr.; E. W. Lemon, Pur. Agt.; E. T. Barringer, Chief Engr.
PRODUCTS: Machine tools.

HOLLEY CARBURETOR CO.,
5930 Vancouver Ave., Detroit, Mich.
PERSONNEL: E. Holley, Pres & Treas.; B. W. Westcott, V. Pres. & Sales Mgr.; J. F. English, Secy.; D. W. Candler, Gen. Mgr.; H. C. Webb, Pur. Agt.; H. J. Middleditch, Pers. Dir.; M. J. Kittler, Chief Engr.
PRODUCTS: Carburetors.

THE HOLO-KROME SCREW CORP., P. O. Box 98, Elmwood Branch, Hartford, Conn.
PERSONNEL: W. A. Purtell, Pres., Treas. & Gen. Mgr.; W. C. Stauble, V. Pres., Secy & Sales Mgr.; H. A. Neff, Pur. Agt., & Pers. Dir.; R. H. Young, Pub. Dir.
PRODUCTS: Steel parts; Internal wrenching bolts.

HOOF PRODUCTS CO.,
6543 S. Laramie Ave., Chicago, Ill.
PERSONNEL: A. C. Hoof, Pres. & Treas.; H. C. Kepner, V. Pres. & Gen. Mgr.; W. H. Eckert, Secy.; C. E. Johnson, Sales Mgr. & Pub. Dir.; V. H. Eggers, Pur. Agt.; C. A. McJohnston, Pers. Dir.; C. B. Seymour, Chief Engr.
PRODUCTS: Hydraulic controls and assemblies; Hydraulic control valves; Governors.

HOPE WEBBING CO., Providence, R. I.
PRODUCTS: Tapes and webbings.

HOUDAILLE-HERSHEY CORP., 2188 National Bank Bldg., Detroit, Mich.
PERSONNEL: C. Getler, Pres.; R. F. Peo, D. S. Devor, V. Pres.; M. C. Mason, Secy.; G. C. Phelps, Treas.
PRODUCTS: Engine mounts; Hydraulic controls and assemblies; Landing gears; Shock struts; Tail wheel assemblies; Control valves; Vibration dampers.

E. F. HOUGHTON & CO.,
303 W. Lehigh Ave., Philadelphia, Pa.
PERSONNEL: A. E. Carpenter, Pres. & Gen. Mgr.; G. W. Pressell, Exec. V. Pres. & Sales Mgr.; R. H. Patch, V. Pres.; E. A. Carpenter, Secy.; W. F. MacDonald, Treas.; H. B. Fox, Pur. Agt.; D. C. Miner, Pub. Dir.; W. A. Bohne, Chief Engr.
PRODUCTS: Cleaners and cleaning compounds; Lubricants; Gaskets; Oil seals; Leather parts.

CHAS. W. HOUSE & SONS, INC.,
19 Perry St., Unionville, Conn.
PERSONNEL: H. C. House, Pres.; R. K. Brooks, V. Pres.; J. C. Brash, Asst. Secy., Asst. Treas. & Pur. Agt.
PRODUCTS: Basic materials and fabrications; Felt seals; Woolen filters and strainers; Felt gaskets; Oil seals; Felt parts.

THE HOWE SCALE CO., Rutland, Vt.
PERSONNEL: F. G. Riehl, Pres.; A. N. Lyons, V. Pres. & Treas.; H. McK. Dodge, Secy.; L. J. Colenback, Sales Mgr.; N. M. Gron, Pur. Agt.; R. A. Stevens, Pub. Dir.; T. A. Yager, Chief Engr.
PRODUCTS: Scales.

HOYT ELECTRICAL INSTRUMENT CO.,
857 Boylston St., Boston, Mass.
PERSONNEL: W. C. Hoyt, Gen. Mgr.; C. W. Burton, Sales Mgr.; V. S. Church, Chief Engr.
PRODUCTS: Instruments.

M. D. HUBBARD SPRING CO.,
Pontiac, Mich.
PERSONNEL: J. A. Hubbard, Gen. Mgr.; P. M. Hubbard, Pur. Agt.
PRODUCTS: Cotter pins; Springs; Flat washers; Stampings.

HUGHES TOOL CO., Houston, Tex.
PERSONNEL: M. E. Boehm, V. Pres. & Gen. Mgr.; C. S. Johnson, Secy. & Treas.; G. S. Richmond, Sales Mgr.; E. R. Cobden, Pur. Agt.; T. M. Mobley, Pers. Dir.; L. E. Garfield, Chief Engr.
PRODUCTS: Landing gears.

CARL HUSSMAN,
3001-07 N. Oakley Ave., Chicago, Ill.
PERSONNEL: C. Hussman, Pres.
PRODUCTS: Engine mounts; Vibration dampers; Noise silencing hoods.

F. C. HUYCK & SONS, KENWOOD MILLS, Albany, N. Y.
PERSONNEL: W. W. Weed, Pres.; J. L. Braman, V. Pres. & Treas.; F. H. Eldridge, V. Pres. & Gen. Mgr.; H. Eldridge, Secy.; J. S. Heleher, Sales Mgr.; G. L. Brown, Pur. Agt.; F. H. Blessing, Pers. Dir.; E. J. Wilson, Chief Engr.
PRODUCTS: Wool blankets; Woven woolen felts.

HYATT BEARINGS DIV. OF GENERAL MOTORS CORP., Harrison, N. J.
PERSONNEL: H. O. K. Meister, Gen. Mgr.; H. K. Porter, Sales Mgr.; F. A. Weiss, Pur. Agt.; W. C. Nissen, Pers. Dir.; H. M. Carroll, Adv. Mgr.; O. W. Young, Chief Engr.
PRODUCTS: Bearings.

THE HYDRAULIC PRESS MFG. CO., Mount Gilead, O.
PERSONNEL: H. F. MacMillin, Pres.; P. C. Pocock, V. Pres.; W. C. Batchelor, Secy. & Treas.; H. J. Miller, Sales Mgr.; A. L. Boggs, Pur. Agt.; E. Auld, Pers. Dir.; R. W. Powell, Pub. Dir.; W. Ernst, Dir. Engrg.
PRODUCTS: Hydraulic controls and assemblies; Hydraulic presses; Hydraulic pumps; Control valves.

HYLAND MACHINE CO.,
40 Potomac St., Dayton, O.
PERSONNEL: F. Hyland, Pres. & Sales Mgr.; H. Greth, Gen. Mgr. & Pers. Dir.; R. White, Pur. Agt.
PRODUCTS: Clamps; Controls; Fittings; Misc. hardware; Aluminum and steel parts; Stampings; Sub-assemblies; Miscellaneous.

I

IDEAL CLAMP MFG. CO., INC.,
435 Liberty Ave., Brooklyn, N. Y.
PERSONNEL: P. Rauch, Pres.; L. J. Rauch, Treas.
PRODUCTS: Clamps; Fasteners; Hose clamps and hose fittings.

ILLINOIS TESTING LABORATORIES, INC.,
420 N. La Salle St., Chicago, Ill.
PERSONNEL: J. A. Obermaier, Pres., Treas., Gen. Mgr. & Chief Engr.; E. Obermaier, V. Pres.; M. J. Rauscher, Secy., Sales Mgr. & Pub. Dir.; J. M. Lajka, Pur. Agt.
PRODUCTS: Instruments.


PRESTITE
THE SAFE SKIN HOLDER
STANDARD FASTENER
COIL SPRING
FORGED HOLDING PIN
HOUSING
WASHER
PRESTITE—Prestole's latest achievement in the aircraft field—skin holders that are both *safe* and *easy* to use in assembling aircraft skins.
PRESTITE fasteners will not only speed up production but their "Safety First" feature (note solid integral head which holds pin safely in position), will eliminate the danger of "letting go" and injuring workmen.
STANDARD FASTENER—Safe, durable, one-piece thrust pin construction guarantees hole alignment with straight thrust motion. Prestite Fasteners in actual use *longer* without the need for repairs.
NUT PLATE FASTENER
LONG THRUST FASTENER
NUT PLATE FASTENER—Prestites are doing an outstanding job in pre-locating nut plates. Their alignment feature centers the nut plate, and the holding pin is so formed as to prevent damages to threads or fibre inserts.
LONG THRUST FASTENER—This strong, sturdy, one-piece thrust pin and specially designed spring is made for unusual assembly conditions. Thousands of these long thrust fasteners are now in use and more are being developed.
"Featherweight
SAFETY CHAMP" GUN
Almost *half* the weight of other guns, and designed to fit the hand, with an eye to the feminine users. Separate, hardened carbon steel holding ring locks fastener in gun during assembly. This gun is well named the "Safety Champ."
THE SAFE PRESTITE SKIN FASTENER
Wire or write Dept. B today for complete information and prices.
PRESTOLE DIVISION
DETROIT HARVESTER COMPANY
4503 DETROIT AVE. • TOLEDO, OHIO

THE IMPERIAL BRASS MANUFACTURING CO., 1200 W. Harrison St., Chicago, Ill.
PERSONNEL: F. McNellis, Pres.; F. C. Shafer, V. Pres. & Treas.; A. C. Dobrick, Secy.; J. T. Greenlee, Sales Mgr.; W. B. Burnett, Pur. Agt.; B. Maloy, Pers. Dir.; C. H. Benson, Pub. Dir.; R. McIntosh, Chief Engr.
PRODUCTS: Castings and forgings; Throttle controls; De-icer equipment; Filters and strainers; Fittings; Engine primers; Tube cutting and flaring tools; Airplane toilettes.

INDEPENDENT IRON WORKS, LTD., 821 Pine St., Oakland, Calif.
PERSONNEL: W. G. Meagher, Pres.; H. Gede, Jr., V. Pres.; R. Dennis, Secy. & Treas.; K. M. Keegan, Gen. Mgr.; E. C. Williams, Sales Mgr.; C. R. Mader, Pur. Agt.; D. R. Meagher, Chief Engr.
PRODUCTS: Airport equipment; Ammunition boxes and counters; Basic materials and fabrications.

INDEPENDENT PNEUMATIC TOOL CO., 600 W. Jackson Blvd., Chicago, Ill.
PERSONNEL: N. C. Hurley, Pres.; N. C. Hurley, Jr., V. Pres.; W. A. Nugent, V. Pres. & Sales Mgr.; E. G. Gustafson, Treas.; H. Brewer, Gen. Plant Mgr.; L. L. Tess, Pur. Agt.; M. Schultz, Pers. Dir.; C. N. Kirchner, Pub. Dir.; W. G. Mitchell, Chief Engr.
PRODUCTS: Hose clamps and hose fittings; Tools.

INDIANA GEAR WORKS, 1458 E. 19th St., Indianapolis, Ind.
PERSONNEL: L. C. Buehler, Gen. Mgr.; W. A. Groat, Jr., Pur. Agt.; J. A. Hoagland, Pers. Dir.; J. L. Buehler, Chief Engr.
PRODUCTS: Engine gears.

INDUSTRIAL GRINDING CO., 6423 McKinley Ave., Los Angeles, Calif.
PERSONNEL: J. W. Boening, W. E. Miller, Partners; W. J. Phelan, Supt.; M. L. Hannon, Secy.; P. D. Leonis, Pers. Mgr.
PRODUCTS: Tools; Grinding equipment.

INDUSTRIAL SOUND CONTROL, 224 Garden St., Hartford, Conn.
PERSONNEL: G. U. Kierstead, Pres.; C. W. Lemmerman, V. Pres.; C. G. Kierstead, Treas.
PRODUCTS: Soundproofing.

INDUSTRIAL TAPE CORP., New Brunswick, N. J.
PERSONNEL: G. F. Smith, Pres.; W. E. Meyers, V. Pres.; J. S. Nicholls, V. Pres. & Gen. Mgr.; J. J. Gibson, Secy.; F. A. Cosgrove, Treas.; J. H. Scherer, Sales Mgr.; W. H. Roberts, Pur. Agt.; D. Simonds, Chief Engr.
PRODUCTS: Paper; Cloth; Cellophane adhesive tapes.

INDUSTRIAL WIRE CLOTH PRODUCTS CORP., Fourth & Brush Sts., Wayne, Mich.
PERSONNEL: F. A. Vollbrecht, Pres. & Gen. Mgr.; I. C. Vollbrecht, Secy.; W. F. Hoffman, Treas.; H. F. Schulte, Sales Mgr.; G. C. Pushelberg, Pur. Agt.; W. L. Smith, Pers. Dir.; M. A. Mieras, Chief Engr.
PRODUCTS: Airport equipment; Carburetor screens; Filters and strainers; Misc. engine equipment; Protective clothing and equipment; Pump strainers; Sub-assemblies; Miscellaneous.

INGLEWOOD SHEET METAL WORKS, 158 N. La Brea, Inglewood, Calif.
PERSONNEL: H. Wernik, Pres.; K. Wernik, V. Pres.
PRODUCTS: Ammunition boxes; Exhaust manifolds; Water tanks; Sheet metal work.

INTERCONTINENT AIRCRAFT CORP., Miami Springs, Fla.
PERSONNEL: G. M. Williams, Pres.; W. A. Hayward, V. Pres.-Operations; W. S. Leaycraft, V. Pres. & Treas.; R. E. Brown, Works Mgr.; E. N. Laurance, Factory Supt.; Hill & Knowlton, Pub. Dir.
PRODUCTS: Parts; Miscellaneous.

INTERNATIONAL FLARE SIGNAL DIV., **(See Kilgore Manufacturing Co.)**

INTERNATIONAL MACHINE TOOL CORP., 1124 W. 21st St., Indianapolis, Ind.
PERSONNEL: C. R. Feldmann, Pres.; W. J. Hannum, V. Pres. & Gen. Mgr.; J. Hancock, Secy.; G. G. Hathaway, Sales Mgr.; W. L. Hunter, Pur. Agt.
PRODUCTS: Turret lathes.

THE INTERNATIONAL PISTON RING CO., 2401 W. Superior Ave., Cleveland, O.
PERSONNEL: H. F. Gray, Pres. & Chief Engr.; H. C. Crawford, V. Pres.; W. M. Gray, Secy.; C. Wenzel, Treas.; F. P. Gray, Sales Mgr. & Pub. Dir.; J. Mack, Pur. Agt.
PRODUCTS: Piston rings.

INTERNATIONAL RESISTANCE CO., 401 N. Broad St., Philadelphia, Pa.
PERSONNEL: E. Searing, Pres.; H. A. Ehle, V. Pres.; R. N. Shires, Secy.; H. A. Schmidt, Treas.; M. J. Bethany, Pur. Agt.; J. Marsten, Chief Engr.
PRODUCTS: Misc. electrical equipment.

INTERNATIONAL SCREW CO., 9444 Roselawn Ave., Detroit, Mich.
PERSONNEL: W. L. Nelson, Pres. & Gen. Mgr.; W. C. Nelson, V. Pres.; Pur Agt. & Pers. Dir.; L. F. Nelson, Secy. & Treas.; T. Stevens, Sales Mgr.; K. E. Nelson, Chief Engr.
PRODUCTS: Fasteners.

INTERNATIONAL STACEY CORP., Columbus, O.
PERSONNEL: O. M. Havekotte, Pres. & Gen. Mgr.; R. R. Bloss, V. Pres.; G. B. Fenton, Secy.; R. B. McCleery, Treas.; W. F. Barnes, Sales Mgr.; J. T. Dunlap, Pur. Agt.; E. J. Roush, Pers. Dir.; C. R. Athy, Pub. Dir.; L. E. Roelofs, Chief Engr.
PRODUCTS: Airport equipment; Basic materials and fabrications; Castings and forgings; Landing and navigation lights; Steel parts.

INTERSTATE AIRCRAFT & ENGINEERING CORP., 3443 Wilshire Blvd., Los Angeles, Calif.
PERSONNEL: D. P. Smith, Pres.; W. E. Hirtensteiner, V. Pres.-Production; W. A. Hite, V. Pres.-Engrg.; L. B. Cameron, Secy. & Treas.; J. E. Koster, Pur. Agt.; R. W. Limacher, Pers. Dir.; H. O. Nelson, Pub. Dir.
PRODUCTS: Aircraft armament; Bomb shackles; Hydraulic controls and assemblies.

INTERSTATE BRAKE TESTING MACHINE CO., 1218 Rio Vista Ave., Los Angeles, Calif.
PERSONNEL: H. W. Langbein, Owner & Gen. Mgr.; D. N. Parks, Sales Mgr.
PRODUCTS: Brake shoe grinders; Brake testing machines.

INTERSTATE DROP FORGE CO., 4051 N. 27th St., Milwaukee, Wisc.
PERSONNEL: C. E. Stone, Pres. & Gen. Mgr.; H. C. Osborn, V. Pres.; C. C. Bremer, Secy. & Treas.; J. A. Webber, Chief Engr.
PRODUCTS: Drop forgings.

IRVINGTON VARNISH & INSULATOR CO., 6 Argyle Terrace, Irvington, N. J.
PERSONNEL: A. E. Jones, Pres.; C. E. Garneau, W. F. Hoffman, Jr., V. Pres.; F. M. Miller, Secy.; C. Egner, Treas.; R. Mezger, Gen. Mgr.; F. Shoemaker, P. C. Goodspeed, Sales Mgrs.; C. K. Johnson, Pur. Agt.; R. J. Wanek, Pub. Dir.; C. F. Hanson, Chief Engr.
PRODUCTS: Insulating materials; Tubing.

ISLIP RADIO MANUFACTURING CORP., Islip Airport, Islip, N. Y.
PERSONNEL: A. E. Theis, Pres. & Treas.; M. Wiener, V. Pres.; W. A. Wiener, Secy. & Chief Engr.; A. C. Newman, Pur. Agt.
PRODUCTS: Navigational radio aids.

J

J. V. W. & CO., 1100 Raymond Blvd., Newark, N. J.
PERSONNEL: C. S. Jones, Pres.; L. D. Warrender, R. Whatham, V. Pres.; G. A. Vaughn, Jr., Secy. & Treas.
PRODUCTS: Link trainers.

JACK & HEINTZ, INC., Solon Rd., Bedford, O.
PERSONNEL: W. S. Jack, Pres., Gen. Mgr. & Sales Mgr.; R. M. Heintz, V. Pres., Secy. & Chief Engr.; W. R. Jack, V. Pres. & Treas.; C. L. Jack, J. Zorn, Pur. Agts.; F. Fehlman, Pub. Dir.
PRODUCTS: Instruments; Starters; Automatic pilots and energizers.

I. JACOEL CABLE SPLICING EQUIPMENT CO., 1880 Hertel Ave., Buffalo, N. Y.
PERSONNEL: I. Jacoel, Pres.
PRODUCTS: Controls; Hoisting slings; Splicing machine tools; Splicing tools.

JARDUR IMPORT CO., 874 Broadway, New York, N. Y.
PERSONNEL: F. W. Donaldson, Gen. Mgr.; H. H. Clapper, Sales Mgr.; T. J. Waters, Pur. Agt.; C. W. Cromwell, Pub. Dir.; W. W. Smith, Chief Engr.
PRODUCTS: Flightmaster; Flight plotter and calculator; Air navigation protractor; Aeronautical chart cases and refills.

JEFFERSON-TRAVIS RADIO MFG. CORP., 380 Second Ave., New York, N. Y.
PERSONNEL: I. M. Felt, Pres. & Treas.; E. Ellinger, Jr., V. Pres. & Secy.; W. C. Hustis, Sales Mgr.; P. Nichols, Pur. Agt.; F. A. Lindley, Chief Engr.
PRODUCTS: Radios.

JESSOP STEEL CO., Washington, Pa.
PERSONNEL: R. E. Emery, Pres.; F. T. H. Youngman, V. Pres. & Treas.; R. J. Murray, Secy.; T. W. Pennington, Sales Mgr.; G. R. Forsberg, Pur. Agt.
PRODUCTS: Light armor plate; Propeller steel; Carbon high speed, special alloy tool and die steels.

JOHNS-MANVILLE SALES CORP., 22 E. 40th St., New York, N. Y.
PERSONNEL: L. H. Brown, Pres.; J. H. Trent, V. Pres.-Sales; V. Brown, Secy.; R. Hackney, Treas.; N. O. Aeby, Pur. Agt.; H. D. Bates, Pub. Dir.; E. H. Wells, Chief Engr.
PRODUCTS: Gaskets; Insulating materials; Oil seals; Brake linings; Fire barriers; Packings.

THE JOHNSON RUBBER CO., Middlefield, O.
PERSONNEL: S. M. Johnson, Pres.; L. M. Johnson, V. Pres. & Gen. Mgr.; H. G. Johnson, Secy. & Treas.; P. Sperry, Sales Mgr.; R. W. Caslow, Pur. Agt.
PRODUCTS: Bushings; Gaskets and grommets; Rubber and synthetic parts; Shims; Tubing; Molded, extruded and cut rubber products.

S. C. JOHNSON & SON, INC., Racine, Wisc.
PERSONNEL: H. F. Johnson, Jr., Pres.; C. A. Armstrong, V. Pres.; K. R. Nelson, Secy.; J. R. Ramsey, Treas. & Gen. Mgr.; P. M. Petersen, Sales Mgr.; R. P. Gardiner, Pur. Agt.; S. R. Belden, Pers. Dir.; W. N. Connolly, Pub. Dir.
PRODUCTS: Cleaners and cleaning compounds; Paints, varnishes and finishes; Wax-coatings.

JOHNSON TOOL CO., INC., 65 Massasoit Ave., East Providence, R. I.
PERSONNEL: A. E. Johnson, Pres. & Treas.; A. Johnson, V. Pres.; M. S. Millard, Secy.; M. G. Swanson, Gen. Mgr.
PRODUCTS: Machine tools; Sub-assemblies; Aircraft engine service tools.

JONES-DABNEY CO., Louisville, Ky.
PERSONNEL: W. C. Dabney, Pres.; A. W. Bornhauser, V. Pres.; F. H. Volk, Secy. & Treas.; H. C. Reed, Mgr., Aviation Div.; J. C. Cullan, Pur. Agt.
PRODUCTS: Paints, varnishes and finishes.

JUSTRITE MFG. CO., 2090 Southport Ave., Chicago, Ill.
PRODUCTS: Safety cans; Electric lanterns.

FRANK E. JONES MACHINERY CORP., 1403 Santa Fe Ave., Los Angeles, Calif.
PERSONNEL: A. S. Jones, V. Pres.; H. W. Jones, Secy. & Treas.
PRODUCTS: Machine tools.

JONES MOTROLA SALES CO., 432 Fairfield Ave., Stamford, Conn.
PERSONNEL: C. E. Rees, Pres.; C. F. Thiele, Chief Engr.
PRODUCTS: Portable hand type tachometers.

W. B. JONES SPRING CO., 124 E. Seventh St., Cincinnati, O.
PERSONNEL: W. B. Jones, Pres.; A. G. George, Secy.
PRODUCTS: Coiled wire springs.

JOWEIN INC. AIRCRAFT DIV.,
Jamaica, N. Y.
PERSONNEL: M. E. Harker, Sr., Exec. V. Pres.; J. Olivant, Secy., Treas. & Production Engr.
PRODUCTS: Lubricating, hydraulic and fuel screens; Filters and strainers; Machined and fabricated parts.

K

THE K D LAMP CO.,
610 W. Court St., Cincinnati, O.
PERSONNEL: H. R. Kerans, Pres. & Gen. Mgr.; H. F. Griffin, V. Pres., Sales Mgr. & Pub. Dir.; C. C. Clark, Secy., Treas. & Pers. Dir.; A. B. Dettmer, Pur. Agt.; W. Trautner, Chief Engr.
PRODUCTS: Flares.

THE KAWNEER CO., Niles, Mich.
PERSONNEL: L. J. Plym, Pres.; F. R. Eaglesfield, V. Pres. & Sales Mgr.; E. M. Bigelow, Secy.; H. W. Zimmer, Treas.; A. M. Simpson, Gen. Mgr.; E. C. Witwer, Pur. Agt.; G. Horst, Pers. Dir.; J. H. Taylor, Jr., Pub. Dir.; K. Knott, Chief Engr.
PRODUCTS: Ammunition boxes and counters; Basic materials and fabrications; Aluminum and steel parts; Stampings; Sub-assemblies; Tubing.

KELITE PRODUCTS, INC.,
909 E. 60th St., Los Angeles, Calif.
PERSONNEL: L. C. Sorensen, Pres. & Gen. Mgr.; H. L. Smith, V. Pres.; H. Burrell, Secy. & Treas.; R. Medanich, Sales Mgr.; F. W. Frisenfeldt, Pur. Agt. & Pub. Dir.; J. F. Hart, Chief Chemist.
PRODUCTS: Cleaners and cleaning compounds.

KELLETT AUTOGIRO CORP.,
58th & Grays Ave., Philadelphia, Pa.
PERSONNEL: W. W. Kellett, Pres.; R. G. Kellett, Exec. V. Pres., Sales Mgr. & Pub. Dir.; R. H. Prewitt, V. Pres.- Engrg.; W. F. Palmer, Secy. & Treas.; S. P. Lyon, Gen. Mgr.; J. E. Robertson, Pur. Agt.; A. W. Hendrickson, Pers. Dir.
PRODUCTS: Engine mounts; Sub-assemblies.

KELLOGG SWITCHBOARD & SUPPLY CO.,
6650 S. Cicero Ave., Chicago, Ill.
PERSONNEL: M. K. McGrath, Pres.; J. G. Kellogg, V. Pres.; J. H. Kellogg, Secy.; H. C. McCluskey, Treas.; C. D. Manning, Sales Mgr.; J. Geiger, Pur. Agt.; B. Holland, Pers. Dir.; R. C. Krueger, Pub. Dir.; R. M. Kalb, Chief Engr.
PRODUCTS: Disconnect plugs; Switches; Terminals; Misc. electrical equipment.

KELSEY HAYES WHEEL CO.,
3600 Military Ave., Detroit, Mich.
PERSONNEL: G. W. Kennedy, Pres. & Gen. Mgr.; M. S. P. Williams, V. Pres. & Pub. Dir.; L. C. Brooks, Secy.; L. W. Downie, Treas.; J. M. Kerr, Sales Mgr.; J. H. Murphy, Pur. Agt.; P. Denzig, Pers. Dir.; C. W. Sinclair, Chief Engr.
PRODUCTS: Tail wheel assemblies; Tanks; Wheels and brakes.

KENDALL REFINING CO., Bradford, Pa.
PERSONNEL: O. F. Koch, Pres. & Treas.; J. B. Fisher, Exec. V. Pres. & Secy.; T. O. Grisell, Sales Mgr.; F. W. Wodrich, Jr., Pur. Agt.; W. M. Magee, Pers. Dir.; W. T. Moffatt, Pub. Dir.
PRODUCTS: Fuels and lubricants.

KENNEDY NAME PLATE CO.,
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PERSONNEL: J. W. Hayek, Pres. & Chief Engr.; D. R. Koelling, V. Pres. & Pur. Agt.; W. J. Kennedy, Secy., Treas., Sales Mgr. & Pub. Dir. A. Van Selow, Pers. Dir.
PRODUCTS: Airport equipment; Instruments; Misc. hardware; Stampings; Miscellaneous.

F. C. KENT CO.,
64-72 Howard St., Irvington, N. J.
PERSONNEL: F. C. Kent, Pres.; W. Grunhof, Jr., V. Pres. & Sales Mgr.; H. E. Ferris, Secy.; T. H. McGechin, Pur. Agt.; W. Binszus, Chief Engr.
PRODUCTS: Exhaust manifolds; Hydraulic controls and assemblies; Manifolds; Radio and ignition shielding; Tubing.

KENT-MOORE ORGANIZATION, INC.,
General Motors Research Bldg., Detroit, Mich.
PERSONNEL: W. A. Kent, Pres.; J. E. Moore, V. Pres.; F. C. Bowles, Secy. & Treas.; H. L. Faust, Sales Mgr.; A. Bacon, Pur. Agt.; S. M. Graham, Chief Engr.
PRODUCTS: Tools; Service equipment.

KENT-OWENS MACHINE CO.,
958 Wall St., Toledo, O.
PERSONNEL: W. J. Donkel, Pres. & Gen. Mgr.; E. E. Burke, Sales Mgr.; J. J. Jackman, Pur. Agt.; A. B. Bok, Chief Engr.
PRODUCTS: Machine tools.

KENYON TRANSFORMER CO., INC.,
840 Barry St., New York, N. Y.
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PRODUCTS: Electrical transformers; Reactors; Electric wave filters.

KESTER SOLDER CO.,
4201 Wrightwood Ave., Chicago, Ill.
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PRODUCTS: Solders and soldering fluxes.

KEYSTONE TOOL & SUPPLY CO.,
7720 Maie Ave., Los Angeles, Calif.
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PRODUCTS: Airport equipment; Clamps; Fasteners; Fittings; Machine tools; Misc. hardware; Steel parts; Stampings; Tools; Miscellaneous.

WALTER KIDDE & CO., INC.,
140 Cedar St., New York, N. Y.
PERSONNEL: C. L. Griffin, Sales Mgr.; C. E. Gischel, Pub. Dir.
PRODUCTS: Airport equipment; Fire extinguishers; Life saving equipment.

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PRODUCTS: Flares and signals; Military pyrotechnics.

KING-SEELEY CORP., Ann Arbor, Mich.
PERSONNEL: J. Airey, Pres. & Gen. Mgr.; W. E. Bandemer, V. Pres. & Sales Mgr.; K. M. Conklin, Secy.; D. T. Warner, Treas. & Pur. Agt.; L. E. Quinn, Pers. Dir.; R. C. Darnell, Chief Engr.
PRODUCTS: Instruments; Control valves.

KINGSBURY MACHINE TOOL CORP., Keene, N. H.
PERSONNEL: E. J. Kingsbury, Pres.; G. Swahnberg, V. Pres.; E. Hagland, Pur. Agt.; B. N. Foster, Chief Engr.
PRODUCTS: Machine tools.

KLEMM AUTOMOTIVE PRODUCTS CO., 1718 N. Damen Ave., Chicago, Ill.
PERSONNEL: E. R. Klemm, Jr., Pres., Sales Mgr. & Chief Engr.; P. E. Klemm, Secy., Treas. & Pur. Agt.
PRODUCTS: Speed controls.

KLIEGL BROS. UNIVERSAL ELECTRIC STAGE LIGHTING CO., INC., 321 W. 50th St., New York, N. Y.
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PRODUCTS: Disconnect plugs; Indirect lighting systems.

W. B. KNIGHT MACHY. CO., 3920 W. Pine, St. Louis, Mo.
PERSONNEL: W. B. Knight, Pres.; H. E. Knight, V. Pres.; C. W. Knight, Treas.
PRODUCTS: Machine tools.

THE KNIGHT SCREW PRODUCTS CO., 7401 Lyndon, Detroit, Mich.
PERSONNEL: W. C. Knight, Pres. & Gen. Mgr.; J. R. Adams, V. Pres.; F. F. Bastien, Secy., Treas. & Pur. Agt.; A. B. Edwards, Pers. Dir.; C. E. Barr, Chief Engr.
PRODUCTS: Steel parts; Miscellaneous.

KNU-VISE, INC., 2200 Eighth St., Detroit, Mich.
PERSONNEL: J. A. Herrington, Pres.; L. J. Portnoy, Secy.; J. F. Kowalik, Sales Mgr.; L. Saulter, Pur. Agt.; M. F. Barkus, Pers. Dir.
PRODUCTS: Clamps.

GEORGE KOCH SONS, INC., Evansville, Ind.
PERSONNEL: A. C. Koch, Pres.; G. W. Koch, V. Pres.; R. L. Koch, Secy. & Treas.; L. J. Koch, Gen. Mgr.; C. Robb, Sales Mgr.; E. E. Lyons, Pur. Agt.; G. A. Koch, Pers. Dir.; H. F. Cooper, Pub. Dir.; F. L. Elliott, Chief Engr.
PRODUCTS: Bomb racks; Machine tools; Aluminum and steel parts; Stampings; Tools; Ventilating and air conditioning equipment.

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PRODUCTS: Fuel filters and strainers; Solenoid engine primers; Engine valves and valve parts.

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PRODUCTS: Instruments.

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PRODUCTS: Dies; Steel and aluminum parts; Stampings.

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PERSONNEL: O. M. Krembs, Prop.
PRODUCTS: Fluxes; Welding fluxes.

KROPP FORGE AVIATION CO., 5301 W. Roosevelt Rd., Chicago, Ill.
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L

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PRODUCTS: Machine tools.

L & R MANUFACTURING CO.,
54-56 Clinton St., Newark, N. J.
PERSONNEL: M. A. Lazarus, Pres.; M. Steinhardt, Pur. Agt. & Pub. Dir.
PRODUCTS: Cleaners and cleaning compounds.

LACKAWANNA LEATHER CO.,
900 Grand Ave., Hackettstown, N. J.
PERSONNEL: D. S. Good, V. Pres. & Treas.; C. F. Good, Secy.
PRODUCTS: Leather parts.

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PRODUCTS: Upholstery; Curtain material; Carpet.

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PRODUCTS: Shims.

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PRODUCTS: Machine tools.

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PRODUCTS: Flight and landing control gear boxes.

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PRODUCTS: Stampings.

LASALCO, INC.,
2818-38 La Salle St. St. Louis, Mo.
PERSONNEL: B. G. Daw, Pres.; H. Struckhoff, Sales Mgr.
PRODUCTS: Cleaners and cleaning compounds; Controls.

LAWRANCE ENGINEERING & RESEARCH CORP., Linden, N. J.
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PRODUCTS: Auxiliary power plants.

LEA MANUFACTURING CO.,
Waterbury, Conn.
PRODUCTS: Shop equipment.

H. LEACH MACHINERY CO.,
387 Charles St., Providence, R. I.
PERSONNEL: M. Leach, Pres. & Gen. Mgr.; H. Leach, Treas.; J. H. Goodman, Sales Mgr.
PRODUCTS: Machine tools.

DAVE LEAHY CO.,
612 W. 18th St., Los Angeles, Calif.
PERSONNEL: D. Leahy, Pres.
PRODUCTS: Cockpit lights.

LEAR AVIA, INC., Piqua, O.
PERSONNEL: W. P. Lear, Pres.; T. S. Harris, V. Pres.; H. C. Morrison, Secy. & Treas.; C. E. Mead, Gen. Mgr.; S. Nesbitt, Sales Mgr. & Pub. Dir.; G. Storar, Sr., Pur. Agt.; E. B. Archibald, Pers. Dir.; R. M. Mack, M. Harges, Chief Engrs.
PRODUCTS: Controls; Auxilary motors; Generators; Misc. electrical equipment; Instruments; Landing gears; Propellers and propeller parts; Radios; Radio compasses.

THE R. K. LeBLOND MACHINE TOOL CO.,
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PRODUCTS: Machine tools.

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PRODUCTS: Machine tools.

LEHMANN MACHINE CO.,
3560 Chouteau Ave., St. Louis, Mo.
PERSONNEL: F. H. Nichaus, Pres.; L. A. Carter, Secy. & Chief Engr.; E. J. Nestor, Pur. Agt.
PRODUCTS: Machine tools.

THE LELAND ELECTRIC CO.,
1501 Webster St., Dayton, O.
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PRODUCTS: Dynamotors; Auxiliary motors; Voltage regulators; Inverters.

LEMPCO PRODUCTS, INC., Bedford, O.
PERSONNEL: J. F. Strand, Pres.; J. Y. Blazek, V. Pres.; P. F. Hronek, Secy. & Treas.; J. S. Longdon, Sales Mgr.; J. H. Gulick, Pur. Agt.; O. T. Hillschafer, Pers. Dir.; V. Roy, Chief Engr.
PRODUCTS: Drum lathes; Perfectors; Hydraulic and electric arbor presses.

LESLIE WELDING CO.,
2943 Carroll Ave., Chicago, Ill.
PERSONNEL: F. H. Leslie, Prop.
PRODUCTS: Machine tools.

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PRODUCTS: Plating and anodizing generators; Polishing and buffing lathes and supplies.

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PRODUCTS: Bomb racks; Floats, skiis; Aluminum and steel parts; Pumps.

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PRODUCTS: Synthetic rubber gaskets; Oil seals; Synthetic parts.

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LINK-BELT CO.,
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PRODUCTS: Auxiliary power plants; Bearings; Castings; Chain drives; Conveyors; Vibration testers.

DAVID LINZER & SONS, INC.,
10-20 Astor Pl., New York, N. Y.
PERSONNEL: Aaron Linzer, Pres.; S. Linzer, V. Pres.; Abraham Linzer, Secy., Treas. & Pur. Agt.; A. V. Linzer, Sales Mgr.; J. Klein, Pers. Dir.; R. Sauter, Chief Engr.
PRODUCTS: Brushes.

THE LIQUIDOMETER CORP., 36th St. & Skillman Ave., Long Island City, N. Y.
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PRODUCTS: Airport equipment; Instruments.

LISLE CORP., Clarinda, Ia.
PERSONNEL: C. V. Lisle, Pres. & Gen. Mgr.; J. R. Arthur, V. Pres.; T. E. Brooks, Secy. & Chief Engr.; A. A. Cambre, Treas. & Sales Mgr.; E. G. Thompson, Pur. Agt.
PRODUCTS: Magnetic drain plugs.

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PERSONNEL: C. E. Wehn, Pres. & Gen. Mgr.; A. S. Cooper, V. Pres.; R. F. Oldershaw, Secy. & Pur. Agt.; I. M. Stuart, Treas.; D. G. Stuart, Sales Mgr. & Pub. Dir.
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PRODUCTS: Covers; Panels; Parachutes; Protective clothing and equipment; Miscellaneous.

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THE LOBDELL-EMERY MANUFACTURING CO., Alma, Mich.
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PRODUCTS: Engine, tool room and automatic lathes.

LOGAN CO., 1115 Franklin St., Louisville, Ky.
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PRODUCTS: Airport equipment; Ammunition boxes and counters; Bomb racks; Castings and forgings; Engine mounts; Seats; Stampings.

LOGAN ENGINEERING CO., Lawrence & Lamon Aves., Chicago, Ill.
PERSONNEL: H. H. Logan, Pres.; R. E. Hines, V. Pres.; O. W. Lilliedahl, V. Pres. & Chief Engr.; O. E. Hesse, Secy. & Treas.; L. H. Fenwick, Sales Mgr.; L. H. Partridge, Pur. Agt.
PRODUCTS: Filters and strainers; Machine tools.

LONGINES WITTNAUER WATCH CO., 580 Fifth Ave., New York, N. Y.
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PRODUCTS: Instruments; Miscellaneous.

LORD MANUFACTURING CO., 1635 W. 12th St., Erie, Pa.
PERSONNEL: H. C. Lord, Pres.; T. Lord, V. Pres.; B. M. Hartman, Secy. & Treas.; W. B. Fisher, Works Mgr.; C. E. Beavan, Seals Mgr. & Pub. Dir.; F. J. Kuhn, Pur. Agt.; D. Coddington, Pers. Dir.
PRODUCTS: Vibration dampers.

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PERSONNEL: H. K. Lorentzen, Pres.; S. R. Bond, V. Pres.; J. B. Hawkins, Gen. Mgr.; J. R. Bond, Pur. Agt.; C. J. Jeckel, Pers. Dir.; H. Nelson, Chief Engr.
PRODUCTS: Camera equipment; Aluminum and steel parts; Radio compass equipment; Stampings.

LORENZEN INDUSTRIES, Municipal Airport, Niles, Mich.
PERSONNEL: R. E. Lorenzen, Pres. & Chief Engr.
PRODUCTS: Flight indicator; Check, pressure and vacuum relief valves; Propellers and propeller parts; Miscellaneous.

LOS ANGELES STAMP & STATIONERY CO., 1500 S. Los Angeles St., Los Angeles, Calif.
PERSONNEL: A. C. Davidson, Pres.; F. Heylek, V. Pres.; G. E. Rinehart, Secy. & Treas.; W. Knapp, Gen. Mgr.; F. Heylek, Jr., Pur. Agt.; H. R. Wade, Chief Engr.
PRODUCTS: Fibre parts; Stampings; Instrument dials; Metal, fibre and phenol name and instruction plates.

LOWE BROS. CO., 424 E. Third St., Dayton, O.
PERSONNEL: D. A. Kohr, Pres. & Gen. Mgr.; C. W. Parrott, V. Pres. & Secy.; D. P. Haber, Treas.; E. F. Teyber, Sales Mgr.; W. T. Loges, Pur. Agt.; G. L. Clark, Pers. Dir.; P. B. Willis, Pub. Dir.; H. C. Howell, Chief Engr.
PRODUCTS: Paints, varnishes and finishes.

THE LUFKIN RULE CO., Saginaw, Mich.
PERSONNEL: R. G. Thompson, Pres. & Gen. Mgr.; E. Russell, V. Pres.; H. F. Krauss, Secy. & Treas.; G. C. McBeth, Sales Mgr.; W. Zoellner, Pur. Agt.; R. Andrus, Pers. Dir.; N. A. Ellis, Pub. Dir.; E. J. Witchger, Chief Engr.
PRODUCTS: Machinist tools; Measuring tapes and rules.

LYON METAL PRODUCTS, INC., 242 Madison Ave., Aurora, Ill.
PERSONNEL: E. D. Power, Pres. & Gen. Mgr.; H. B. Spackman, V. Pres. & Sales Mgr.; E. W. Nix, Secy. & Treas.; J. T. Hillenbrand, Pur. Agt.; M. A. Judd, Pers. Dir.; L. B. Rhodes, Pub. Dir.; J. B. O'Connor, Chief Engr.
PRODUCTS: Ammunition boxes and counters; Bomb racks; Collector rings, cowls, streamlines; Cowlings; Aluminum and steel control surfaces; Seats; Radio and ignition shielding; Stampings; Sub-assemblies; Tanks; Tubing.

LYON-RAYMOND CORP., Greene, N. Y.
PERSONNEL: G. G. Raymond, Pres.; C. F. Kellogg, Asst. to Pres.; G. G. Raymond, Jr., Sales Mgr.; W. House, Chief Engr.
PRODUCTS: Airplane engine positioning hoists; Portable elevating plane repair stands; Propeller racks and stands.

M

THE M B MANUFACTURING CO., INC., 1060 State St., New Haven, Conn.
PERSONNEL: R. W. Mettler, Pres.; A. W. Chambers, Secy. & Pub. Dir.; G. H. Mettler, Treas.; L. K. Allen, Pur. Agt.; J. M. Wirtz, Pers. Dir.; J. Blasius, Chief Engr.
PRODUCTS: Clamps; Engine mounts; Fittings; Aluminum and steel parts; Vibration dampers.

WARREN McARTHUR CORP., One Park Ave., New York, N. Y.
PERSONNEL: W. McArthur, Pres. & Gen. Mgr.; H. Lewis, V. Pres.; C. McArthur, V. Pres. & Secy.; K. C. Crouse, V. Pres. & Sales Mgr.; P. E. Plehn, Treas.; D. B. Robinson, Pur. Agt.; E. S. Jordan, Pub. Dir.; S. J. Lloyd, Chief Engr.
PRODUCTS: Seats.

McCAULEY STEEL PROPELLER CO., Dayton, O.
PRODUCTS: Propellers and propeller parts.

McCORD RADIATOR & MFG. CO., 2587 E. Grand Blvd., Detroit, Mich.
PERSONNEL: A. C. McCord, Pres.; C. O. Chesnut, V. Pres.; L. M. Hamlin, Secy.; W. G. Hancock, Sales Mgr.; D. A. Pyke, Pur. Agt.; J. A. Harley, Pers. Dir.; E. O. Bodkin, Pub. Dir.; H. E. Schank, Chief Engr.
PRODUCTS: Gaskets; Oil seals; Radiators; Shims; Stampings.

McGILL MFG. CO., INC., BEARING DIV., Valparaiso, Ind.
PERSONNEL: C. S. McGill, Pres., Treas. & Gen. Mgr.; R. McGill, V. Pres.; W. E. Brownell, Secy. & Sales Mgr.; J. J. O'Connor, Pur. Agt.; O. V. Cederberg, Chief Engr.
PRODUCTS: Ball and roller bearings.

THE McKAY CO., York, Pa.
PERSONNEL: T. J. McKay, Pres. & Treas.; J C. McKay, V. Pres.; F. A. Bond, V. Pres.. Secy. & Sales Mgr.
PRODUCTS: Sling chains; Arc welding electrodes.

McKENNA METALS CO., 1 Lloyd Ave., Latrobe, Pa.
PERSONNEL: M. M. McKenna, A. G. McKenna, Partners, W. L. Kennicott, Sales Mgr.; W. Newcomer, Pur. Agt. & Supt.; W. S. Jones, Pub. Dir.
PRODUCTS: Carbide cutting tools.

IRWIN McNIECE, 5314 Mt. Royal Dr., Los Angeles, Calif.
PERSONNEL: I. McNiece, Owner & Gen. Mgr.; N. E. Jones, Associate.
PRODUCTS: Tools.

McQUAY, INC., 1600 Broadway St., Minneapolis, Minn.
PERSONNEL: R. J. Resch, Pres. & Gen. Mgr.; G. Kelting, V. Pres.; R. C. Colman, V. Pres. & Sales Mgr.; E. H. Seelert, Secy. & Treas.; E. M. Fox, Pur. Agt.; Pers. Dir. & Pub. Dir.; C. L. Bensen, Chief Engr.
PRODUCTS: Ammunition boxes and counters; Heaters; Tanks; Ventilating and air conditioning equipment.

McQUAY-NORRIS MFG. CO., 2320 Narconi St., St. Louis, Mo.
PERSONNEL: W. K. Norris, Pres.; A. J. Mummert, V. Pres.; A. G. Drefs, V. Pres. & Treas.; H. W. Knapp, Secy. & Sales Mgr.; D. M. Smith, Chief Engr.
PRODUCTS: Piston rings.

MACWHYTE CO., Kenosha, Wisc.
PERSONNEL: J. S. Whyte, Pres. & Gen. Mgr.; R. B. Whyte, V. Pres.; H. E. Sawyer, V. Pres. & Treas.; H. Gay, Secy.; R. G. Diehl, Sales Mgr.; C. F. Lamich, Pur. Agt.; E. G. Knoedler, Pers. Dir.; F. J. Nelson, Pub. Dir.; H. G. Kinder, Chief Engr.
PRODUCTS: Aircraft control cable assemblies; Tie rods; Wire rope slings; Cable ends for control cables.

MAGEE SHEET METAL MACHINERY CO., Ypsilanti, Mich.
PERSONNEL: W. R. Magee, Prop.; D. G. Seymour, Supt.; R. Kiser, Pur. Agt.
PRODUCTS: Machine tools.

MAGNAFLUX CORP., 5908 Northwest Highway, Chicago, Ill.
PERSONNEL: A. V. de Forest, Pres.; F. B. Doane, V. Pres. & Treas.; T. C. Diller, Secy.; W. E. Thomas, Sales Mgr.; W. L. Burson, Jr., Pur. Agt.; H. T. Nordstrom, Chief Engr.
PRODUCTS: Testing and inspection equipment.

MAGNUS CHEMICAL CO., INC., South Ave., Garwood, N. J.
PERSONNEL: W. M. Campbell, Pres.; R. W. Mitchell, V. Pres.; W. M. Garbe, Secy.; O. Buss, Gen. Mgr.; D. Blanchard, Sales Mgr.; A. H. Johnson, Pur. Agt.; R. Kreie, Pub. Dir.; M. Zinty, Chief Engr.
PRODUCTS: Cleaners and cleaning compounds.

MALL TOOL CO., 7740 S. Chicago Ave., Chicago, Ill.
PERSONNEL: A. W. Mall, Pres. & Gen. Mgr.; A. L. Heald, V. Pres.; W. H. Sanders, Secy. & Treas.; F. A. McGonigle, Sales Mgr.; J. W. Innes, Pur. Agt.; C. J. Hart, Pers. Dir.; M. Rehnquist, Pub. Dir.; P. Walzak, Chief Engr.
PRODUCTS: Controls.

P. R. MALLORY & CO., INC., Indianapolis, Ind.
PERSONNEL: P. R. Mallory, Pres.; G. Fotheringham, Secy.; M. E. Hamilton, Treas.; J. E. Cain, Gen. Mgr.; R. F. Sparrow, Sales Mgr.; G. C. Mercer, Pur. Agt.; A. E. Sinclair, Pers. Dir.; P. N. Cook, Pub. Dir.; L. Robbin, Chief Engr.
PRODUCTS: Battery chargers; Bomb releases and timers; Bearings; Bushings; Collector rings, cowls, streamlines; Switches; Misc. electrical equipment; Starters.

THE MANHATTAN RUBBER MFG. DIV. OF RAYBESTOS-MANHATTAN, INC., 61 Willett St., Passaic, N. J.
PERSONNEL: J. J. DeMario, Pub. Dir.
PRODUCTS: Bushings; Engine mounts; Gaskets; Oil seals; Rubber and synthetic parts; Radio and ignition shielding; Tubing; Engine valves and valve parts; Vibration dampers; Rubber hose.

MANLOVE & SPAULDING MFG. CO., 3524 Union Pacific Ave., Los Angeles, Calif.
PERSONNEL: P. M. Manlove, Pres. & Pur. Agt.; L. B. Manlove, V. Pres. & Pers. Dir.; R. E. Spaulding, Secy., Gen. Mgr. & Sales Mgr.
PRODUCTS: Aluminum and steel parts; Subassemblies.

MANNING, MAXWELL & MOORE, INC., 11 Elias St., Bridgeport, Conn.
PERSONNEL: R. R. Wason, Pres.; C. H. Butterfield, V. Pres. & Sales Mgr.; F. M. Kreiner, Secy. & Treas.; H. Merrill, Gen. Works Mgr.; W. T. O'Connor, Pur. Agt.; W. I. Newman, Pers. Dir.; I. B. VanHouten, Pub. Dir.; E. H. Hammond, Chief Engr.
PRODUCTS: Instruments.

MANUFACTURERS SCREW PRODUCTS, 216-222 W. Hubbard St., Chicago, Ill.
PERSONNEL: B. J. Sackheim, Pres.; N. R. Sackheim, V. Pres.; S. R. Maness, Secy.; R. B. Sackheim, Treas.; R. M. Le Glaire, Sales Mgr.; I. B. Green, Pur. Agt.; J. S. Molan, Pers. Dir.; A. C. Schatz, Pub. Dir.; A. J. Cherry, Chief Engr.
PRODUCTS: Terminals; Screws; Nuts; Washers; Cotter pins; Misc. hardware; Aluminum washers; Stampings.

MAPLEWOOD MACHINERY CO., 2634 Fullerton Ave., Chicago, Ill.
PERSONNEL: J. J. Ingels, Pres.; B. Ingels, V. Pres.; F. D. Sadler, Secy. & Sales Mgr.
PRODUCTS: Stampings; Tanks; Miscellaneous.

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America's invasion forces took over airfields and other key points in Northern Africa in record time. An operation of this kind calls for both planes and equipment-carrying "chutes" in great numbers—chutes made of fine cottons. In addition to the priority "musts" for our drills, twills, duck and many other fabrics, our B*A*30 AIRPLANE CLOTH and WARWICK BALLOON CLOTH are available only on a priority basis and in accordance with the provisions of Conservation Orders M-197, M-127.

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PRODUCTS: Machine tools.

MARLIN-ROCKWELL CORP.,
Jamestown, N. Y.
PERSONNEL: A. C. Davis, Pres. & Gen. Mgr.; J. H. Walters, Secy. & Treas.; H. A. Johnston, Sales Mgr.; C. A. Berg, Pur. Agt.; L. A. Cummings, Chief Engr.
PRODUCTS: Ball and roller bearings.

MARMAN PRODUCTS CO.,
940 W. Redondo Blvd., Inglewood, Calif.
PERSONNEL: Z. Marx, Pres.; A. J. Miller, Secy. & Treas.; G. A. Cunningham, Gen. Mgr.; J. T. King, Chief Engr.
PRODUCTS: Clamps; Collector rings; Manifold parts; Shock struts; Tools.

THE MARQUETTE METAL PRODUCTS CO., 1145 Galewood Dr., Cleveland, O.
PERSONNEL: H. Gleitz, Pres.; J. S. Kustin, Secy. & Treas.; E. D. Jackson, Mgr., Aircraft Accessories Dept.; C. E. Miller, Sales Mgr.; W. O. Yohe, Pur. Agt.
PRODUCTS: Windshield de-icer equipment; Misc. engine equipment; Parts; Propellers and propeller parts; Pumps; De-icing alcohol tanks; Windshield wipers.

MARTIN-DECKER CORP.,
3431 Cherry Ave., Long Beach, Calif.
PERSONNEL: W. R. Martin, Pres. & Gen. Mgr.; E. L. Decker, Secy., Treas. & Sales Mgr.; H. J. Blythe, Pur. Agt.
PRODUCTS: Aircraft cable tensiometers.

THE MARTIN-SENOUR CO.,
2520 S. Quarry St., Chicago, Ill.
PERSONNEL: Z. E. Martin, Pres.; W. M. Stuart, V. Pres. & Gen. Mgr.; H. T. Johnson, Aviation Sales Mgr.
PRODUCTS: Cleaners and cleaning compounds; Paints, varnishes and finishes; Aircraft fabrics.

THE MARTINDALE ELECTRIC CORP.,
1375 Hird Ave., Lakewood, O.
PERSONNEL: E. H. Martindale, Pres.; G. E. Martindale, V. Pres.; W. N. Osbun, Secy.; H. McFarland, Treas.; O. W. Scharping, Chief Engr.
PRODUCTS: Tools.

MARVEL-SCHEBLER CARBURETER DIV., BORG-WARNER CORP., 1910 St. John St., Flint, Mich.
PERSONNEL: S. W. Gray, Pres.; J. R. Emerson, V. Pres. & Chief Engr.; W. E. Walpole, Secy. & Treas.; N. M. Hurry, Sales Mgr.; W. G. Ryan, Pur. Agt.
PRODUCTS: Carburetors.

MARYLAND METAL BUILDING CO., Race & McComas St., Baltimore, Md.
PERSONNEL: C. H. Michel, Pres., Gen. Mgr., Sales Mgr. & Chief Engr.; O. F. Murphy, V. Pres.; I. J. Wilcoxon, Secy.; R. G. Bristow, Treas.
PRODUCTS: Ammunition boxes and counters; Steel hangers.

MASTER LOCK CO., Milwaukee, Wisc.
PERSONNEL: P. E. Yolles, Pres.; S. M. Soref, V. Pres.; S. Stahl, Secy. & Pur. Agt.; H. E. Soref, Treas.; E. J. Tower, Sales Mgr.; H. Peterson, Chief Engr.
PRODUCTS: Padlocks.

THE W. L. MAXSON CORP.,
460 W. 34th St., New York, N. Y.
PERSONNEL: W. L. Maxson, Pres.
PRODUCTS: Instruments; Miscellaneous.

MELLUS BROTHERS & CO.,
305 E. Fourth St., Los Angeles, Calif.
PERSONNEL: L. R. Mellus, Pres. & Gen. Mgr.; F. H. Mellus, E. J. Mundy, V. Pres.; G. G. Mellus, Secy. & Treas.
PRODUCTS: Covers; Canvas and airplane cloth; Webbing cotton; Life preserver cushions.

MENASCO MANUFACTURING CO., 805 S. San Fernando Blvd., Burbank, Calif.
PERSONNEL: J. E. Royall, Pres. & Gen. Mgr.; R. R. Miller, V. Pres., Secy., Sales Mgr. & Pub. Dir.; E. V. Carlson, Treas.; C. P. Hunt, Pur. Agt.; C. H. Allred, Pers. Dir.; J. C. Barker, W. G. Wood, Chief Engrs.
PRODUCTS: Heaters; Hydraulic controls and assemblies; Hydraulic landing gears; Aluminum parts; Shock struts.

J. E. MENAUGH CO.,
549 W. Washington Blvd., Chicago, Ill.
PERSONNEL: J. E. Menaugh, Pres.; A. S. Dusenberg, Chief Engr.
PRODUCTS: Bearings; Bushings; Misc. engine equipment; Parachutes; Seats; Spark plugs; Tires and tubes.

MERCURY AIRCRAFT INC.,
Hammondsport, N. Y.
PERSONNEL: J. F. Meade, Pres. & Gen. Mgr.; E. M. Meade, V. Pres.; M. C. Close, Secy.; S. Singer, Treas.; R. F. Moore, Dir. of Procurment; C. F. Guthy, Pur. Agt.; M. D. Linehan, Pers. Dir.; C. L. Roloson, Prod. Mgr.; R. W. Heffer, Chief Engr.
PRODUCTS: De-icer equipment; Floats, skiis; Aluminum parts; Sub-assemblies; Fuel tanks; Oil separators.

MERCURY CHEMICAL CO.,
2706 David Stott Bldg., Detroit, Mich.
PERSONNEL: W. M. Keese, Gen. Mgr.
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PERSONNEL: J. B. Meriam, Pres. & Gen. Mgr.; H. G. Schowe, V. Pres.; C. Meriam, Secy.; J. B. Meriam, Jr., Treas.; A. A. Hejduk, Sales Mgr.; L. C. Deunk, Pur. Agt.
PRODUCTS: Gauges; Testing instruments; Manometers; Meters.

MERRILL ENGINEERING LABORATORIES, 1230 Lincoln St., Denver, Colo.
PERSONNEL: M. S. Merrill, Pres. & Chief Engr.; J. W. Williams, Gen. Mgr. & Pur. Agt.; R. L. West, Sales Mgr.
PRODUCTS: Plane wheel and propeller balancing equipment.

MET-L-WOOD CORP.,
6755 W. 65th St., Chicago, Ill.
PERSONNEL: C. C. Kendrick, Pres.; L. M. Crow, Jr., V. Pres., Treas., Gen. Mgr. & Pur. Agt.; I. J. Novotny, Secy. & Chief Engr.; G. K. Lewis, Sales Mgr.; L. L. Lord, Pers. Dir.
PRODUCTS: Collector rings, cowls, streamlines; Exhaust manifolds; Panels; Aluminum, plywood and steel parts; Stampings.

METAL & THERMIT CORP.,
120 Broadway, New York, N. Y.
PERSONNEL: F. H. Hirschland, Pres.; E. Becher, W. S. Smith, V. Pres.; J. B. Tinnon, V. Pres. & Sales Mgr.; H. E. Rogers, Secy.; B. Anderson, Treas.; E. A. Leaverty, Pur. Agt.; M. L. Smith, Pub. Dir.; J. H. Deppeler, Chief Engr.
PRODUCTS: Welding rods.

METALLIZING ENGINEERING CO., INC.,
21-07 41st Ave., Long Island City, N. Y.
PERSONNEL: R. A. Axline, Pres.; W. C. Reid, V. Pres., Sales Mgr. & Pub. Dir.; G. S. Lufkin, Secy. & Treas.; R. Dwyer, Pur. Agt.; H. Ingham, Chief Engr.
PRODUCTS: Metal spraying machines; Metal spray wire and supplies.

METALS & CONTROLS CORP., GENERAL PLATE DIV., 34 Forest St., Attleboro, Mass.
PERSONNEL: R. Willard, Pres.; C. J. Stone, Treas.; V. Davignon, Gen. Mgr.; J. A. Payette, Sales Mgr.; E. Carpenter, Pur. Agt.
PRODUCTS: Collector rings; Tubing.

METZGAR CO., 115 Logan St., S. W., Grand Rapids, Mich.
PERSONNEL: L. Metzgar, R. H. Metzgar, Partners.
PRODUCTS: Miscellaneous.

E. B. MEYROWITZ, INC.,
520 Fifth Ave., New York, N. Y.
PERSONNEL: E. Meyrowitz, Pres.; W. N. Cook, V. Pres. & Gen. Mgr.; J. S. Schultz, Secy. & Treas.
PRODUCTS: Goggles.

MICA INSULATOR CO.,
200 Varick St., New York, N. Y.
PERSONNEL: M. A. Chapman, Pres.; J. M. Coffey, V. Pres.; E. Nelson, Secy. & Treas.; C. P. Mills, Sales Mgr.; Q. F. Jardine, Pur. Agt.; R. H. Spry, Chief Engr.
PRODUCTS: Insulating materials; Panels; Plastic parts.

MICHIGAN TOOL CO.,
7171 E. McNichols Rd., Detroit, Mich.
PERSONNEL: O. L. Bard, Pres. & Treas.; M. R. Anderson, V. Pres.; J. C. Drader, Gen. Mgr.; P. Norman, Pur. Agt.; C. R. Staub, Chief Engr.
PRODUCTS: Landing gears; Machine tools; Tools.

MICHIGAN WIRE CLOTH CO.,
2100 Howard St., Detroit, Mich.
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PRODUCTS: Filters and strainers.

MICRO SWITCH CORP., Freeport, Ill.
PERSONNEL: W. B. Schulte, Pres. & Pub. Dir.; A. L. Riche, V. Pres., Gen. Mgr. & Sales Mgr.; M. W. Eaton, Secy., Treas. & Pers. Dir.; W. J. Young, Pur. Agt.; O. H. Kaminky, Chief Engr.
PRODUCTS: Switches.

MICROMATIC HONE CORP.,
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PERSONNEL: K. W. Connor, Pres. & Gen. Mgr.; H. M. Whittaker, V. Pres. & Sales Mgr.; A. J. Prentice, Secy. & Treas.; W. R. Gauss, Pur. Agt.; W. J. Pinkerton, Pers. Dir.; L. S. Martz, Pub. Dir.; W. H. Harris, Jr., Chief Engr.
PRODUCTS: Machine tools.

MID-STATE MFG. CO.,
21 E. Jefferson St., Waupun, Wisc.
PERSONNEL: C. O. Thomas, Pres. & Treas.; A. W. Fairchild, V. Pres. & Secy.; A. G. Gibbons, Gen. Mgr.; B. H. Bredeson, Pur. Agt.; H. C. Engelbracht, Pers. Dir.; H. H. Hanson, Chief Engr.
PRODUCTS: Aluminum, steel, copper, iron, and brass rivets.

THE ALEXANDER MILBURN CO.,
1424 W. Baltimore St., Baltimore, Md.
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PRODUCTS: Cutting and welding torches and tips; Air pressure regulators; Spray guns; Flare lights.

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PERSONNEL: F. H. Merwin, Pres. & Gen. Mgr.; S. Simpson, V. Pres.; R. B. Davis, Secy.; A. R. Knight, Treas.; A. M. Birks, Sales Mgr.; H. P. Brewer, Pur. Agt.; V. M. Caltham, Chief Engr.
PRODUCTS: Fasteners.

JAMES MILLEN MFG. CO., INC.,
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PERSONNEL: J. Millen, Pres., Treas. & Gen. Mgr.; R. S. Millen, V. Pres.; C. Barrett, Secy.; F. Bearse, Pur. Agt.; R. W. Caywood, Chief Engr.
PRODUCTS: Insulating materials; Radios.

MILLER & CROWNINGSHIELD,
Greenfield, Mass.
PERSONNEL: F. K. Crowningshield, Gen. Mgr.
PRODUCTS: Machine tools.

MILLERS FALLS CO., Greenfield, Mass.
PERSONNEL: P. Rogers, Pres. & Gen. Mgr.; G. U. Hatch, V. Pres. & Sales Mgr.; E. D. Holtby, Secy. & Treas.; C. W. Parsons, Pur. Agt.
PRODUCTS: Tools.

W. K. MILLHOLLAND MACHINERY CO.,
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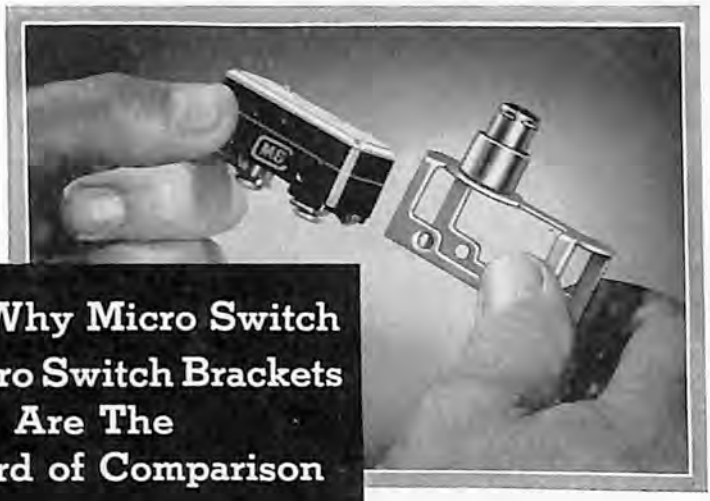
PERSONNEL: W. K. Millholland, Pres. & Gen. Mgr.; I. M. Millholland, Secy., Treas., & Pur. Agt.; D. Millholland, Sales Mgr.
PRODUCTS: Machine tools.

MILWAUKEE VALVE CO.,
2375 S. Burrell St., Milwaukee, Wisc.
PERSONNEL: V. Fina, Pres.; P. Fina, Secy.; C. S. Bigelow, Sales Mgr.; A. A. Stollenwerk, Pur. Agt.; W. Hoelzer, Chief Engr.
PRODUCTS: Castings and forgings; Control valves.



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Thumb-size, feather-weight, rugged and sensitive, Micro Switch is accurately built to exact standards from precisely made parts. Its performance characteristics can be changed to meet functional requirements . . . Type R-31, shown above, is designed to operate satisfactorily at 40,000 feet and in extremes of temperature. All switches must pass a factory harmonics vibration test up to 60 cycles per second. It is designed and constructed to withstand acceleration of 10 G's. Strong, light weight actuator brackets, shown below, permit fast installation of the switch and easy replacement in the field. They are specifically designed to accommodate Type R-31 Micro Switch. They require no deviation permit.

This new Type M-B skeleton bracket is complete with over-travel plunger. Is interchangeable with Army switches A-1 and A-2. Weighs only .14 pound with switch. Plunger has controlled pre-travel and over-travel total of ¼". Mounting holes in top of bracket are on standard 1 13/16" centers and accept number 6-32 bolts.

The Type T series bracket has met instant adoption as a throttle warning switch, singly or in gangs. They are operated by cams on the throttle quadrant or dogs on the cables. Any switch held depressed can be instantly opened by manual release without disturbing others in the gang.

Send for this catalog. Catalog No. 70 contains information regarding switches specifically designed for aircraft use.

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PRODUCTS: First aid equipment; Protective clothing and equipment.

MINIATURE PRECISION BEARINGS, Keene, N. H.
PERSONNEL: H. D. Gilbert, Treas.; W. S. Pierce, Jr., Chief Engr.
PRODUCTS: Precision bearings.

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PRODUCTS: Hole saws.

MOBILE REFRIGERATION, INC., 630 Fifth Ave., New York, N. Y.
PERSONNEL: D. Pyzel, IV, Pres.; G. T. Senseney, V. Pres.; P. W. Hunter, V. Pres. & Gen. Mgr.; F. C. Butler, Treas.; A. A. Ayers, Pur. Agt.; E. Lodwig, Chief Engr.
PRODUCTS: Testing equipment.

MOLDED INSULATION CO., 335 E. Price St., Philadelphia, Pa.
PERSONNEL: V. I. Zelov, Pres. & Treas.; A. Heer, V. Pres.; W. T. Bradbury, Gen. Mgr.; E. A. Berger, Sales Mgr. & Pers. Dir.; R. M. Connor, G. E. Schoen, Pur. Agts.; A. Zillger, A. Aichinger, Chief Engrs.
PRODUCTS: Controls; Disconnect plugs; Misc. electrical equipment; Switches; Terminals; Instruments; Insulating materials; Panels; Aluminum, plastic and synthetic parts; Radios; Miscellaneous.

MONARCH ALLOYS CO., Ravenna, O.
PERSONNEL: E. P. Carter, Gen. Mgr.
PRODUCTS: Bearings; Non-ferrous castings.

MONARCH ALUMINUM MFG. CO., 9301 Detroit Ave., Cleveland, O.
PERSONNEL: R. Deutsch, Pres. & Treas.; H. J. Deutsch, V. Pres.; D. R. Gould, Secy.; H. Davis, Sales Mgr.; O. Ulrich, Pur. Agt.; C. Carver, Chief Engr.
PRODUCTS: Basic materials and fabrications; Castings and forgings; Aluminum parts.

THE MONARCH MACHINE TOOL CO., Sidney, O.
PERSONNEL: W. E. Whipp, Pres., Treas. & Gen. Mgr.; P. A. Abe, V. Pres.; F. C. Dull, V. Pres. & Secy.; J. A. Raterman, V. Pres. & Pur. Agt.; H. A. Toy, Sales Mgr.; C. A. Bickel, Chief Engr.
PRODUCTS: Machine tools.

MONARCH METAL WEATHERSTRIP CORP., 6333 Etzel Ave., St. Louis, Mo.
PERSONNEL: J. A. Goellner, Pres.; A. N. Lane, V. Pres. & Sales Mgr.; H. C. Albrecht, Secy. & Treas.; F. J. Kick, Chief Engr.
PRODUCTS: Aircraft armament; Basic materials and fabrications; Castings and forgings; Covers; Fasteners; Fittings; Misc. hardware; Aluminum and steel parts; Stampings.

MONITE WATERPROOF GLUE CO., 1628 N. Second St., Minneapolis, Minn.
PERSONNEL: H. L. Prestholdt, Pres.; H. W. Mattison, V. Pres. & Treas.
PRODUCTS: Glue and adhesives.

MONMOUTH PRODUCTS CO., 1929-41 E. 61st St., Cleveland, O.
PERSONNEL: E. L. Davis, Pres. & Gen. Mgr.; G. M. Salzman, V. Pres.; G. L. Jameson, Secy.; H. D. Hubbs, Treas. & Sales Mgr.; S. Waite, Pur. Agt.; G. L. Ferguson, Chief Engr.
PRODUCTS: Bearings; Bushings; Steel parts; Supercharger clutch discs; Throttle parts.

MONSANTO CHEMICAL CO., St. Louis, Mo.
PERSONNEL: E. M. Queeny, Pres.; C. Belknap, V. Pres.; W. W. Schneider, Secy.; F. A. Ulmer, Treas.

Plastics Div. Springfield, Mass.
PERSONNEL: J. C. Brooks, Gen. Mgr.; J. H. Clark, Sales Mgr.; G. M. Bullard, Pur. Agt.; S. H. Colton, Pers. Dir.; J. R. Turnbull, Pub. Dir.
PRODUCTS: Paints, varnishes and finishes; Transparent plastic windows; Side-lights.

Merrimac Div. Everett Station, Boston, Mass.
PERSONNEL: E. M. Queeny, Pres.; W. M. Rand, V. Pres., & Gen. Mgr.; W. W. Schneider, Secy.; F. A. Ulmer, Treas.; L. A. Pratt, Sales Mgr.; E. E. Brainard, Pur. Agt.; C. E. Serrens, Pers. Dir.; P. A. Singleton, Pub. Dir.; J. B. Flaws, Chief Engr.
PRODUCTS: Paints, varnishes and finishes.

MOORE DROP FORGING CO., Springfield, Mass.
PERSONNEL: J. M. Collins, Pres. & Treas.; H. G. Dickey, A. T. Murray, V. Pres.; E. Abbe, V. Pres. & Chief Engr.; F. Hatch, Secy.; N. B. Ellison, Sales Mgr.; A. Converce, Pur. Agt.
PRODUCTS: Steel, aluminum and brass forgings; Finished machined parts.

MOORE-EASTWOOD & CO., 537 Monument Ave., Dayton, O.
PERSONNEL: H. C. Moore, Gen. Mgr.; L. N. Moore, Secy. & Treas.; L. Scheid, Pur. Agt.; R. C. Moore, Chief Engr.
PRODUCTS: Bomb racks and shackles; Gun sights; Gun mount adapters; Aircraft armament; Aluminum and steel parts; Filler valves; Cablemeters; Tab controls; Generators; Gun synchronizer.

MORSE TOOL CO., 116 E. Goldengate Ave., Detroit, Mich.
PERSONNEL: W. S. Morse, Pres.; M. J. Morse, Secy.; W. H. Morse, Treas.; J. G. Weeks, Gen. Mgr. & Sales Mgr.; W. L. Janis, Pur. Agt.; F. L. Bearss, Pers. Dir.
PRODUCTS: Tools.

MOTOR MASTER PRODUCTS CORP., AERONAUTICAL DIV., 549 Washington Blvd., Chicago, Ill.
PERSONNEL: J. E. Menaugh, Gen. Mgr.; R. J L. Dutterer, Chief Engr.
PRODUCTS: Spark plugs.

MOTOR REBUILDING SPECIALTIES,
2634 S. Michigan Ave., Chicago, Ill.
PERSONNEL: N. F. Clayborne, Owner, Gen. Mgr., & Sales Mgr.; R. S. Wiencek, Pur. Agt.; I. L. Clayborne, Pers. Dir.; L. E. Plassmeyer, Chief Engr.
PRODUCTS: Airport equipment; Engine mounts; Misc. engine equipment.

MU-SWITCH CORP.,
38 Pequit St., Canton, Mass.
PERSONNEL: T. Deutschmann, Pres.; H. A. Leander, V. Pres. & Treas.; D. A. Calder, Gen. Mgr. & Sales Mgr.; R. Reed, Pur. Agt.; J. Bukey, Pub. Dir.; P. A. Lund, Chief Engr.
PRODUCTS: Switches.

MURPHY VARNISH CO.,
224 McWhorter St., Newark, N. J.
PERSONNEL: C. L. Roh, Pres.; P. S. Kennedy, V. Pres.; Z. Belcher, Secy.; F. Praegner, Treas.; H. W. Lay, Gen. Sales Mgr.; T. I. Savage, Pur. Agt.; R. H. Sommer, Pub. Dir.; A. Anderson, Chief Engr.
PRODUCTS: Paints, varnishes and finishes.

THE MURRAY CORP. OF AMERICA,
7700 Russell St., Detroit, Mich.
PERSONNEL: C. W. Avery, Pres.; C. D. Widman, V. Pres.; C. H. Menge, Sales Mgr.; E. A. Ruggles, Pur. Agt.; M. B. Lindquist, Pers. Dir.
PRODUCTS: Wings; Tail surfaces; Stainless steel shrouds and firewalls; Panels; Aluminum and steel parts.

MUSKEGON PISTON RING CO.,
Sixth & Alpha Sts., Muskegon, Mich.
PERSONNEL: T. E. McFall, Pres.; H. G. Vaughan, V. Pres.; G. A. Fifield, Secy.; G. W. Lundeen, Treas.; J. A. Nadeau, Pur. Agt.; R. L. Swanson, Pers. Dir.; P. S. Lane, Chief Engr.
PRODUCTS: Piston rings; Aircraft propeller housing ring.

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THE NASH ENGINEERING CO.,
South Norwalk, Conn.
PERSONNEL: I. C. Jennings, Pres.; D. E. Nash, V. Pres. & Treas.; H. L. Nash, Secy.; E. A. Mead, Sales Mgr.; H. E. Bradbury, Pur. Agt.; G. B. Wright, Pub. Dir.; H. E. Adams, Chief Engr.
PRODUCTS: Altitude chamber pumps.

NATIONAL AIRCRAFT EQUIPMENT CO.,
275 North Ave. 19, Los Angeles, Calif.
PERSONNEL: R. T. Kinney, Pres.; W. H. Kinney, L. L. Martin, V. Pres.; J. H. Byrnes, Treas.; R. P. Lewis, Plant Mgr.; D. Reynolds, Sales Mgr.; W. W. Grace, Pur. Agt.; H. H. Cox, Pers. Dir.; F. P. Bucklein, Chief Engr.
PRODUCTS: Basic materials and fabrications; Castings and forgings; Engine mounts; Landing gears; Aluminum, fibre, magnesium, plywood and steel parts; Sub-assemblies; Tail wheel assemblies; Tools.

NATIONAL AIRCRAFT MATERIALS CORP.,
P. O. Box 469, Rutland, Vt.
PERSONNEL: P. R. Eaton, Pres., Gen. Mgr., Sales Mgr. & Pur. Agt.; L. E. Eaton, Secy.; M. J. Eaton, Treas. & Pub. Dir.; M. V. Quigley, Pers. Dir.; C. Smith, Chief Engr.
PRODUCTS: Ammunition boxes and counters; Plywood parts; Wood wingbeams and struts; Wood propeller and propeller parts.

THE NATIONAL ALUMINUM CYLINDER HEAD CO., 3420 E. 93rd St., Cleveland, O.
PERSONNEL: J. L. Schmeller, Pres.; F. G. Diffin, V. Pres. & Sales Mgr.; G. N. Wright, V. Pres. & Pur. Agt.; H. T. Schmeller, Secy.; L. G. Smith, Treas.
PRODUCTS: Aluminum cylinder heads.

NATIONAL BROACH & MACHINE CO.,
5600 St. Jean Ave., Detroit, Mich.
PERSONNEL: R. S. Drummond, Pres.; W. S. Praeg, V. Pres.; M. H. Crawford, Secy.; J. I. Schultz, Treas. & Pub. Dir.; F. Kirsten, Pur. Agt.; T. S. Gates, B. F. Bregi, Chief Engrs.
PRODUCTS: Machine tools; Tools.

THE NATIONAL BRONZE & ALUMINUM FOUNDRY CO., 529 Union Commerce Bldg., Cleveland, O.
PERSONNEL: J. L. Schmeller, Pres. & Sales Mgr.; W. A. Muth, V. Pres. & Secy.; G. N. Wright, V. Pres. & Pur. Agt.; L. G. Smith, Treas.; E. Davis, Pers. Dir.; W. Butcher, Pub. Dir.
PRODUCTS: Castings and forgings.

THE NATIONAL COPPER & SMELTING CO., 1862 E. 123rd St., Cleveland, O.
PERSONNEL: H. B. Smith, Pres.; C. L. Smith, Treas.
PRODUCTS: Tubing.

NATIONAL MACHINE PRODUCTS,
150 W. Slauson Ave., Los Angeles, Calif.
PERSONNEL: R. F. Sopris, Pres.; J. K. Moffett, V. Pres.; H. E. Vorhis, Secy. & Treas.; A. T. Haugh, Sales Mgr.; W. A. Griffin, Pur. Agt.; D. M. Soule, Pers. Dir.; C. A. Nimz, Chief Engr.
PRODUCTS: Aircraft armament; Bomb racks; Controls; Hydraulic controls and assemblies; Instruments; Aluminum, magnesium and steel parts; Pumps; Sub-assemblies; Control valves; Engine valves and valve parts.

THE NATIONAL MACHINERY CO.,
Tiffin, O.
PRODUCTS: Cold headers; Forging machines; Maxipresses; Precision nut tappers.

THE NATIONAL SCREW & MFG. CO.,
2440 E. 75th St., Cleveland, O.
PERSONNEL: H. P. Ladds, Pres.; C. F. Newpher, V. Pres. & Sales Mgr.; E. E. Griese, Secy. & Treas.; R. G. Burnham, Pur. Agt.; F. W. Oldham, Pers. Dir.; H. C. Erdman, Chief Engr.
PRODUCTS: Bolts; Nuts; Screws; Cotters; Steel rivets.

NATIONAL TUBE CO.,
Frick Bldg., Pittsburgh, Pa.
PERSONNEL: W. F. McConnor, Sales Mgr.
PRODUCTS: Seamless steel tubing.

NATIONAL TWIST DRILL & TOOL CO., 6522 Brush St., Detroit, Mich.
PERSONNEL: H. L. McGregor, Pres.; E. J. Chamberlain, V. Pres. & Sales Mgr.; A. B. Hulsapple, Secy.; A. H. Mueckler, Treas.; H. A. McGregor, Gen. Mgr.; R. B. Kane, Pur. Agt.; C. J. Oxford, Pub. Dir. & Chief Engr.
PRODUCTS: Metal cutting tools.

NATIONAL VENEER & LUMBER CO., 1635 W. Michigan St., Indianapolis, Ind.
PERSONNEL: B. F. Swain, Jr., Pres.; M. B. Swain, V. Pres.; L. J. Heyne, Secy.; E. S. McDonald, Gen. Mgr.; E. F. Scherer, Sales Mgr.
PRODUCTS: Structural aircraft veneer.

THE NEDCO CO., 87 Rumford Ave., Waltham, Mass.
PERSONNEL: A. C. Burleigh, Pres., Treas. & Gen. Mgr.; C. S. Burleigh, Secy.
PRODUCTS: Sanding and rubbing machines.

NEU-BART STAMPING & MFG. CO., 120 W. Slauson Ave., Los Angeles, Calif.
PERSONNEL: A. H. Neubauer, Pres. & Gen. Mgr.; G. Bartholomew, V. Pres., Secy. & Treas.
PRODUCTS: Ammunition boxes and counters; Basic materials and fabrications; Propellers and propeller parts; Stampings; Sub-assemblies.

NEW DEPARTURE DIV., GENERAL MOTORS CORP., Bristol, Conn.
PERSONNEL: C. S. Joy, Treas.; F. G. Hughes, Gen. Mgr.; L. G. Sigourney, Sales Mgr.; J. A. Ashwell, Pur. Agt.; C. B. Greene, Pers. Dir.; C. B. Beckwith, Pub. Dir.; T. C. D. Crow, Chief Engr.
PRODUCTS: Ball bearings.

NEW ENGLAND SCREW CO., Keene, N. H.
PERSONNEL: G. J. Holt, Pres. & Treas.; C. G. Holt, V. Pres., Secy. & Treas.; G. B. Holt, Gen. Mgr. & Sales Mgr.; L. W. Hewitt, Pur. Agt.
PRODUCTS: Fasteners.

THE NEW HAVEN CLOCK CO., New Haven, Conn.
PERSONNEL: R. H. Whitehead, Pres. & Gen. Mgr.; E. Stevens, V. Pres. & Sales Mgr.; A. Ham, Secy.; P. H. English, Treas.; J. Whitehead, Pur. Agt.; S. Truesch, Pers. Dir.; R. H. Chirgwin, Pub. Dir.; G. Gabriel, Chief Engr.
PRODUCTS: Misc. electrical equipment.

NEW JERSEY FULGENT CO., INC., Whitman Ave., Metuchen, N. J.
PERSONNEL: S. D. Wiley, Pres.; A. R. Wiley, Secy.; G. D'Eustachio, Pur. Agt.; W. B. Hutchinson, Pers. Dir.; W. F. Buchanan, Chief Engr.
PRODUCTS: Military pyrotechnics.

NIXON NITRATION WORKS, Nixon, N. J.
PERSONNEL: C. F. Schuster, Pres. & Gen. Mgr.; L. Spinx, V. Pres.; M. Breitkopf, Secy.; O. S. Blaine, Treas.; M. W. Peters, Sales Mgr.; H. A. Hendrickson, Pur. Agt.; G. Schmelter, Chief Engr.
PRODUCTS: Insulating materials; Plastic parts.

NORMA-HOFFMAN BEARINGS CORP., Stamford, Conn.
PERSONNEL: O. P. Wilson, Pres. & Treas.; H. J. Ritter, V. Pres., Secy. & Sales Mgr.; C. E. Stevens, V. Pres.-Plant Operations; C. A. Wattson, Pur. Agt.; D. E. Batesole, Chief Engr.
PRODUCTS: Bearings.

NORTH AMERICAN ELECTRIC LAMP CO., 1014 Tyler St., St. Louis, Mo.
PERSONNEL: C. M. Rice, Pres.; E. O. Cohn, V. Pres.; L. Lander, Secy., Treas. & Gen. Mgr.; H. N. Adelstein, Pur. Agt.
PRODUCTS: Infra-red ray lamps; Drying equipment.

NORTH BROS. MFG. CO., Lehigh Ave. & American St., Philadelphia, Pa.
PERSONNEL: R. S. Rauch, Pres.; J. T. Fegley, V. Pres. & Treas.; E. J. Weierstall, Secy. & Sales Mgr.; W. G. Macht, Pur. Agt.
PRODUCTS: Tools.

NORTHILL CO., INC., 9851 Sepulveda Blvd., Los Angeles, Calif.
PERSONNEL: J. C. Garrett, Pres.; W. C. Brownlee, V. Pres.; H. W. Elliott, Secy.; E. Barlow, Treas.; E. H. Messereau, Mgr.; J. Meyer, Pur. Agt.
PRODUCTS: Stainless steel folding anchors.

NORTON CO., Worcester, Mass.
PERSONNEL: G. N. Jeppson, Pres.; H. A. Stanton, W. T. Montague, V. Pres.; C. S. Anderson, Secy.; M. P. Higgins, Treas.; P. Fielden, Pur. Agt.; W. I. Clark, Pers. Dir.; A. B. Fritts, Pub. Dir.

Abrasive Div.
PERSONNEL: A. B. Holmstrom, V. Pres. & Gen. Mgr.; W. R. Moore, Sales Mgr.; C. W. Daniels, Chief Engr.

Machine Div.
PERSONNEL: H. W. Dunbar, V. Pres. & Gen. Mgr.; F. W. Smith, Sales Mgr.; A. G. Belden, Chief Engr.
PRODUCTS: Precision grinding machines; Engine crankshaft grinders; Production lapping machines; Abrasives; Grinding wheels; Lapping and honing sticks; Super-refractories.

NUMBERALL STAMP & TOOL CO., Huguenot Park, Staten Island, N. Y.
PERSONNEL: M. Bayerdorffer, Pres.; C. Zeitler, V. Pres.
PRODUCTS: Stampings.

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THE O. K. TOOL CO., INC., Shelton, Conn.
PRODUCTS: Machine tool parts.

THE OHIO PISTON CO., 5340 Hamilton Ave., Cleveland, O.
PERSONNEL: C. Birnbaum, Pres.; E. J. Gutman, V. Pres.; D. P. Shaw, Secy., Gen. Mgr., Sales Mgr., Pur. Agt., Pers. Dir., & Pub. Dir.; R. G. Horsburgh, Treas.; G. Svetcoff, Chief Engr.
PRODUCTS: Hydraulic controls and assemblies; Misc. engine equipment; Aluminum and steel parts; Pistons; Pumps.

THE OHIO SEAMLESS TUBE CO.
Shelby, O.
PERSONNEL: W. C. Connelly, Pres., & Gen. Mgr.; W. W. Van Horn, V. Pres.; E. W. McNeill, Secy., & Treas.; A. Waines, Jr., Sales Mgr.; D. Reagan, Pur. Agt.; H. C. Mayer, Pers. Dir.; M. W. Freese, Pub. Dir.; R. Dewey, Chief Engr.
PRODUCTS: Tubing.

OHIO UNITS,
515-531 Hunter Ave., Dayton, O.
PERSONNEL: A. R. Lambert, Prop.; H. L. Brump, Chief Engr.
PRODUCTS: Truck wheel replacement parts; Superfinishers; Cam grinder.

OHMITE MANUFACTURING CO.,
4835 W. Flournoy St., Chicago, Ill.
PERSONNEL: D. T. Siegel, Gen. Mgr.; R. S. Laird, Sales Mgr.; A. Stolzenfeldt, Pur. Agt.; W. C. Hart, Pers. Dir.; H. Levy, Chief Engr.
PRODUCTS: Resistors; Rheostats; Switches.

THE OILGEAR CO.,
1403 W. Bruce St., Milwaukee, Wisc.
PERSONNEL: H. M. Swigart, Pres.; G. H. Fobian, W. Ferris, V. Pres.; S. M. Heller, Secy. & Treas.; W. G. Prasse, Sales Mgr.; G. L. Hartman, Pur. Agt.; M. E. Engebretson, Pub. Dir.; E. Wiedman, Chief Engr.
PRODUCTS: Machine tools.

OLDS ALLOYS CO.,
8686 Rheem Ave., South Gate, Calif.
PERSONNEL: R. B. Olds, Pres.; P. S. Rattle, V. Pres., Secy. & Treas.
PRODUCTS: Bearings.

TINIUS OLSEN TESTING MACHINE CO.,
500 N. 12th St., Philadelphia, Pa.
PERSONNEL: T. Y. Olsen, Pres., Treas. & Gen. Mgr.; T. Olsen, II, V. Pres.; J. F. Sutton, Secy.; T. L. Richards, Sales Mgr.; C. R. Tait, Pur. Agt.; R. B. Lewis, Chief Engr.
PRODUCTS: Measuring instruments; Testing machines; Static and dynamic balancing machines.

ONSRUD MACHINE WORKS, INC.,
3900 Palmer St., Chicago, Ill.
PERSONNEL: O. Onsrud, Pres.; T. W. Foote, V. Pres.; R. F. Onsrud, Secy. & Gen. Mgr.; H. Krabol, Treas.; R. C. Reinhartsen, Sales Mgr.; J. Knox, Pur. Agt.; G. Anderson, Pers. Dir.; G. M. Campbell, Pub. Dir.; H. C. Grondahl, Chief Engr.
PRODUCTS: Machine tools; Tools.

OPERADIO MANUFACTURING CO.,
St. Charles, Ill.
PERSONNEL: J. M. Stone, Pres.; G. R. Haase, V. Pres. & Gen. Mgr.; L. A. King, Secy., Treas. & Sales Mgr.; E. E. Swick, Pur. Agt.; K. S. Purkiss, Pers. Dir.; E. H. Kruse, Pub. Dir.; J. F. McCraigh, Chief Engr.
PRODUCTS: Misc. electrical equipment; Paging, public address and intercommunication equipment.

ORANGE ROLLER BEARING CO., INC.,
557 Main St., Orange, N. J.
PERSONNEL: J. A. Burden, Jr., Pres.; C. L. Ritchie, V. Pres., Treas. & Gen. Mgr.; A. F. Schaeffner, Secy.; R. J. Gales, Chief Engr.
PRODUCTS: Bearings.

KARL ORT, 614 W. Poplar St., York, Pa.
PRODUCTS: Basic materials and fabrications; Batteries; Bearings; Control sticks and wheels; Covers; Electrical equipment; Fasteners; Filters and strainers; Fire extinguishers; First aid equipment; Fittings; Flares; Floats, skiis; Gaskets; Hose clamps and hose fittings; Instruments; Insulating materials; Landing and navigation lights; Life saving equipment; Misc. hardware; Misc. engine equipment; Paints, varnishes and finishes; Parachutes; Parts; Piston rings; Engine primers; Propellers and propeller parts; Protective clothing and equipment; Pumps; Radiators; Radios; Radio compasses; Seats; Radio and ignition shielding; Shims; Shock struts and cord; Spark plugs; Stampings; Starters; Tail wheel assemblies; Tanks; Tires and tubes; Tools; Tubing; Control valves; Engine valves and valve parts; Wheels and brakes; Miscellaneous.

THE OSTER MFG. CO.,
E. 61st at Carnegie Ave., Cleveland, O.
PERSONNEL: R. Tewksbury, Pres., Treas. & Gen. Mgr.; A. S. Gould, V. Pres. & Sales Mgr.; H. A. Maurer, Secy.; W. Blank, Pur. Agt.; G. S. Scriven, Pers. Dir.; L. S. Newman, Pub. Dir.; R. Hyde, Chief Engr.
PRODUCTS: Machine tools.

J. A. OTTERBEIN,
55-61 Hubbard St., Middletown, Conn.
PERSONNEL: J. A. Otterbein, Prop.
PRODUCTS: Machine tools; Parachute hardware.

OWENS-CORNING FIBERGLAS CORP.,
15th Floor, Nicholas Bldg., Toledo, O.
PERSONNEL: H. Boeschenstein, Pres.; W. P. Zimmerman, V. Pres. & Gen. Mgr.; C. G. Staelin, Secy.; H. R. Winkle, Treas.; J. H. Thomas, Sales Mgr.; R. R. Bastian, Pur. Agt.; E. C. Ames, Pers. Dir.; W. D. Thackeray, Pub. Dir.; A. C. Wilson, Chief Engr.
PRODUCTS: Aircraft armament; Auxiliary power plants; Batteries; Auxiliary motors; Generators; Magnetos; Power and light cable and wire; Filters and strainers; First aid equipment; Flares; Gaskets; Heaters; Insulating materials; Oil seals; Fibre, plastic, plywood and rubber parts; Protective clothing and equipment; Radios; Starters; Tanks; Tubing; Ventilating and air conditioning equipment.

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PAASCHE AIRBRUSH CO.,
1909 Diversey Parkway, Chicago, Ill.
PERSONNEL: J. A. Paasche, Pres.; H. F. Reck, V. Pres.; W. A. Sharman, Treas.; W. H. Geisser, Sales Mgr.; L. R. Stensland, Pur. Agt.; R. H. Smutzer, Pub. Dir.; E. W. Berg, Chief Engr.
PRODUCTS: Paint spraying equipment.

PACIFIC-AIRMAX CORP., 7631 Roseberry Ave., Huntington Park, Calif.
PERSONNEL: H. A. Hartfield, Pres.; R. C. Gross, V. Pres. & Gen. Mgr.; E. S. Weiss, Treas. & Asst. Secy.; L. M. Hull, Sales Mgr. & Pub. Dir.; J. B. Marchand, Pur. Agt.; J. Davis, Pers. Dir.; A. A. Arnhym, Chief Engr.
PRODUCTS: De-icer equipment; Heaters; Insulating materials; Aluminum and steel parts; Stampings Sub-assemblies; Cabin supercharges; Ventilating and air conditioning equipment.

PACIFIC AVIATION, INC., 927 N. Sycamore Ave., Los Angeles, Calif.
PERSONNEL: H. V. Reynolds, Pres.; T. E. Springer, W. M. Jameson, V. Pres.; P. J. Brady, Secy., Treas. & Gen. Mgr.; W. M. McIlvain, Pur. Agt.; H. Scott, Pers. Dir.; H. F. Frimel, Chief Engr.
PRODUCTS: Bomb racks; Hydraulic controls and assemblies; Landing gear assemblies; Pumps; Shock struts and cord; Wheels and brakes.

PACIFIC GEAR WORKS OF LOS ANGELES, 2053 E. 38th St., Los Angeles, Calif.
PERSONNEL: P. Bannon, Jr., Gen. Mgr.; J. H. Coffey, Sales Mgr.; C. A. Hasenstab, Pur. Agt.; G. Malme, Pers. Dir.; J. K. Morris, Chief Engr.
PRODUCTS: Gears and gear assemblies.

PACIFIC SCIENTIFIC CO., 1430 Grande Vista Ave., Los Angeles, Calif.
PERSONNEL: W. P. Balderston, Pres.
25 Stillman St., San Francisco, Calif.
PERSONNEL: D. H. Grubb, V. Pres.; D. G. McAllister, Secy. & Treas.
PRODUCTS: Meteorological airport equipment; Batteries; Flares; Instruments; Pumps.

PACKARD ELECTRIC DIV., GENERAL MOTORS CORP., Warren, O.
PERSONNEL: B. N. MacGregor, Gen. Mgr.; G. S. Carr, R. J. Montgomery, Sales Mgr.; E. E. DeBolt, Pur. Agt.; K. H. Hoffman, Pers. Dir.; L. C. Wolcott, Chief Engr.
PRODUCTS: Cable; Radio and ignition shielding.

PACKARD MANUFACTURING CORP., 2900 Columbia, Indianapolis, Ind.
PERSONNEL: H. E. Capehart, Pres.; E. E. Collison, V. Pres. & Chief Engr.; W. F. Struby, Secy. & Gen. Mgr.; O. C. Roberts, Asst. Treas.; W. C. Brase, Pur. Agt.; H. Stephens, Pers. Dir.; D. V. Kennedy, Pub. Dir.
PRODUCTS: Collector rings.

PACKLESS METAL PRODUCTS CORP., 31 Winthrop Ave., New Rochelle, N. Y.
PERSONNEL: G. M. Pettee, Pres.; M. W. McLaren, V. Pres.; R. S. Frichette, Secy.; H. W. Cole, Treas.; W. L. Bryde, Sales Mgr.; T. J. Callagy, Pur. Agt.; S. Guarnaschelli, Chief Engr.
PRODUCTS: Fittings; Flexible bronze and metallic hose; Vibration absorbers and dampers.

THE PALNUT CO., 67 Cordier St., Irvington, N. J.
PERSONNEL: J. R. Hotchkin, Pres.; A. H. Beggs, V. Pres.
PRODUCTS: Fasteners; Locknuts.

PANNIER BROS. STAMP CO., 207 Sandusky St. N. S., Pittsburgh, Pa.
PERSONNEL: O. N. Pannier, Pres.; W. J. Pannier, V. Pres.; R. A. Pannier, Treas.
PRODUCTS: Steel stamps; Rubber etching stamps; Acid inks.

PARAGON-REVOLUTE CORP., 79 South Ave., Rochester, N. Y.
PERSONNEL: H. H. Sullivan, Pres. & Treas.; L. G. Booth, V. Pres.; W. L. Sullivan, Secy., Gen. Mgr. & Chief Engr.; L. G. Booth, Sales Mgr.; W. H. Wilder, Pur. Agt.
PRODUCTS: Blueprinting machinery and equipment.

THE PARK DROP FORGE CO., 735 E. 79th St., Cleveland, O.
PERSONNEL: G. C. Gordon, Pres.; F. L. Ball, Secy. & Treas.; W. A. Humel, Gen. Mgr.; J. W. Grinder, Pur. Agt.
PRODUCTS: Drop and crankshaft forgings; Steel parts.

THE PARKER APPLIANCE CO., 17325 Euclid Ave., Cleveland, O.
PERSONNEL: A. L. Parker, Pres., & Treas.; H. I. Markham, V. Pres.; F. A. Rolla, Secy.; F. E. Amon, Jr., Sales Mgr.; E. G. Johnson, Pur. Agt.; W. R. Meredith, Pers. Dir.; L. H. Schmohl, Chief Engr.
PRODUCTS: De-icer equipment; Fittings; Lubricants; Hydraulic controls and assemblies; Machine tools; Synthetic parts; Engine primers; Tools; Control valves; Engine valves and valve parts.

THE PARKER STAMP WORKS, INC., 650 Franklin Ave., Hartford, Conn.
PERSONNEL: H. L. Bitter, Pres., Treas. & Gen. Mgr.; K. Lingo, V. Pres.; J. T. F. Bitter, Secy., Sales Mgr. & Pur. Agt.; H. C. Bitter, Chief Engr.
PRODUCTS: Plastic and steel parts; Tools.

VICTOR F. PASTUSHIN CO., 4608 Blackthorne Ave., Lakewood Village, Long Beach, Calif.
PERSONNEL: V. F. Pastushin, Pres.
PRODUCTS: Castings and forgings; Misc. hardware.

THE PAULSON TOOLS, INC., Wallingford, Conn.
PERSONNEL: C. H. Loucks, Pres. & Gen. Mgr.; E. W. Thompson, V. Pres.; J. E. Wrinn, Secy.; J. J. Brosnan, Treas.
PRODUCTS: Forgings; Tools.

THE PECK, STOW & WILCOX CO., Southington, Conn.
PERSONNEL: M. J. Lacey, Pres. & Gen. Mgr.; F. L. Wilcox, V. Pres.; S. C. Wilcox, Secy. & Treas.; E. J. Murray, L. Bromel, Sales Mgrs.; W. T. Morrissey, Pur. Agt.; M. J. Wooding, Pers. Dir.; W. H. Moore, Pub. Dir.; W. L. Ludwick, Chief Engr.
PRODUCTS: Sheet metal working machines; Tools.

PENN RIVET CORP., 3rd & Huntingdon Sts., Philadelphia, Pa.
PERSONNEL: T. M. Searles, Pres.; J. A. Barnett, V. Pres.; E. M. Barto, Secy.; H. L. Lowe, Treas.; J. J. Clement, Pur. Agt.; J. Rieher, Chief Engr.
PRODUCTS: Rivets; Parts.

PERMATEX CO., INC., 1720 Ave. Y, Brooklyn, N. Y.
PERSONNEL: C. A. Benoit, Pres. & Treas.; L. C. Wills, V. Pres.; H. C. Fuchs, Secy.; H. J. Enders, Sales Mgr.; W. C. Corbett, Pur. Agt.; E. G. Heeren, Pers. Dir.; N. Levy, Pub. Dir.; T. L. Camp, Chief Engr.
PRODUCTS: Cleaners and cleaning compounds; Gasket assembling compounds; Oil seals; Aircraft chemical service and repair products.

THE PERMOLD CO.,
W. Liberty St., Medina, O.
PERSONNEL: E. G. Fahlman, Pres., Treas. & Gen. Mgr.; H. R. Doswell, V. Pres. & Secy.; L. E. DeGroat, Sales Mgr.; A. Eble, Pur. Agt.; R. C. Hicks, Pers. Dir. & Pub. Dir.; S. W. Jackson, Chief Engr.
PRODUCTS: Castings; Aluminum and magnesium parts.

PERRY AIRCRAFT PRODUCTS CORP.,
1127 Atlantic Ave., Brooklyn, N. Y.
PERSONNEL: S. Sack, Pres., Treas. & Sales Mgr.; P. Lannert, V. Pres.; M. Rubinson, Secy.; O. Gishow, Gen. Mgr. & Chief Engr.; B. Lawrence, Pur. Agt.; L. Reis, Pers. Dir.; B. Cooper, Pub. Dir.
PRODUCTS: Airport equipment; Ammunition boxes and counters; Bearings; Bomb racks; Bushings; Castings and forgings; Clamps; Collector rings, cowls, streamlines; Covers; Cowlings; Engine mounts; Exhaust manifolds; Fasteners; Filters and strainers; Fittings; Gaskets; Heaters; Hose clamps and hose fittings; Landing gears; Machine tools; Manifolds; Misc. hardware; Misc. engine equipment; Oil seals; Aluminum, cork, felt, fibre, rubber, steel and synthetic parts; Propellers and propeller parts; Shims; Shock struts and cord; Stampings; Sub-assemblies; Tail wheel assemblies; Tanks; Tools; Control valves; Engine valves and valve parts; Ventilating and air conditioning equipment; Vibration dampers.

PERRY-AUSTEN MANUFACTURING CO.,
Grasmere, Staten Island, N. Y.
PERSONNEL: F. T. Perry, Pres.; W. F. Doerflinger; V. Pres. & Treas.; A. J. Kurtz, Secy.
PRODUCTS: Paints, varnishes and finishes.

PHEOLL MANUFACTURING CO.,
5700 Roosevelt Rd., Chicago, Ill.
PERSONNEL: M. Phelps, Pres.; E. M. Whiting, V. Pres. & Gen. Mgr.; J. J. Schwander, Secy. & Treas.; J. A. Perry, Sales Mgr.; A. A. Schmid, Pur. Agt.; M. E. Jensen, Pers. Dir.; N. L. Marvin, Pub. Dir.; F. J. Tisch, Chief Engr.
PRODUCTS: Screws; Bolts; Nuts; Slotted head screws; Recessed head screws; Hexagon head bolts.

PHILADELPHIA DIV., BENDIX AVIATION CORP., 4700 Wissahickon Ave., Philadelphia, Pa.
PERSONNEL: N. B. McLean, Gen. Mgr.; L. F. Lieb, Pur. Agt.; H. E. Kay, Pers. Dir.; H. Loen, Chief Engr.
PRODUCTS: Instruments; Starters; Cabin superchargers.

PHILCO CORP.,
Tioga & C Sts., Philadelphia, Pa.
PERSONNEL: J. T. Buckley, Pres.; G. E. Deming, Secy.; W. R. Wilson, Treas.; R. A. Boyce, Pur. Agt.; H. W. Butler, Pers. Dir.; D. Grimes, Chief Engr.
PRODUCTS: Batteries; Radios.

PHILLIPS MANUFACTURING CO., 3475 W. Touhy Ave., Northtown Station, Chicago, Ill.
PERSONNEL: W. D. Phillips, Pres.; E. Atherton, V. Pres.; J. M. Bash, Secy., Treas., Gen. Mgr. & Sales Mgr.; I. Duskin, Pur. Agt.; R. A. Van Fossen, Chief Engr.
PRODUCTS: Cleaners and cleaning compounds; Metal cleaning equipment.

THE PHOENIX OIL CO.,
9505 Cassius Ave., Cleveland, O.
PERSONNEL: M. J. Murphy, Pres. & Gen. Mgr.; R. M. Murphy, V. Pres.; E. F. Horak, Secy. & Treas.
PRODUCTS: Cleaners and cleaning compounds; Lubricants.

PHOTO RECORD EQUIPMENT CO.,
511 E. Seventh St., St. Paul, Minn.
PERSONNEL: J. B. McGrath, Pres.; E. J. McGrath, Secy. & Pur. Agt.
PRODUCTS: Aircraft armament; Airport equipment; Basic materials and fabrications; Cameras; Hose clamps and hose fittings; Hydraulic controls and assemblies; Instruments; Tools.

PHOTOSWITCH, INC.,
21 Chestnut St., Cambridge, Mass.
PERSONNEL: A. H. Avery, Pres. & Treas.; J. A. Long, V. Pres., Secy., Sales Mgr. & Pers. Dir.; B. W. Steverman, Gen. Mgr.; G. L. Wyman, Pur. Agt.; R. C. Grichton, Pub. Dir.; E. C. Thomson, Chief Engr.
PRODUCTS: Airport equipment.

PHYSICISTS RESEARCH CO.,
343 S. Main St., Ann Arbor, Mich.
PERSONNEL: E. J. Abbott, Pres.; D. E. Williamson, Gen. Mgr. & Sales Mgr.; C. Shankland, Pur. Agt.
PRODUCTS: Electronic gaging equipment.

PIERCE & STEVENS, INC.,
710 Ohio St., Buffalo, N. Y.
PERSONNEL: R. D. Stevens, Pres.; A. L. Stevens, V. Pres.; P. P. Dauscher, Treas.; G. T. Swing, Sales Mgr.; D. E. Ellis, Chief Engr.
PRODUCTS: Cleaners and cleaning compounds; Paints, varnishes and finishes.

PILOT PROPELLERS, INC.,
2816 Gibroy St., Los Angeles, Calif.
PERSONNEL: W. E. Greenwood, Pres., Gen. Mgr., Sales Mgr. & Pur. Agt.; J. B. F. Bacon, V. Pres., Treas. & Chief Engr.; H. Bacon, Secy.
PRODUCTS: Propellers and propeller parts; Test clubs.

PIONEER ENGINEERING & MFG. CO.,
19669 John R St., Detroit, Mich.
PERSONNEL: A. M. Sargent, Pres. & Gen. Mgr.; E. M. Beyma, V. Pres.; F. C. Querry, Secy. & Treas.; D. C. Lowe, Pur. Agt.; H. C. French, Chief Engr.
PRODUCTS: Machine tools; Pumps; Tools.

PIONEER GEN-E-MOTORS,
5841 W. Dickens Ave., Chicago, Ill.
PERSONNEL: D. E. Bright, Pres.; R. O. Goldberg, V. Pres.; H. Goldberg, Secy., Treas. & Chief Engr.; S. F. Hart, Gen. Mgr.; M. Hoffman, Sales Mgr.; I. M. Temen, Pur. Agt.; R. T. Plocar, Pers. Dir.; E. J. Decker, Pub. Dir.
PRODUCTS: Auxiliary power plants; Dynamotors; Generators.

PIONEER INSTRUMENT DIV., BENDIX AVIATION CORP., Bendix, N. J.
PERSONNEL: K. MacGrath, Gen. Mgr.; R. H. Isaacs, Dir. Sales & Service; G. A. Lewthwaite, Sales Mgr.; W. A. Reichel, Dir. of Engrg.; R. C. Sylvander, Chief Engr.; T. H. Leeming, Dir. Pur.
PRODUCTS: Controls; Instruments; Flares.

PIONEER PARACHUTE CO., INC.,
168 Forest St., Manchester, Conn.
PERSONNEL: H. R. Mallory, Pres. & Treas.; J. F. Smith, V. Pres.-Engrg.; L. H. Ford, V. Pres. & Sales Mgr.; J. C. Schumacher, Pur. Agt.
PRODUCTS: Parachutes.

PITTSBURGH PLATE GLASS CO.,
Grant Bldg., Pittsburgh, Pa.
PERSONNEL: R. L. Clause, Pres.; H. B. Higgins, Exec. V. Pres.; H. B. Brown, Secy.; F. W. Currier, Treas.; J. A. Wilson, Gen. Mgr.; R. B. Tucker, Sales Dir.; M. E. Carlisle, Pur. Agt.; R. L. Gridley, Pub. Dir.; J. H. Sherts, Chief Aviation Engr.
PRODUCTS: Aircraft armament; Airport equipment; Basic materials and fabrications; Cleaners and cleaning compounds; De-icer equipment; Paints, varnishes and finishes; Plastic parts; Sub-assemblies; Tanks; Tubing; Dials; Lenses; Glass.

PITTSBURGH STEEL CO., P. O. Box 118, Grant Bldg., Pittsburgh, Pa.
PERSONNEL: J. H. Carter, Pres.; D. B. Carson, V. Pres.; J. U. Anderson, Treas.; J. A. Voelker, Sales Mgr.; J. H. Phillips, Pur. Agt.; V. Chartner, Chief Engr.
PRODUCTS: Airport equipment; Basic materials and fabrications.

PLASKON CO., INC.,
2112 Sylvan Ave., Toledo, O.
PERSONNEL: J. L. Rodgers, Jr., Pres.; W. N. Shepard, Sales Mgr.
PRODUCTS: Resin adhesives.

PLOMB TOOL CO.,
2209 Santa Fe Ave., Los Angeles, Calif.
PERSONNEL: M. B. Pendleton, Pres.; D. Stevens, V. Pres.; J. E. Mills, Secy.; R. W. Kerr, Treas.; M. F. Christensen, Sales Mgr.; F. Pearsen, Pur. Agt.; W. Saint, Pers. Dir.; F. W. Kirwin, Pub. Dir.; A. L. Hawley, Chief Engr.
PRODUCTS: Tools.

PNEUMATIC DROP HAMMER CO.,
200 Adams St., Braintree, Mass.
PERSONNEL: R. P. Fitzgerald, Pres. & Gen. Mgr.; E. Ward, Treas.; J. Brow, Pur. Agt.; R. E. Vergobbe, Chief Engr.
PRODUCTS: Cylinder deflectors, baffles, brackets; Exhaust manifolds; Stampings; Tanks.

JOSEPH POLLAK CORP.,
85 Freeport St., Dorchester, Mass.
PERSONNEL: J. Pollak, Pres., Treas. & Gen. Mgr.; E. Shaw, Secy.; W. Pollak, Sales Mgr. & Pur. Agt.; G. M. Hemmer, Pers. Dir. & Pub. Dir.; R. Holub, Chief Engr.
PRODUCTS: Disconnect plugs; Switches; Terminals; Misc. electrical equipment.

POLLAK MANUFACTURING CO.,
541 Devon St., Arlington, N. J.
PERSONNEL: L. L. Pollak, Pres. & Sales Mgr.; C. Schlesinger, V. Pres. & Treas.; P. Calabro, Secy.; F. Hazen, Pur. Agt.; T. Breen, Pers. Dir.; H. E. Davies, Chief Engr.
PRODUCTS: Aircraft armament; Ammunition boxes and counters; Bomb racks and shackles; Clamps; Collector rings, cowls, streamlines; Cowlings; Disconnect plugs; Exhaust manifolds; Manifolds; Misc. hardware; Tanks; Self locking nuts; Miscellaneous.

THE PORCUPINE CO.,
200 Eliot St., Fairfield, Conn.
PERSONNEL: J. K. Williamson, Pres.; J. R. Williamson, V. Pres.; H. H. Williamson, Secy. & Treas.
PRODUCTS: Salt bath tanks.

H. K. PORTER, INC., Everett, Mass.
PERSONNEL: H. W. Porter, Pres.; J. G. Geddes, V. Pres.; J. Geddes, Treas.
PRODUCTS: Bolt, wire and cable cutters.

PORTER-CABLE MACHINE CO.,
1714 N. Salina St., Syracuse, N. Y.
PERSONNEL: W. A. Ridings, Pres.; D. J. Ridings, V. Pres., Secy. & Gen. Mgr.; L. B. Benham, Treas.; H. L. Ramsay, Sales Mgr.; A. S. Bancroft, Pur. Agt.; S. J. Palmer, Pers. Dir.; A. N. Emmons, Chief Engr.
PRODUCTS: Machine tools.

J. V. G. POSEY & CO.,
1008 S. W. 6th Ave., Portland, Ore.
PERSONNEL: J. V. G. Posey, Pres.
PRODUCTS: Basic materials and fabrications; Wood leading edges; Spruce spars; Wing beams; Ribs; Plywood and sliced veneer parts.

POSEY MANUFACTURING CO.,
Ontario St., Hoquiam, Wash.
PERSONNEL: Z. M. Galloway, Pres.; T. B. Stinchfield, Secy., Treas. & Gen. Mgr.
PRODUCTS: Spruce spars and parts.

POULSEN & NARDON, INC.,
2665 Leonis Blvd., Los Angeles, Calif.
PERSONNEL: G. Poulsen, Pres.; C. J. Nardon, V. Pres.; J. J. Strutzel, Secy. & Treas.; J. P. Strutzel, Sales Mgr. & Adv. Mgr.; E. L. Akin, Pur. Agt.
PRODUCTS: Junction boxes; Stampings; Tanks; Tank caps; Electrical equipment; Fittings; Radio shielding and equipment; Screws; Cable terminals; Conduit fittings.

PRATT & LAMBERT, INC.,
75 Tonawanda St., Buffalo, N. Y.
PERSONNEL: H. E. Webster, Pres.; W. P. Werheim, V. Pres., Secy. & Pub. Dir.; R. W. Lindsay, V. Pres., Treas. & Sales Mgr.; J. P. Nolan, Pur. Agt.; H. C. Loomis, Pers. Dir.; W. Jones, Chief Engr.
PRODUCTS: Paints, varnishes and finishes.

PRATT & WHITNEY, DIV. NILES-BEMENT-POND CO., Charter Oak Blvd., West Hartford, Conn.
PERSONNEL: C. R. Burt, Pres. & Gen. Mgr.; H. D. Tanner, V. Pres.; E. L. Morgan, Secy. & Treas.; W. P. Kirk, Sales Mgr.; H. H. Wallace, Pur. Agt.; C. B. Perkins, Pers. Dir.; E. C. Shultz, Pub. Dir.; C. Knowles, Chief Engr.
PRODUCTS: Machine tools.

PRECISE TOOL & MANUFACTURING CO.,
33431 Grand River, Farmington, Mich.
PERSONNEL: J. A. Lutz, Pres.; E. F. Lutz, H. Ford, V. Pres.; W. G. Beaumont, Secy. & Treas.; C. E. Williams, Pur. Agt.; F. W. Edwards, Pers. Dir.; A. Grimal, Chief Engr.
PRODUCTS: Basic materials and fabrications; Bushings; Misc. hardware; Steel engine parts; Propeller parts.

PRECISION BEARINGS, INC.,
1706 S. Grand Ave., Los Angeles, Calif.
PERSONNEL: O. P. Wilson, Pres.; H. R. Swanton, V. Pres., Asst. Secy., Gen. Mgr. & Sales Mgr.; L. H. Travis, Treas.; C. M. Slocum, Pur. Agt.; E. Austen, Pers. Dir.; M. Hojrup, Pub. Dir.; R. Seidel, Engr.
PRODUCTS: Anti-friction bearings; Bearing lubrication equipment.

PRECISION PRODUCTS, INC.,
420 W. Main St., Corry, Pa.
PERSONNEL: S. J. Irvine, Pres.; P. Waite, V. Pres. & Gen. Mgr.; L. E. Graham, Secy.; H. G. Cragg, Treas.
PRODUCTS: Bushings; Controls; Misc. hardware; Misc. engine equipment; Aluminum and steel parts; Propeller parts; Stampings; Miscellaneous.

PRECISION TUBE CO.,
3828 Terrace St., Philadelphia, Pa.
PERSONNEL: N. H. Jack, Pres.; F. Castleman, Secy. & Pur. Agt.; N. H. Jack, Jr., Gen. Mgr.; E. Turney, Sales Mgr. & Pub. Dir.; G. Swint, Chief Engr.
PRODUCTS: Instruments; Radio and ignition shielding; Tubing.

H. P. PREIS ENGRAVING MACHINE CO.,
155 Summit St., Newark, N. J.
PERSONNEL: E. J. Preis, Pres.; M. H. Preis, V. Pres.; A. M. Malloy, Secy.; J. A. Hoffmann, Chief Engr.
PRODUCTS: Electrical equipment; Grinders; Cutters; Engraving, etching and marking machines.

PRESSED & WELDED STEEL PRODUCTS CO., INC., 38-61 11th St., Long Island City, N. Y.
PERSONNEL: W. E. Haskin, Pres., Treas. & Gen. Mgr.; W. C. Foster, V. Pres.; W. J. Carnes, Secy. & Sales Mgr.; J. Upton, Jr., Pur. Agt.; E. V. Ketcham, Jr., Pers. Dir.
PRODUCTS: Aluminum and steel parts; Stampings; Sub-assemblies; Miscellaneous.

THE PRESSTITE ENGINEERING CO.,
3900 Chouteau Ave., St. Louis, Mo.
PERSONNEL: W. C. Ferguson, Pres. & Treas.; C. H. Smith, V. Pres.; J. E. Harrison, Secy.; W. C. Snyder, Sales Mgr.; G. Knapp, Pur. Agt.; G. Sheehan, Pers. Dir.
PRODUCTS: Basic materials and fabrications; Gaskets; Oil seals.

PREST-O-LITE BATTERY CO., INC.,
Indianapolis, Ind.
PERSONNEL: J. H. McDuffee, Pres.; H. E. Komitch, V. Pres., Gen. Mgr. & Sales Mgr.; F. H. Landwehr, Secy.; J. B. Fenner, Treas.; R. A. Nowlan, Pur. Agt.; O. M. Hoyt, Pub. Dir.; N. E. Hehner, Chief Engr.
PRODUCTS: Batteries.

PRESTOLE DIV.,
4500 Detroit Ave., Toledo, O.
PERSONNEL: H. W. Kost, Gen. Mgr.; I. L. Carron, Sales Mgr.; C. J. Metzger, Pur. Agt.; N. H. Fender, Chief Engr.
PRODUCTS: Aircraft skin holders; Sheet metal fastenings; Clamps; Tools; Miscellaneous.

PRESTON MACHINE TOOL SALES CO.,
2018 Capitol Ave., Houston, Tex.
PERSONNEL: J. C. Preston, Gen. Mgr.; P. A. Bob, Chief Engr.
PRODUCTS: Machine tools; Tools.

PROCUNIER SAFETY CHUCK CO.,
18 S. Clinton St., Chicago, Ill.
PERSONNEL: H. G. Procunier, Pres.; J. A. McConnell, Secy.
PRODUCTS: Machine tools; Tools.

PRODUCTION TOOL & DIE CO., INC.,
572 St. James Ave., Springfield, Mass.
PERSONNEL: R. J. Gaudreau, Pres., Treas. & Gen. Mgr.; E. R. Gaudreau, V. Pres. & Secy.; M. W. Duclos, Sales Mgr.; G. F. Russell, Pur. Agt.
PRODUCTS: Tools.

PRODUCTS ENGINEERING CO.,
700 E. Florence Ave., Los Angeles, Calif.
PERSONNEL: L. Wallace, L. A. Spievak, Owners; E. J. Landry, Gen. Mgr.; L. Wallace, Sales Mgr.; S. Weisbart, Pur. Agt. & Compt.; A. Smith, Pers. Dir.; L. A. Spievak, Chief Engr.
PRODUCTS: Aircraft armament; Bushings; Castings and forgings; Clamps; Fasteners; Machine tools; Stampings; Sub-assemblies; Tools.

PULMOSAN SAFETY EQUIPMENT CORP.,
176 Johnson St., Brooklyn, N. Y.
PERSONNEL: F. Wahlert, Pres.; E. W. Burke, Treas.
PRODUCTS: Fire extinguishers; First aid equipment; Protective clothing and equipment.

PUMP ENGINEERING SERVICE CORP., PESCO DIV. OF BORG-WARNER, Cleveland, O.
PERSONNEL: R. J. Minshall, Pres. & Gen. Mgr.; H. H. Brooksieker, V. Pres.; C. Bissell, Secy.; J. L. Menart, Treas.; N. M. Forsythe, Sales Mgr.; H. H. Krause, Pur. Agt.; S. E. Voran, Pub. Dir.; J. M. Roth, Chief Engr.
PRODUCTS: Controls; De-icer equipment; Hydraulic controls and assemblies; Propellers and propeller parts; Pumps; Cabin superchargers; Control valves.

PURITAN CO., INC.,
573 Lyell Ave., Rochester, N. Y.
PERSONNEL: A. Beach, Pres. & Treas.; J. F. Bush, Jr., V. Pres., Gen. Mgr. & Sales Mgr.; C. S. Wilcox, Secy.; M. F. Radtke, Pur. Agt.; C. M. White, Chief Engr.
PRODUCTS: Cleaners and cleaning compounds.

PUROLATOR PRODUCTS, INC.,
91 Empire St., Newark, N. J.
PERSONNEL: R. R. Layte, Pres. & Gen. Mgr.; S. Letzler, V. Pres. & Compt.; F. P. Herman, J. M. Clarke, V. Pres.-Sales; C. M. Owen, Secy.; H. W. Thogode, Treas. & Pers. Dir.; L. E. Welch, Pur. Agt.; J. P. Kovacs, Chief Engr.
PRODUCTS: Filters and strainers; Misc. engine equipment.

THE PYLE-NATIONAL CO.,
1334 N. Kostner Ave., Chicago, Ill.
PERSONNEL: J. A. Amos, Pres.; R. D. Grant, V. Pres.; E. W. Botts, Secy. & Treas.; W. A. Ross, Sales Mgr.; H. A. Redmon, Pur. Agt.; W. A. Wulle, Pub. Dir.; T. E. McDowell, Chief Engr.
PRODUCTS: Airport lighting equipment; Disconnect plugs.

PYRENE MANUFACTURING CO.,
560 Belmont Ave., Newark, N. J.
PERSONNEL: E. A. Clapp, Pres. & Treas.; E. J. Waring, V. Pres. & Gen. Mgr.; E. G. Weed, V. Pres. & Secy.; G. H. Boucher, Sales Mgr.; H. L. Friedauf, Pur. Agt.; G. H. Phillips, Pers. Dir.; T. Young, Pub. Dir.; W. L. Rea, Chief Engr.
PRODUCTS: Fire extinguishers.

PYROXYLIN PRODUCTS, INC.,
4851 S. St. Louis Ave., Chicago, Ill.
PERSONNEL: P. S. Fawkes, Pres.; W. C. Wilson, V. Pres.; C. E. Fawkes, Secy. & Sales Mgr.; I. Erhardt, Pur. Agt.
PRODUCTS: Paints, varnishes and finishes.

Q

QUALITY ELECTRIC CO., 1235 E. Olympic Blvd., Los Angeles, Calif.
PERSONNEL: J. O. Case, Pres., Gen. Mgr., Sales Mgr. & Pub. Dir.; A. W. Wotkyns, V. Pres., Treas. & Pers. Dir.; W. R. Frampton, Secy.; J. M. Wells, Pur. Agt.; C. C. Adams, Chief Engr.
PRODUCTS: Dynamotors; Auxiliary motors; Switches.

R

R-B-M MANUFACTURING CO.,
Logansport, Ind.
PERSONNEL: A. E. Holton, Pres.; R. L. Dashner, V. Pres. & Gen. Mgr.; R. G. Schoel, Secy. & Treas.; R. T. Pierson, Sales Mgr.; A. W. Tuttle, Pur. Agt.; W. J. Canavan, Pers. Dir.; H. H. Clayton, Chief Engr.
PRODUCTS: Aircraft armament; Switches; Misc. electrical equipment; Stampings; Sub-assemblies.

RCA VICTOR DIV., RADIO CORP. OF AMERICA, Front & Cooper Sts., Camden, N. J.
PERSONNEL: R. Shannon, Pres.; M. Brunet, V. Pres.; F. H. Corregan, Secy.; E. F. Haines, Treas.; H. M. Hucke, Sales Mgr.-Aviation Prod.; F. D. Wilson, Pur. Agt.; E. C. Morse, Pers. Dir.; T. F. Joyce, Pub. Dir.; J. B. Coleman, Chief Engr.
PRODUCTS: Radios; Radio compasses.

R E F AIRCRAFT CORP., Syosset, N. Y.
PERSONNEL: L. E. Faust, Pres.; R. H. Faust, V. Pres.; M. Rochman, Secy.; A. R. Willis, Jr., Treas.; C. D. Birmingham, Pur. Agt.
PRODUCTS: Hydraulic control parts; Sub-assemblies; Tools.

RADEL LEATHER MFG. CO.,
445 Wilson Ave., Newark, N. J.
PERSONNEL: F. J. Radel, Pres.; C. B. Schubert, Secy. & Treas.; R. H. Cudlipp, Sales Mgr.
PRODUCTS: Cowlings; Leather parts.

RADIANT LAMP CORP.,
260 Sherman Ave., Newark, N. J.
PERSONNEL: J. Glassberg, Pres.; L. Weil, V. Pres.; M. W. Weil, Secy. & Treas.; A. B. Slocum, Pur. Agt.; A. F. Bleiweiss, Chief Engr.
PRODUCTS: Landing and navigation lights.

RADIATOR SPECIALTY CO.,
1700-1900 Dowd Rd., Charlotte, N. C.
PERSONNEL: I. D. Blumenthal, Pres.; H. F. Meltsner, V. Pres. & Sales Mgr.; M. A. Brown, Treas. & Pur. Agt.
PRODUCTS: Gasketing and joint-sealing compound; Insulating materials; Oil seals.

RADIO CONDENSER CO., Camden, N. J.
PERSONNEL: S. S. Cramer, Pres.; R. E. Cramer, V. Pres.; W. W. Paul, Secy. & Treas.; W. J. May, Sales Mgr.; J. W. Willard, Pur. Agt.; S. McKenty, Pers. Dir.; J. S. Robb, Chief Engr.
PRODUCTS: Variable air condensers for receiving and transmitting sets.

RADIO FREQUENCY LABORATORIES, INC.
Boonton, N. J.
PERSONNEL: R. W. Seabury, Jr., Pres.; R. S. Corbin, V. Pres., Sales Mgr. & Pur. Agt.; B. E. Holley, Secy. & Treas.; L. R. Damon, Chief Engr.
PRODUCTS: Misc. electrical equipment; Instruments; Radios.

RADIO NAVIGATIONAL INSTRUMENT CORP., 500 Fifth Ave., New York, N. Y.
PERSONNEL: E. J. Simon, Pres.; F. A. Kolster, V. Pres.; M. May, Secy.; H. W. Pfahler, Treas.; L. Freed, Pur. Agt.; R. Muniz, Chief Engr.
PRODUCTS: Radio compasses.

RADIO RECEPTOR CO., INC.,
251 W. 19th St., New York, N. Y.
PERSONNEL: L. Arnson, Pres.; H. Cohn, V. Pres.; H. Zeamans, Secy.; W. Ostrove, Pur. Agt.; I. B. Seidler, Pers. Dir.; E. D. Gibbs, Chief Engr.
PRODUCTS: Radios.

RAMSEY ACCESSORIES MFG. CORP.,
3693 Forest Park Blvd., St. Louis, Mo.
PERSONNEL: J. A. Ramsey, Pres.; H. Ramel, V. Pres.; L. A. Ramsey, Secy. & Treas.; R. Dubois, Gen. Mgr.; O. C. Holoday, Sales Mgr.; G. D. Whitling, Pur. Agt.; K. Rutledge, Pers. Dir.; W. G. Myers, Pub. Dir.; C. A. Marien, Sr., Chief Engr.
PRODUCTS: Piston rings; Rings for oil seals.

RANDALL GRAPHITE PRODUCTS CORP.,
609 W. Lake St., Chicago, Ill.
PERSONNEL: R. H. Whiteley, Pres. & Gen. Mgr.; W. P. Thacher, V. Pres.; E. A. Zimmerman, Secy. & Treas.; M. E. Clark, Sales Mgr.; W. E. Dickerson, Pur. Agt.; C. E. Lowgren, Pers. Dir.; M. G. Miller, Pub. Dir.; H. B. Hostetler, Chief Engr.
PRODUCTS: Bearings.

RANDOLPH FINISHING PRODUCTS CO.,
Carlstadt, N. J.
PERSONNEL: W. G. Randolph, Pres.; T. V. V. Ely, V. Pres.; M. J. Fenton, Sales Mgr., Aircraft Div.; A. B. Long, Chief Engr.
PRODUCTS: Paints, varnishes and finishes.

N. RANSOHOFF, INC., Township St., Elmwood Pl., Cincinnati, O.
PERSONNEL: N. Ransohoff, Pres.; M. B. Ransohoff, V. Pres.; J. W Freiberg, Secy.; L. F. Weston, Treas.; R. C. Wigger, Gen. Mgr.; W. E. Niesslein, Chief Engr.
PRODUCTS: Cleaning machines.

RAY DAY PISTON CORP. OF DETROIT, 6656 Walton Ave., Detroit, Mich.
PERSONNEL: R. E. Day, Pres.; D. W. Bay, V. Pres. & Sales Mgr.; J. M. Ready, Secy. & Treas.; M. Franklin, Pur. Agt.; G. Bliss, Pers. Dir.
PRODUCTS: Aluminum pistons and castings.

RAYMOND MFG. CO., DIV. ASSOCIATED SPRING CORP., 226 S. Center St., Corry, Pa.
PERSONNEL: F. F. Barnes, Pres.; F. E. Whittlesey, V. Pres.; G. Gauffreau, Secy.; C. H. Holden, Treas. & Pur. Agt.; E. W. Feldt, Gen. Mgr.; J. E. Mount, Sales Mgr.; R. Bachofner, Pers. Dir.
PRODUCTS: Coil and flat springs; Wire forms; Small metal stampings.

READING BATTERIES, INC. P. O. Box 916, Reading, Pa.
PERSONNEL: D. R. Bomberger, Pres. & Treas.; J. T. Moore, Jr., Secy. & Gen. Mgr.; H. Peck, Sales Mgr. & Pub. Dir.; C. G. Reetz, Pur. Agt. & Chief Engr.
PRODUCTS: Storage batteries.

READING CHAIN & BLOCK CORP., 2100 Adams St., Reading, Pa.
PERSONNEL: F. A. Howard, Pres. & Pur. Agt.; P. K. Howard, V. Pres.; F. M. Howard, Secy. & Treas.; A. K. Hartzell, Chief Engr.
PRODUCTS: Cranes; Electric and chain hoists.

REDA MANUFACTURING CO., 311 Page Blvd., Springfield, Mass.
PERSONNEL: D. B. Gish, Pres. & Treas.; S. A. Tetreault, V. Pres. & Gen. Mgr.; K. T. Gish, Secy.; H. A. Johnson, Sales Mgr., Pers. Dir. & Pub. Dir.; C. A. Badore, Pur. Agt.; H. M. Richter, Chief Engr.
PRODUCTS: Precision gages; Screw machine and turret lathe parts; Hydraulic coupled hose and unions.

REED-PRENTICE CORP., 677 Cambridge St., Worcester, Mass.
PERSONNEL: R. E. Thompson, Pres. & Treas.; F. W. McIntyre, V. Pres. & Gen. Mgr.; E. Connolly, Secy.; C. W. Gallagher, Asst. Sales Mgr.; R. P. Harrington, Pur. Agt.; H. Mongeau, Pers. Dir.; E. K. Heath, Pub. Dir.; R. L. Rougemont, Chief Engr.
PRODUCTS: Machine tools.

REED & PRINCE MFG. CO., 1 Duncan Ave., Worcester, Mass.
PERSONNEL: C. T. Reed, Pres.; E. C. Boyd, V. Pres. & Sales Mgr.; R. E. Borgeson, Secy.; A. Reed, Treas.; C. A. Thompson, Pur. Agt.
PRODUCTS: Recessed head screws; Slotted screws; Machine screw nuts; Aluminum rivets; Steel clevis pins.

REPUBLIC STEEL CORP., Republic Bldg., Cleveland, O.
PERSONNEL: T. M. Girdler, Ch.; R. J. Wysor, Pres.; N. J. Clark, C. M. White, D. B. Gillies, P. F. Boyer, V. Pres.; W. W. Hancock, V. Pres.; Secy. & Treas.
PRODUCTS: Alloy, stainless, carbon and cold finished steels; Armor plate; Bolts; Nuts; Studs; Rivets; Steel parts; Stampings; Tubing.

RESISTOFLEX CORP., Belleville, N. J.
PRODUCTS: Tubing.

REVERE COPPER & BRASS, INC., 230 Park Ave., New York, N. Y.
PERSONNEL: C. D. Dallas, Pres.; R. G. Scott, V. Pres.; J. J. Russell, Secy. & Treas.; H. A. Schlieder, Pur. Agt.; J. E. Walters, Pers. Dir.; N. A. Schuele, Pub. Dir.
PRODUCTS: Basic materials and fabrications; Castings and forgings; Aluminum and magnesium parts; Stampings; Tubing.

REYNOLDS METALS CO., Federal Reserve Bank Bldg., Richmond, Va.
PERSONNEL: R. S. Reynolds, Sr., Pres.; W. G. Golden, V. Pres.; J. L. Reynolds, V. Pres. & Gen. Mgr.; T. A. Lynch, V. Pres. & Sales Mgr.; C. P. Manning, Secy.; R. S. Reynolds, Jr., Treas.; M. W. Henry, Pur. Agt.; N. T. Yager, Jr., Pers. Dir.; H. J. Herbert, Pub. Dir.; G. Simms, Chief Engr.
PRODUCTS: Ammunition boxes and counters; Basic materials and fabrications; Fittings; Insulating materials; Panels; Aluminum parts; Stampings; Sub-assemblies; Tanks; Tubing; Miscellaneous.

RICHLAND AUTO PARTS CO., Mansfield, O.
PERSONNEL: O. P. Crouse, Gen. Mgr.; J. O. Crouse, Sales Mgr.; Pers. Dir. & Chief Engr.
PRODUCTS: Bushings; Controls; Misc. engine equipment; Miscellaneous.

RICHMOND RING CO., Souderton, Pa.
PERSONNEL: E. H. Burk, Gen. Mgr.
PRODUCTS: Piston rings.

REIKER INSTRUMENT CO., 1919 Fairmount Ave., Philadelphia, Pa.
PERSONNEL: M. A. Rieker, Pres.
PRODUCTS: Aircraft armament.

RIPLEY MANUFACTURING CO., 35216 Forest Ave., Wayne, Mich.
PERSONNEL: J. H. Taylor, Pres., Gen. Mgr. & Pur. Agt.; J. M. Lents, V. Pres., Sales Mgr. & Pub. Dir.; J. R. Taylor, Secy.; J. S. Ripley, Treas.; T. J. Fisher, Pers. Dir.; D. P. Fosdick, Chief Engr.
PRODUCTS: Screens; Strainers.

RIVETT LATHE & GRINDER INC., 18 Riverview Rd., Brighton, Mass.
PERSONNEL: T. S. Ross, Pres. & Gen. Mgr.; F. S. Moulton, V. Pres.; A. B. Hunt, Treas. & Sales Mgr.; H. E. Baker, Pur. Agt.
PRODUCTS: Machine tools.

ROBBINS & MYERS, INC., Springfield, O.
PERSONNEL: W. S. Quinlan, Pres., Treas. & Gen. Mgr.; C. H. Clark, V. Pres. & Sales Mgr.; J. H. Horstman, V. Pres. & Secy.; F. S. Brady, Pur. Agt.; W. A. Hill, Pers. Dir.; F. W. Burmeister, Pub. Dir.; T. C. Lloyd, Chief Engr.
PRODUCTS: Dynamotors; Auxiliary motors; Generators; Misc. electrical equipment; Pumps.

ROBERTS & MANDER STOVE CO., 237 Jacksonville Rd., Hatboro, Pa.
PERSONNEL: H. S. Minster, Pres.; R. S. Agee, V. Pres. & Pers. Dir.; W. A. Jaeger, Secy. & Treas.; G. Kelley, Pur. Agt.
PRODUCTS: Bomb racks; Cowlings; Aluminum and steel parts; Stampings; Miscellaneous.

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PRODUCTS: Roofing and siding coverings; Ventilators; Skylights; Steel floor; Roof decks.

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100 Rockwood St., Rochester, N. Y.
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PRODUCTS: Instruments.

ROCHESTER ROPES, INC.,
Jamaica, N. Y.
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PRODUCTS: Control cables and assemblies; Wire rope; Cords; Cables.

ROCKBESTOS PRODUCTS CORP.,
50 Mitchell Rd., New Haven, Conn.
PERSONNEL: A. G. Newton, Pres.; B. H. Reeves, V. Pres.; W. C. Armstrong, Secy. & Treas.; H. O. Anderson, Gen. Sales Mgr.; E. L. Alvord, Pur. Agt.; K. A. Redfield, Pub. Dir.; H. S. Moore, Chief Engr.
PRODUCTS: Insulated wire.

ROCKY MOUNTAIN STEEL PRODUCTS, INC., 1356 Wall St., Los Angeles, Calif.
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PRODUCTS: Electric industrial trucks; Airport equipment; Aluminum and magnesium parts; Miscellaneous.

RODDIS LUMBER & VENEER CO.,
Marshfield, Wisc.
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PRODUCTS: Control cords and assemblies; Swaged terminals; Aircraft thimbles; Wire cords.

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PRODUCTS: Plastic parts.

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PRODUCTS: Bomb racks; Collector rings, cowls, streamlines; Cowlings; Panels; Aluminum and steel parts; Stampings; Sub-assemblies; Miscellaneous.

ROLLER BEARING CO. OF AMERICA, Trenton, N. J.
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PRODUCTS: Needle bearings.

ROMEC PUMP CO.,
Abbe & Taylor Sts., Elyria, O.
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PRODUCTS: Pumps.

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PRODUCTS: Protective clothing and equipment.

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PRODUCTS: Paints, varnishes and finishes.

RUCKSTELL BURKHARDT MANUFACTURING CORP., 999 S. Main St., Elmira, N. Y.
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PRODUCTS: Auxiliary power plants.

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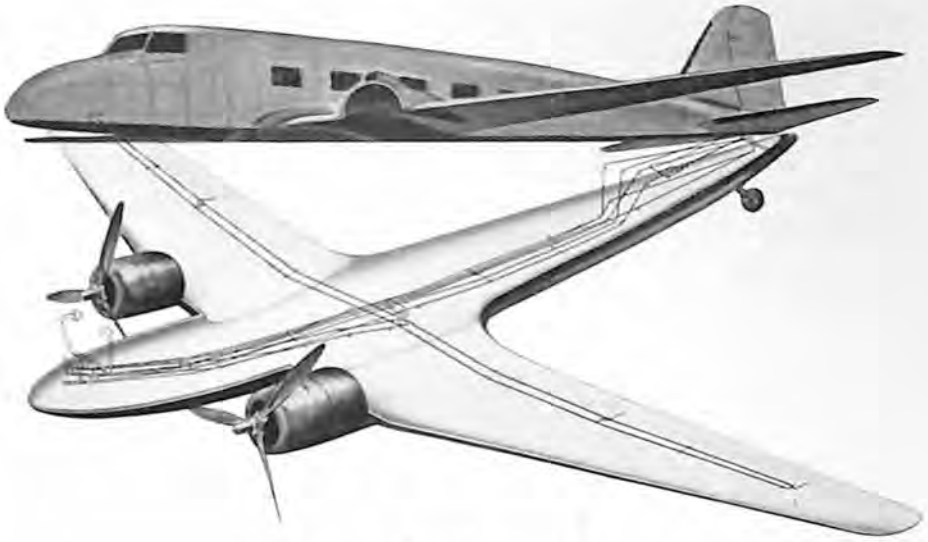
PRODUCTS: Shock struts and cord; Seat belts; Straps; Webbings, Misc. hardware.



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SKF INDUSTRIES, INC.,
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PRODUCTS: Floats, skiis.

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PRODUCTS: Piston rings; Tail wheel assemblies.

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PRODUCTS: Machine tools.

SAWYER BELT HOOK CO.,
16 Warren Ave., Pawtucket, R. I.
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PRODUCTS: Misc. hardware.

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PRODUCTS: Hydraulic controls and assemblies; Landing gears; Aluminum and steel parts; Tail wheel assemblies.

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2060 Reading Rd., Cincinnati, O.
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PRODUCTS: Speed lathes.

SCHLEGEL MFG. CO.,
277 N. Goodman St., Rochester, N. Y.
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PRODUCTS: Basic materials and fabrications; Protective clothing and equipment; Shock struts and cord; Sub-assemblies; Shock cord assemblies; Weatherstripping.

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PRODUCTS: Radio and ignition shielding.

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PERSONNEL: W. T. Hunter, Pres. & Gen. Mgr.; R. L. deBrauwere, Secy.; V. C. Greaves, Treas.; G. A. Drew, Sales Mgr.; C. Wilcox, Pur. Agt.; K. Scott, Pers. Dir.; D. S. Hunter, Pub. Dir.; S. T. Williams, Chief Engr.
PRODUCTS: Hose clamps and hose fittings; Life saving equipment; Shock strut parts; Tire valves.

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PERSONNEL: W. A. Schuyler, Owner.
PRODUCTS: Thread rolling machines.

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PRODUCTS: Silk; Parachute pyrotechnic; Silk and nylon parachute cloth; Cartridge cloth.

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PRODUCTS: Instruments.

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PRODUCTS: Thermometers.

SCINTILLA MAGNETO DIV., BENDIX AVIATION CORP., Sidney, N. Y.
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PRODUCTS: Magnetos; Radio and ignition shielding; Spark plugs; Radio shielded ignition harnesses.

SCOTT AVIATION CORP.,
207 Erie St., Lancaster, N. Y.
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PRODUCTS: Airport equipment; Castings; Control wheels; Instruments; Aluminum parts; Tail wheel assemblies; Wheels and brakes.

SCOVILL MANUFACTURING CO.,
99 Mill St., Waterbury, Conn.
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PRODUCTS: Fasteners.

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PRODUCTS: Clamps; Fasteners; Hose clamps and hose fittings.

SEALED POWER CORP., Muskegon, Mich.
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PRODUCTS: Piston rings.

SEAMLEX CO., INC.,
27-27 Jackson Ave., Long Island City, N. Y.
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PRODUCTS: Flexible, seamless, metallic conduit, hose and tubing; Vibration dampers.

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PRODUCTS: Misc. electrical equipment; Radios; Radio and ignition shielding; Sub-assemblies; Tubing; Miscellaneous.

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PRODUCTS: Rubber bushings; Rubber engine mounts; Rubber and synthetic gaskets; Life saving equipment; Rubber and synthetic parts; Rubber tubing; Vibration dampers.

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PRODUCTS: Machine tools; Tanks.

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PRODUCTS: Welding goggles and helmets; Chipping goggles; Lenses.

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PERSONNEL: H. M. Sensenich, Gen. Mgr.; R. N. Bomberger, Sales Mgr.; M. S. Erb, Pur. Agt.; H. R. Uhrich, Chief Engr.; M. M. Sensenich, Opr. Mgr.
PRODUCTS: Propellers and propeller parts.

THE SENTRY CO., Foxboro, Mass.
PERSONNEL: P. B. Crocker, Treas. & Gen. Mgr.; G. Wheeler, Sales Mgr.
PRODUCTS: Airport equipment; Heat treating equipment and supplies.

THE SERVICE RECORDER CO.,
1375 Euclid Ave., Cleveland, O.
PERSONNEL: H. R. Cool, Pres., Treas. & Gen. Mgr.; E. L. Viets, V. Pres. & Sales Mgr.; K. A. Cool, Secy.
PRODUCTS: Instruments.

SEWALL PAINT & VARNISH CO.,
Kansas City, Mo.
PERSONNEL: E. R. Kyger, V. Pres. & Secy.; A. C. Bales, V. Pres.; R. E. Bernauer, Treas.; E. D. Liddy, Gen. Mgr.; G. W. Weissert, Sales Mgr.; W. LaBrant, Pur. Agt.; B. VanDel, Pub. Dir.
PRODUCTS: Paints, varnishes and finishes.

SHAFER BEARING CORP.,
35 E. Wacker Dr., Chicago, Ill.
PERSONNEL: R. P. Tennes, Pres. & Treas.; J. F. Ditzell, V. Pres. & Gen. Mgr.; A. H. Williams, V. Pres. & Chief Engr.; T. B. Lipson, Secy.; W. L. Kinnaw, Pur. Agt.; J. M. O'Dea, Pub. Dir.
PRODUCTS: Roller bearings.

SHAKESPEARE PRODUCTS CO., 241 E. Kalamazoo Ave., Kalamazoo, Mich.
PERSONNEL: H. G. Shakespeare, Pres. & Gen. Mgr.; D. E. Wallace, V. Pres.; M. Shakespeare, Secy.; W. J. Harrison, Treas.; M. Balch, Sales Mgr.; H. Barron, Pur. Agt.; E. Batterson, Chief Engr.
PRODUCTS: Controls; Tubing.

SHALLCROSS MFG. CO., 10 Jackson Ave., Collingdale, Pa.
PERSONNEL: D. A. Shallcross, Gen. Mgr.; J. S. Shallcross, Sales Engr.; E. H. Miller, Pur. Agt.; F. D. Mitchell, Chief Engr.
PRODUCTS: Fuel pump selector switches; Testing instruments.

THE SHEFFIELD CORP., 721 Springfield St., Dayton, O.
PERSONNEL: L. Polk, Pres.; C. H. Reynolds, V. Pres.; E. T. Noe, Secy.; C. F. Nelson, Treas.; J. Bernard, Gen. Mgr.; P. Polk, Sales Mgr.; R. H. Cannon, Pur. Agt.; W. Conrad, Pers. Dir.; W. I. Wilt, Pub. Dir.; A. F. Polk, Chief Engr.
PRODUCTS: Gages; Gaging instruments; Machine tools; Tools.

SHELL OIL CO., INC., 50 W. 50th St., New York, N. Y.
PERSONNEL: A. Fraser, Pres.; F. A. C. Guepin, Senior V. Pres.; P. E. Lakin, V. Pres.-Marketing; J. F. M. Taylor, V. Pres.-Mfg.; C. S. Gentry, Secy.; J. W. Watson, Treas.; H. Jacobs, Sales Mgr.; W. H. Bratches, Pur. Agt.; E. H. Walker, Pers. Dir.; G. G. Biggar, Pub. Dir.
PRODUCTS: Fuels and lubricants.

SHELL OIL CO., INC., AVIATION DEPT., 50 W. 50th St., New York, N. Y.
PERSONNEL: R. T. Goodwin, Mgr.; J. W. Freeman, J. L. Wheeler, Aviation Supervisors.
PRODUCTS: Fuels and lubricants.

H. B. SHERMAN MFG. CO., Battle Creek, Mich.
PERSONNEL: D. P. Ordway, Pres.; E. D. Sperry, V. Pres. & Gen. Mgr.; G. Townsend, Secy. & Treas.; H. H. Isaac, Pur. Agt.; W. Barrett, Pub. Dir.; L. M. Stinchcomb, Engr.
PRODUCTS: Clamps; Terminals; Brass and bronze pipe fittings; Hose clamps.

SHERWIN-WILLIAMS CO., 101 Prospect Ave., N. W., Cleveland, O.
PERSONNEL: A. W. Steudel, Pres.; H. D. Whittlesey, V. Pres.; T. G. Murphey, Secy.; L. H. Schroeder, Treas.; N. E. Van Stone, Gen. Mgr.; W. J. Montgomery, Sales Mgr.; F. E. Davis, Pur. Agt.; L. E. Ebeling, Pers. Dir.; C. M. Lemperly, Pub. Dir.
PRODUCTS: Paints, varnishes and finishes.

SHULER AXLE CO., INC., Louisville, Ky.
PERSONNEL: J. P. Potter, Pres. & Gen. Mgr.; R. L. Bishop, V. Pres.; J. J. Hart, Secy. & Treas.; C. M. Erthle, Pur. Agt.; W. Anderson, Pub. Dir.; R. B. Liggatt, Chief Engr.
PRODUCTS: Castings and forgings.

SHURE BROTHERS, 225 W. Huron St., Chicago, Ill.
PERSONNEL: S. N. Shure, Gen. Mgr.; J. A. Berman, Sales Mgr.; M. A. Cope, Pur. Agt.; B. B. Bauer, Chief Engr.
PRODUCTS: Microphones.

SIGMA INSTRUMENTS, INC., 78 Freeport St., Boston, Mass.
PERSONNEL: S. B. Allen, Pres.; C. Bassett, Treas. & Pur. Agt.; H. N. Boyle, Jr., Gen. Mgr. & Sales Mgr.; R. T. Fisher, Chief Engr.
PRODUCTS: Sensitive electrical relays.

SIMMONDS AEROCESSORIES, INC., 10 Rockefeller Plaza, New York, N. Y.
PERSONNEL: W. R. Enyart, Pres. & Gen. Mgr.; E. M. Dowd, Secy.; J. C. de Graaf, Sales Mgr.; H. V. Beazlie, Pur. Agt.; E. F. Gamache, Pers. Dir.; R. Newcomb, Pub. Dir.; J. W. Overbake, Chief Engr.
PRODUCTS: Bearings; Controls; Fasteners; Hydraulic controls and assemblies; Instruments; Spark plugs; Induction pressure boost controls.

SIMONS PAINT SPRAYING EQUIPMENT CO., 17 Maryland Ave., Dayton, O.
PERSONNEL: G. W. Simons, Prop.
PRODUCTS: Air compressor; Paint spraying equipment.

SIMPLEX PRODUCTS CORP., 3830 Kelley Ave., Cleveland, O.
PERSONNEL: F. G. Ferguson, Pres., Secy & Treas.; D. M. Solenberger, V. Pres.; H. T. Scoville, Sales Mgr.; D. Schappi, Pur. Agt.; R. C. Thompson, Chief Engr.
PRODUCTS: Oil seals; Piston rings.

SINCLAIR REFINING CO., 630 Fifth Ave., New York, N. Y.
PERSONNEL: E. W. Sinclair, Pres.; J. W. Carnes, V. Pres.; M. L. Gosney, V. Pres. & Treas.; O. M. Gerstung, Secy.; L. P. Lochridge, Mgr.-Domestic Lubricating Sales; D. S. Bixler, Asst. Mgr.-Aviation Sales; C. M. Larson, Chief Consulting Engr.; C. W. McAllister, Aeronautical Engr.
PRODUCTS: Fuels and lubricants.

SKYLARK MANUFACTURING CO., INC., 350 Washington Blvd., Venice, Calif.
PERSONNEL: F. G. Perkins, Pres.; E. A. Perkins, V. Pres.; V. R. G. Wilbur, Secy. & Treas.; F. H. Perkins, Pur. Agt.
PRODUCTS: Engine mounts; Exhaust manifolds; Landing gears.

A. O. SMITH CORP., 3533 N. 27th St., Milwaukee, Wisc.
PERSONNEL: W. C. Heath, Pres.; R. F. Bell, J. M. Floyd, V. Pres.; J. J. Stamm, Secy. & Treas.; W. Froderman, Pur. Agt.; L. J. Parrish, Pers. Dir.; D. W. Sherman, Chief Engr.
PRODUCTS: Landing gears; Stampings.

D. B. SMITH & CO., 414 Main St., Utica, N. Y.
PERSONNEL: M. H. Smith, Pres.; T. M. Burton, V. Pres.; G. R. Smith, Jr., Secy.; A. P. Smith, Treas.
PRODUCTS: Fire extinguishers; Water bilge pumps; Weed burners.

SMITH WELDING EQUIPMENT CORP., 2633 Fourth St., S. E., Minneapolis, Minn.
PERSONNEL: E. H. Smith, Pres.; L. L. McBurney, Secy. & Gen. Mgr.; N. J. Andrus, Asst. Sales Mgr.; E. B. Johnson, Pur. Agt.; L. J. Ganyaw, Chief Engr.
PRODUCTS: Welding equipment.

SNAP-ON TOOLS CORP., Kenosha, Wisc.
PERSONNEL: J. Johnson, Pres.; R. Palmer, V. Pres. & Sales Mgr.; W. A. Seidemann, V. Pres.; & Secy.; W. C. Nemitz, Treas.; F. A. Tetzlaff, Pur. Agt.; C. Holderness, Pers. Dir.; G. A. Smith, Pub. Dir.; G. Walraven, Chief Engr.
PRODUCTS: Wrenches.

SNOW REMOVAL EQUIPMENT CO., 400 Seventh St., San Francisco, Calif.
PERSONNEL: N. K. Davis, Pres.; A. E. Mason, V. Pres., Gen. Mgr. & Sales Mgr.; J. M. Azevedo, Secy., Treas. & Pur. Agt.; H. Pruss, Pub. Dir.
PRODUCTS: Rotoblade snow plows.

M. L. SNYDER & SON, Jasper & York Sts., Philadelphia, Pa.
PERSONNEL: H. A. Greene, Pres.; C. Synder, Treas.; F. M. Greene, Sales Mgr.; H. M. Simpson, Pur. Agt.; O. P. Montgomery, Pub. Dir.
PRODUCTS: Fire extinguishers; First aid equipment; Rubber and asbestos gaskets; Hose clamps and hose fittings; Rubber parts; Protective clothing and equipment; Rubber tubing.

SOCONY VACUUM OIL CO., INC., 26 Broadway, New York, N. Y.
PERSONNEL: J. A. Brown, Pres.; C. E. Arnott, V. Pres.; W. D. Bickham, Secy.; A. T. Roberts, Treas.
PRODUCTS: Fuels and lubricants.

SOLAR AIRCRAFT CO., Lindbergh Field, San Diego, Calif.
PERSONNEL: E. T. Price, Pres. & Gen. Mgr.; R. E. Craig, H. F. Sturdy, C. S. Marston, D. M. Miller, R. R. Vought, V. Pres.; J. L. Oatman, Secy.; A. W. Briggs, Treas.; P. S. Seitz, Sales Mgr.; B. H. Bateman, Pur. Agt.; P. L. Ferris, Pub. Dir.; W. C. Heath, Chief Engr.
PRODUCTS: Ammunition boxes and counters; Clamps; Collector rings, cowls, streamlines; Cowlings; Cylinder deflectors, baffles, brackets; De-icer equipment; Exhaust manifolds; Manifolds; Misc. engine equipment; Stampings; Miscellaneous.

SOSS MANUFACTURING CO., 21777 Hoover Rd., Detroit, Mich.
PERSONNEL: C. J. Soss, Pres.; S. Soss, V. Pres.; Secy., & Sales Mgr.; H. Soss, Treas.; S. R. Synder, Pur. Agt.; W. Hamilton, Pers. Dir.; A. TenEyck, Pub. Dir.; F. Wambold, Chief Engr.
PRODUCTS: Misc. hardware; Stampings.

THE SOUND SCRIBER CORP., 82 Audubon St., New Haven, Conn.
PERSONNEL: L. Thompson, Pres.; H. Gfroerer, V. Pres., Treas. & Gen. Mgr.; H. K. Greer, Secy.; O. M. Ober, Pur. Agt.; R. L. Stone, Chief Engr.
PRODUCTS: Airport equipment; Misc. electrical equipment; Recording devices.

SOUTH BEND LATHE WORKS, South Bend, Ind.
PRODUCTS: Machine tools.

SOUTH SHORE MACHINE & TOOL WORKS, INC., Merrick Rd., Seaford, N. Y.
PERSONNEL: G. A. Bauer, Pres.; A. G. Bauer, V. Pres.; J. A. Sullivan, Secy. & Treas.
PRODUCTS: Controls; Hydraulic controls and assemblies; Sub-assemblies.

SOUTHERN AIRCRAFT CORP., Garland, Tex.
PERSONNEL: J. R. McClain, Ch. of Board; W. C. Brown, Pres.; A. E. Pattison, V. Pres. & Treas.; F. H. Brown, Secy.
PRODUCTS: Component parts.

SOUTHERN CALIFORNIA AIRPARTS, 924 Thompson Ave., Glendale, Calif.
PERSONNEL: S. M. Jarvis, Pres. & Gen. Mgr.; W. D. Lawrie, V. Pres.; W. P. Campbell, Secy.; Treas. & Pub. Dir.; L. Kepler, Sales Mgr.; G. Pettit, Pur. Agt.; E. Doherty, Pers. Dir.; D. A. Trail, Chief Engr.
PRODUCTS: Ammunition boxes and counters; Bomb racks; Cowlings; Engine mounts; Aluminum and steel parts; Seats; Sub-assemblies; Tanks.

SOUTHERN ENGINEERING CO., INC., 816 W. Fifth St., Los Angeles, Calif.
PERSONNEL: H. R. Peacock, Pres.; C. Coe, V. Pres. & Gen. Mgr.; D. B. Coe, Secy.
PRODUCTS: Metal forming equipment; Dies.

SPARKS WITHINGTON CO., North St., Jackson, Mich.
PERSONNEL: W. Sparks, Pres.; W. J. Corbett, V. Pres.; D. Johnson, Secy.; H. Johnston, Treas.; R. W. Clark, Gen. Mgr.; E. T. H. Hutchinson, Sales Mgr.; J. Towler, Pur. Agt.
PRODUCTS: Landing gear warning signal; Mooring kit; Bomb rack release; Bomb hoist.

SPARTAN AIRCRAFT CO., 1900 N. Sheridan Rd., Tulsa, Okla.
PERSONNEL: J. P. Getty, Pres.; M. W. Balfour, V. Pres.; F. T. Hopp, Secy. & Treas.; G. F. Shortess, Contract Officer; J. Bredouw, Pur. Agt.; W. H. Woodward, Pers. Dir.; F. Stewart, Chief Engr.
PRODUCTS: Aircraft parts.

SPAULDING FIBRE CO., INC., 310 Wheeler St., Tonawanda, N. Y.
PERSONNEL: C. C. Steck, Pres. & Gen. Mgr.; H. W. Grieser, V. Pres.; S. E. Clow, Treas.; A. P. Hardleben, Pur. Agt.
PRODUCTS: Basic materials and fabrications; Bearings; Bushings; Gaskets; Insulating materials; Panels; Fibre, plastic and synthetic parts.

SPECIAL MACHINE TOOL ENGINEERING WORKS, 254 Canal St., New York, N. Y.
PERSONNEL: W. Silber, V. Silber, Partners; V. Silber, Gen. Mgr.; D. Blatt, Pur. Agt.; D. Alton, Chief Engr.
PRODUCTS: Airport equipment; Bushings; Cameras; Misc. electrical equipment; Fittings; Hydraulic controls and assemblies; Aluminum magnesium and steel parts; Propellers and, propeller parts; Sub-assemblies.

SPEED WAY MFG. CO., 1834 S. 52nd Ave., Cicero, Ill.
PERSONNEL: G. L. Newcome, Pres.; M. Chapek, Treas. & Gen. Mgr.; F. W. Anderson, Sales Mgr.; D. A. Baker, Pur. Agt.; R. S. McKeage, Chief Engr.
PRODUCTS: Auxiliary motors; Instrument motors; Sub-assemblies.

SPENCER THERMOSTAT CO.,
34 Forest St., Attleboro, Mass.
PERSONNEL: R. Willard, Pres.; D. T. Schultz, V. Pres.; C. J. Stone, Treas.; V. G. Vaughan, Gen. Mgr.; E. F. Kurtz, Sales Mgr.; E. B. Carpenter, Pur. Agt.; J. D. Bolesky, Chief Engr.
PRODUCTS: Circuit breakers; Circuit and motor protectors; Thermostats.

SPERRY GYROSCOPE CO., INC.,
Manhattan Bridge Plaza, Brooklyn, N. Y.
PERSONNEL: R. E. Gillmor, Pres. & Gen. Mgr.; R. B. Lea, V. Pres.-Sales; P. R. Bassett, V. Pres.- Engrg.; L. Malkovsky, V. Pres.- Mfg.; J. Sanderson, V. Pres.-Finance; J. E. Webb, Secy. & Treas.; A. R. Weckel, Aeronautical Sales Mgr.; R. V. Elms, Pur. Agt.; L. Swart, Pers. Dir.; J. A. Fitz, Pub. Dir.; E. Sparling, Chief Engr.
PRODUCTS: Aircraft armament; Instruments.

SPERRY PRODUCTS, INC.,
1505 Willow Ave., Hoboken, N. J.
PERSONNEL: J. B. Farwell, Pres. & Gen. Mgr.; E. G. Sperry, V. Pres., & Treas.; J. H. Lipschutz, Secy.; M. F. Sproul, Sales Mgr.; L. C. Wohlberg, Pur. Agt.; E. P. Dodge, Pers. Dir.; P. E. Moreton, Pub. Dir.; E. A. Crawford, Chief Eng.
PRODUCTS: Exactor hydraulic controls.

THE SPOOL COTTON CO., CROWN FASTENER DIV., 745 Fifth Ave., New York, N. Y.
PERSONNEL: W. B. Bachof, Pres.; H. Grandage, V. Pres.; J. Bell, Secy.; J. Dunlop, Treas.; R. G. Plumley, Gen. Mgr.; J. S. Campbell, Sales Mgr.; C. H. Neuer, Pur. Agt.; D. F. Sullivan, Pub. Dir.; L. H. Morin, Chief Engr.
PRODUCTS: Zippers; Small zinc die-castings.

SPRAY ENGINEERING CO.,
114 Central St., Somerville, Mass.
PERSONNEL: W. B. Thompson, Pres. & Treas.; F. G. Dennison, V. Pres. & Chief Engr.; A. S. True, Sales Mgr.; A. L. Maclachlan, Pur. Agt.
PRODUCTS: Fire fog equipment; Spray painting and finishing equipment.

SPRIESCH TOOL & MFG. CO., INC.,
10 Howard St., Buffalo, N. Y.
PERSONNEL: J. Cheney, Pres. & Treas.; J. Spriesch, V. Pres.; W. Cheney, Secy.
PRODUCTS: Aircraft armament; Bomb racks; Stampings.

SPRUCE LUMBER & VENEER CO.,
Vancouver, Wash.
PERSONNEL: H. H. McLaughlin, G. K. Voss, Partners.
PRODUCTS: Spruce and hemlock aircraft lumber; Spruce, hemlock and fir sliced veneer.

SQUARE D CO.,
6060 Rivard St., Detroit, Mich.
PERSONNEL: F. W. Magin, Pres.; L. W. Mercer, V. Pres.; H. Morgan, Secy. & Treas.; C. L. Hull, Sales Mgr.; K. L. Winslow, Pur. Agt.; E. W. Fry, Pers. Dir.; J. H. Vernum, Pub. Dir.; J. L. Jackson, Chief Engr.
PRODUCTS: Airport equipment; Switches; Circuit breakers; Misc. electrical equipment; Instruments; Plastic parts.

STALEY MANUFACTURING CORP.,
14th & Union Sts., Columbus, Ind.
PERSONNEL: J. H. Staley, Pres.
PRODUCTS: Airport equipment; Misc. engine equipment; Engine repair stands.

STANDARD AIRCRAFT PRODUCTS, INC.,
121 Franklin St., Dayton, O.
PERSONNEL: R. N. Webster, Pres.; C. Wilcke, V. Pres.; T. E. Wilson, Secy.; A. Ellinger, Treas.; R. Casey, Gen. Mgr.; L. G. Zarbock, Sales Mgr.; F. Prinz, Pur. Agt.; D. E. Stauffer, Pers. Dir.; J. E. Golob, Chief Engr.
PRODUCTS: Cockpit and dome lamps; Running lights; Liquid coolant thermostats; Header tanks; Relief valves; Pneumatic radiator flap rams; Supercharger rams.

STANDARD ELECTRIC CO., INC.,
Route 3, Box 121-B, San Antonio, Tex.
PERSONNEL: B. Dubinski, Pres.; L. Dubinski, Secy. & Gen. Mgr.; E. E. Eckert, Sales Mgr.
PRODUCTS: Batteries.

THE STANDARD ELEC. TIME CO.,
Springfield, Mass.
PERSONNEL: F. A. Riggs, Pres.; C. M. Whiteford, V. Pres.; H. W. Angier, Secy.; C. B. Fitts, Treas. & Gen. Mgr.; H. P. Blake, Sales Mgr.; L. P. Marshall, Pur. Agt., Pers. Dir. & Chief Engr.; C. F. Barrett, Pub. Dir.
PRODUCTS: Switches; Terminals; Misc. electrical equipment; Panels.

THE STANDARD ELECTRICAL TOOL CO.,
2488 River Rd., Cincinnati, O.
PERSONNEL: W. A. Ferguson, Pres. & Treas.; L. A. Hauck, V. Pres. & Chief Engr.; R. A. Huhn, Secy. & Sales Mgr.; J. J. Klopp, Pur. Agt.
PRODUCTS: Machine tools.

STANDARD FELT CO., DIV. OF HUNTINGTON LAND AND IMPROVEMENT CO., 29-115 S. Palm Ave., Alhambra, Calif.
PERSONNEL: H. S. Cook, V. Pres. & Gen. Mgr.; J. S. Roome, Pur. Agt.; C. M. O'Donnell, Pers. Dir.; J. S. Murray, Chief Engr.
PRODUCTS: Felt parts.

STANDARD MACHINERY CO., 351 Indiana Ave., N. W., Grand Rapids, Mich.
PERSONNEL: J. Monahan, Owner.
PRODUCTS: Machine tools.

STANDARD OIL CO. OF CALIFORNIA, 225 Bush St., San Francisco, Calif.
PERSONNEL: E. J. McClanahan, Gen. Mgr. of Sales; R. F. Bradley, Aviation Sales Mgr.
PRODUCTS: Aviation gasolines; Oils; Greases; Hydraulic fluids.

STANDARD OIL CO., OF KENTUCKY,
426 Bloom St., Louisville, Ky.,
PERSONNEL: W. E. Smith, Pres.; W. G. Violette, V. Pres.; D. F. Cocks, Secy.
PRODUCTS: Fuels and lubricants.

STANDARD OIL CO. OF NEW JERSEY,
26 Broadway, New York, N. Y.
PERSONNEL: R. C. Oertel, Sales Mgr., Aviation Dept.
PRODUCTS: Fuels and lubricants.

STAR PATTERN WORKS,
1248 Ray St., Dayton, O.
PERSONNEL: C. L. Templeton, Gen. Mgr.
PRODUCTS: Photographic equipment.

THE L. S. STARRETT CO., Athol, Mass.
PERSONNEL: D. Findlay, Pres.; A. H. Starrett, V. Pres.; W. G. Nims, Treas.; W. J. Greene, Sales Mgr.; E. E. Warner, Pur. Agt.; J. Hunton, Pers. Dir.; H. E. Masters, Pub. Dir.; A. E. Williams, Chief Engr.
PRODUCTS: Mechanic precision hand tools; Dial gages; Hand and power hacksaw blades; Metal cutting band saws; Steel tapes.

THE STATES CO.,
19 New Park Ave., Hartford, Conn.
PERSONNEL: E. C. Alden, Pres.; H. N. Porter, Secy. & Sales Mgr.; H. P. Blakeslee, Treas.; C. Fitchner, Pur. Agt.; W. J. Larson, Chief Engr.
PRODUCTS: Woven radio transmitter resistors; Automatic and astronomic time switches.

STAYNEW FILTER CORP.,
11 Centre Park, Rochester, N. Y.
PERSONNEL: L. L. Dollinger, Pres. & Gen. Mgr.; F. J. Willson, V. Pres.; I. H. Bauman, Secy.; N. A. Hamill, Treas.; J. S. Zahniser, Sales Mgr.; L. J. Holden, Pur. Agt.; C. F. Hasselwander, Chief Engr.
PRODUCTS: Filters and strainers.

STEEL FORMING CORP.,
1619 S. Alameda St., Los Angeles, Calif.
PERSONNEL: L. T. Sepin, Pres.; J. A. Stone, V. Pres.; K. E. Drebert, Secy.; N. K. Myers, Pur. Agt.
PRODUCTS: Aircraft armament; Basic materials and fabrications; Clamps; Cowlings; De-icer equipment; Exhaust manifolds; Hose clamps and hose fittings; Aluminum and steel parts; Stampings; Sub-assemblies.

THE STEEL PRODUCTS ENGINEERING CO., 1205 W. Columbia St., Springfield, O.
PERSONNEL: J. E. McAdams, Pres.; S. L. Tatum, V. Pres.; W. C. Jordan, V. Pres. & Gen. Mgr.; I. W. Clark, Secy.; D. Applegate, Pur. Agt.; A. W. Endter, Pers. Dir.; E. F. Fowle, Chief Engr.
PRODUCTS: Aircraft armament; Ammunition boxes and counters; Bomb racks; Aluminum, magnesium and steel parts; Propellers and propeller parts; Pumps; Stampings; Sub-assemblies.

STEEL & TUBES DIV., REPUBLIC STEEL CORP., 224 E. 131st St., Cleveland, O.
PERSONNEL: H. Wick, Operations Mgr.; J. V. Burley, Gen. Sales Mgr.; J. A. Ireland, H. R. Coward, W. W. Shafer, Sales Mgrs.; L. A. Dimon, Pur. Agt.; C. D. Evans, Pers. Dir.; J. F. Keeler, S. L. Willis, Engrs.
PRODUCTS: Welded and stainless steel tubing; Rail carbon steel tubing.

STERLING ELECTRIC MOTORS, INC.,
5401 Telegraph Rd., Los Angeles, Calif.
PERSONNEL: C. E. Johnson, Pres.; E. Mendenhall, V. Pres., Secy. & Gen. Mgr.; A. Adams, Treas.; W. D. Fabling, Sales Mgr.; R. McCormack, Pur. Agt.; M. Frink, Pers. Dir.; B. Palm, G. Whitman, Engrs.
PRODUCTS: Electric motors; Speed transmissions; Gear reduction units; Frequency changers.

STERLING TOOL PRODUCTS CO.,
363 E. Ohio St., Chicago, Ill.
PERSONNEL: S. A. Crosby, Pres. & Gen. Mgr.; B. M. Wood, Secy.; W. B. Muse, Sales Mgr. & Pub. Dir.; C. A. Hamilton, Pur. Agt.
PRODUCTS: Electric and air driven portable sanding machines.

STEWART-WARNER CORP.,
1826 Diversey Pkwy., Chicago, Ill.
PERSONNEL: J. S. Knowlson, Pres.; F. A. Ross, V. Pres.; L. Williams, Jr., V. Pres. & Secy.; F. A. Hiter, V. Pres. & Sales Mgr.; F. Kirch, Treas.; R. F. Stiles, Pur. Agt.; E. H. Dunning, Pers. Dir.; C. W. Grange, Pub. Dir.; A. W. LeFevre, Chief Engr.
PRODUCTS: Castings and forgings; Lubrication fittings; Fuels and lubricants; Heaters; Instruments; Misc. hardware; Panels; Pumps.

HERMAN H. STICHT CO., INC.,
27 Park Pl., New York, N. Y.
PERSONNEL: M. F. Sticht, Pres.; D. Sticht, Secy.; A. H. Volker, Treas., & Gen. Mgr.
PRODUCTS: Instruments.

STONE PROPELLER CO.,
701 E. Gilbert, Wichita, Kans.
PERSONNEL: M. J. Stone, A. M. Stone, Partners; A. M. Stone, Treas.; I. Hayden, Gen. Mgr.; W. Stoessel, Pers. Dir.
PRODUCTS: Propellers and propeller parts.

STORMS DROP FORGING CO.,
70 Storms Court, Springfield, Mass.
PERSONNEL: R. A. Charpentier, Pres., Treas., & Gen. Mgr.; R. E. Whittle, V. Pres.; R. J. McKenna, Sales Mgr.
PRODUCTS: Castings and forgings.

STRICKER-BRUNHUBER CORP.,
19 W. 24th St., New York, N. Y.
PERSONNEL: C. Stricker, Pres.; H. Stricker, Secy.; E. O. Brunhuber, Treas.; F. Christell, Pur. Agt.
PRODUCTS: Plastic models; Mold equipment; Patterns.

THE STRIPPIT CORP.,
345 Payne Ave., N. Tonawanda, N. Y.
PERSONNEL: G. F. Wales, Pres.
PRODUCTS: Hole punching and notching dies.

D. A. STUART OIL CO.,
2727 S. Troy St., Chicago, Ill.
PERSONNEL: W. H. Oldacre, Pres., Gen. Mgr. & Chief Engr.; T. B. Langdon, V. Pres., Sales Mgr. & Pub. Dir.; H. M. Millar, Secy. & Treas.; L. B. Perkins, Pur. Agt. & Pers. Dir.
PRODUCTS: Metal cutting oils and compounds; Specialized greases.

B. F. STURTEVANT CO.,
Damon St., Hyde Park, Boston, Mass.
PERSONNEL: E. B. Freeman, Pres., & Gen; Mgr.; G. C. Derry, H. F. Hagen, H. R. Sewell, N. Foss, E. B. Williams, Vice Pres.; J. H. Melzard, Secy.; B. S. Foss, Treas.; J. C. Thompson, Sales Mgr.; H. D. Orrok, Pur. Agt.; R. W. Chaplin, Pers. Dir.; E. W. Andros, Pub. Dir.; M. S. Leonard, Chief Engr.
PRODUCTS: Airport equipment; Heaters; Ventilating and air conditioning equipment.

P. A. STURTEVANT CO., Addison, Ill.
PERSONNEL: P. A. Sturtevant, Pres.; H. C. Hahn, V. Pres.; A. R. Sturtevant, Secy.; H. Nusperle, Asst. Gen. Mgr.; H. G. Rudd, Sales Mgr.; R. Stone, Pur. Agt.
PRODUCTS: Torque wrenches; Valve and clutch spring testers.

SUMMERILL TUBING CO., Bridgeport, Pa.
PERSONNEL: E. L. Parker, Pres.; R. R. Lawson, Exec. V. Pres.; E. C. Van Orsdell, V. Pres.-Plant Mgr.; G. E. Parker, V. Pres.-Sales; G. P. Kraemer, Secy. & Treas.; J. P. Dods, Research Dir., Pub. Dir. & Adv. Mgr.; C. W. Johnson, Pur. Agt.; D. Frank, Pers. Dir.
PRODUCTS: Steel parts; Propeller parts; Steel tubing.

SUN OIL CO.,
1608 Walnut St., Philadelphia, Pa.
PERSONNEL: J. H. Pew, Pres.; J. N. Pew, Jr., A. E. Pew, Jr., V. Pres.; S. B. Eckert, V. Pres. & Sales Mgr.; F. Cross, Secy. & Treas.; H. Thomas, Pur. Agt.; F. S. Cannan, Pub. Dir.
PRODUCTS: Fuels and lubricants.

SUNCOOK MILLS,
40 Worth St., New York, N. Y.
PERSONNEL: J. L. Weld, Pres., Treas. & Gen. Mgr.; V. Dietz, Jr., Sales Mgr.; O. A. Simmons, Chief Engr.; J. R. Fish, Supt.
PRODUCTS: Fabrics; Tapes.

SUNDSTRAND MACHINE TOOL CO.,
2531 11th St., Rockford, Ill.
PERSONNEL: H. L. Olson, Pres. & Gen. Mgr.; A. E. Johnson, V. Pres.; G. A. Lindblade, Secy. & Treas.; T. B. Buell, Sales Mgr.; A. E. Nelson, Pur. Agt.; B. Granberg, Chief Engr.
PRODUCTS: Machine tools.

SUNNEN PRODUCTS CO.,
7900 Manchester, St. Louis, Mo.
PERSONNEL: J. Sunnen, Pres.; W. A. Douglass, V. Pres., Gen. Mgr. & Sales Mgr.; R. S. Nichols, Secy. & Pur. Agt.; C. J. Schuepbach, Treas.; D. H. Nicholson, Pers. Dir. & Pub. Dir.; M. Langford, Chief Engr.
PRODUCTS: Machine tools; Tools.

SUPERIOR TUBE CO., Norristown, Pa.
PERSONNEL: C. A. Warden, Pres.; R. H. Gabel, V. Pres.; C. A. Warden, Jr., Secy. & Treas.; S. L. Gabel, Gen. Mgr.; H. B. Brown, Jr., Sales Mgr.; J. J. Buckley, Pur. Agt.; W. J. McFarland, Pers. Dir.
PRODUCTS: Engine steel valve push rods; Tubing.

SURFACE COMBUSTION, DIV. OF GENERAL PROPERTIES, INC., 2375 Dorr St., Toledo, O.
PERSONNEL: F. H. Adams, V. Pres. & Gen. Mgr.; C. B. Phillips, V. Pres. & Sales Mgr.; E. H. Taylor, Treas.
PRODUCTS: Heaters; Sub-assemblies; Tanks; Ventilating and air conditioning equipment.

SWIFT LUBRICATOR CO., Elmira, N. Y.
PERSONNEL: C. T. Burke, Gen. Mgr.; C. W. Swift, Jr., Sales Mgr. & Pur. Agt.; E. Stachel, Pers. Dir.
PRODUCTS: Bushings; Fittings; Hose clamps and hose fittings; Misc. hardware; Control valves.

SWITLIK PARACHUTE CO.,
Lalor & Hancock Sts., Trenton, N. J.
PERSONNEL: S. Switlik, W. Switlik, R. Switlik, L. Switlik, Partners; S. Switlik, Gen. Mgr.; J. M. Volk, Sales Mgr.; J. A. McQuillen, J. Marsden, Pur. Agts.; G. Lemmon, Pers. Dir.; R. Switlik, Chief Eng.
PRODUCTS: Parachutes.

SYNTHANE CORP., Oaks, Pa.
PERSONNEL: R. R. Titus, Pres.; J. B. Rittenhouse, V. Pres.; R. E. Heaton, Secy.; S. M. Fox, Pur. Agt.
PRODUCTS: Bushings; Insulating materials; Panels; Synthetic parts.

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THE TAFT-PEIRCE MFG. CO.,
32 Mechanic Ave., Woonsocket, R. I.
PERSONNEL: F. S. Blackall, Jr., Pres., Treas. & Gen. Mgr.; J. W. Wheeler, Jr., V. Pres.; W. A. Gordon, III, Secy.; W. E. Rogers, Sales Mgr.; A. M. Robinson, Pur. Agt.; A. J. B. Hudson, Pers. Dir.; N. E. Brown, Chief Engr.
PRODUCTS: Machine tools; Propellers and propeller parts; Tools.

C. J. TAGLIABUE MFG. CO.,
Park & Nostrand Aves., Brooklyn, N. Y.
PERSONNEL: E. D. Wacker, Sales Mgr.; H. Nichols, Pur. Agt.
PRODUCTS: Petroleum testing instruments.

THE TANNEWITZ WORKS, 315 Edwards St., N. W., Grand Rapids, Mich.
PERSONNEL: C. E. Tannewitz, Gen. Mgr.; O. De Groot, Asst. Mgr.
PRODUCTS: Band sawing and contour die sawing machinery; Foundry band saws.

TAYLOR FIBRE CO., Norristown, Pa.
PERSONNEL: J. M. Taylor, Pres.; L. T. Mc Closkey, C. N. Jacobs, V. Pres.; W. H. Taylor, Secy.; R. S. McIver, Treas.
PRODUCTS: Bushings; Insulating materials; Fibre and plastic parts; Rudders, elevators and tabs; Wing flaps.

TAYLOR-HALL WELDING CORP.,
99 Hope Ave., Worcester, Mass.
PERSONNEL: P. M. Hall, Pres. & Treas.
PRODUCTS: Spot welders.

TAYLOR INSTRUMENT COMPANIES,
95 Ames St., Rochester, N. Y.
PERSONNEL: L. B. Swift, Pres.; H. W. Kimmel, Secy.; H. J. Noble, Treas.; P. R. Jameson, Gen. Mgr.; F. K. Taylor, Sales Mgr.; C. D. Hart, Pur. Agt.; W. W. Lockwood, Pub. Dir.; K. K. Hubbard, Chief Engr.
PRODUCTS: Instruments; Control valves.

THE TAYLOR MACHINE CO.,
1917 E. 61st St., Cleveland, O.
PERSONNEL: W. W. Taylor, Pres. & Gen. Mgr.; M. A. Taylor, Secy. & Treas.; A. E. McGovney, Sales Mgr.; D. Stephenson, Pur. Agt. & Pub. Dir.; A. W. Taylor, Pres. Dir.; C. W. Gifford, Chief Engr.
PRODUCTS: Test club hubs; Bomb hoists; Cargo winches; Engine hoists; Bomb racks; Bushings; Hydraulic controls and assemblies; Propellers and propeller parts; Control valves; Engine valves and valve parts.

SUPERIOR TUBE COMPANY

Norristown, Pennsylvania.

METAL TUBING MANUFACTURERS

SEAMLESS TUBING

Steel
Alloy Steels
Stainless Steels
Composite (Steel and Copper)
Nickel
Monel
Inconel
Copper
Beryllium Copper
Aluminum

*WELDRAWN TUBING

(welded, then drawn)

Stainless Steel
Low Carbon Steel
Chrome-Moly Steel

*BRAWN TUBING

(welded, then drawn)

Monel
Inconel

FABRICATED PRODUCTS

Alloy Steel Valve Push Rods for Aircraft and Tank Engines
Antennas in Brawn Monel for Aircraft and Marine Installations also, for Automotive Purposes

*Trade-marked

TAYLOR MANUFACTURING CO., 3056 W. Meinecke Ave., Milwaukee, Wisc.
PERSONNEL: T. F. Millane, Pres. & Gen. Mgr.; C. V. Kray, Sales Mgr.; R. I. McDonald, Pur. Agt.; H. Karweik, Chief Engr.
PRODUCTS: Dynamometers; Brakes; Static balancing machines; Sensitive and production drilling machines; Dividing heads.

THE TAYLOR-WINFIELD CORP., Warren, O.
PERSONNEL: J. A. Anderson, Pres., W. A. Anderson, V. Pres.; N. H. Cobb, Secy.; J. D. Anderson, Treas.; J. D. Gordon, Gen. Mgr.; T. S. Long, Sales Mgr.; W. H. Marion, Pur. Agt.; L. Van Eeghen, Pers. Dir.; E. J. Del Vecchio, Pub. Dir.; S. M. Humphrey, Exec. Engr.
PRODUCTS: Welders.

TECHNICAL PLY-WOODS, 228 N. LaSalle St., Chicago, Ill.
PERSONNEL: J. R. Fitzpatrick, Dir.; B. H. Larsson, Engr.
PRODUCTS: Ammunition boxes and counters; Basic materials and fabrications; Cylinder deflectors, baffles, brackets; Panels; Fibre, plywood and synthetic parts; Seats.

TECHNICAL PRODUCTS CO., 6670 Lexington Ave., Los Angeles, Calif.
PERSONNEL: E. R. Chilcott, Pres.; F. E. Chilcott, Gen. Mgr.; G. L. Hawkins, Pur. Agt.
PRODUCTS: Airport equipment; Cameras; Sound recording equipment; Stampings.

TEICHER MANUFACTURING CORP., 136-23 34th Ave., Flushing, N. Y.
PERSONNEL: A. A. Teicher, Pres. & Gen. Mgr.; G. B. Cluett, II, V. Pres.; L. L. Wilke, Secy.; L. Teicher, Treas.
PRODUCTS: Aluminum parts.

TELAUTOGRAPH CORP., 16 W. 61st St., New York, N. Y.
PERSONNEL: W. F. Vieh, Pres.; H. Shea, Secy. & Treas.; J. B. Carlyon, Sales Mgr.; H. Wilkins, Pur. Agt.; S. Leonard, Pub. Dir.; G. T. Stanton, Chief Engr.
PRODUCTS: Communication service for plants and fields.

TELEVISO PRODUCTS, INC., 6533 Olmsted Ave., Northwest Highway, Chicago, Ill.
PERSONNEL: S. S. Schiller, Pres.; H. D. Von Jenef, V. Pres. & Chief Engr.; J. B. Atkinson, Secy.; F. Schalk, Gen. Mgr.; J. D. Ellis, Pur. Agt.; D. Sherman, Pers. Dir.
PRODUCTS: Aircraft armament; Misc. electrical equipment; Instruments; Radios; Radio compasses.

TEMPLETON, KENLY & CO., 1020 S. Central Ave., Chicago, Ill.
PERSONNEL: J. B. Templeton, Pres., Treas. & Pub. Dir.; H. C. Dilsizian, V. Pres.; F. W. Krickhan, Secy.; P. H. McManus, Sales Mgr.; R. Webb, Pur. Agt.; F. J. Jakoubek, Chief Engr.
PRODUCTS: Jacks.

TENNESSEE AIRCRAFT, INC., 126 Tenth Ave., South Nashville, Tenn.
PERSONNEL: L. E. Reisner, Pres. & Gen. Mgr.; C. S. Ragland, V. Pres.; W. Phillips, Secy. & Treas.; C. Walden, Pur. Agt.; A. Duling, Pers. Dir.
PRODUCTS: Ammunition boxes and counters; Bomb racks; Collector rings, cowls, streamlines; Controls; Cowlings; Cylinder deflectors, baffles, brackets; Fittings; Floats, skiis; Manifolds; Misc. hardware; Aluminum and magnesium parts; Seats; Stampings; Tanks; Miscellaneous.

TENNESSEE EASTMAN CORP., Kingsport, Tenn.
PERSONNEL: P. S. Wilcox, Pres.; T. J. Hargrave, V. Pres.; J. C. White, V. Pres. & Gen. Mgr.; M. K. Robinson, Secy.; J. C. Stone, Treas.; B. M. Brown, Compt.; S. E. Palmer, Sales Mgr., Cellulose Products Div.; D. V. Hammock, Pur. Agt.
PRODUCTS: Cellulose acetate plastic.

GEORGE A. TERRY CO., 350-356 S. Elmwood Ave., Buffalo, N. Y.
PERSONNEL: G. A. Terry, Owner & Gen. Mgr.; A. M. Dodge, Secy.
PRODUCTS: Drilling attachments.

THE TEXAS CO., 135 E. 42nd St., New York, N. Y.
PERSONNEL: A. Keif, Sales Mgr., Aviation Div.
PRODUCTS: Fuels and lubricants.

M. N. THACKABERRY, 304-308 E. Third St., Los Angeles, Calif.
PERSONNEL: M. N. Thackaberry, Owner & Treas.; R. G. Spangler, Sales Mgr. & Pur. Agt.; L. Smith, Chief Engr.
PRODUCTS: Machine tools; Electric tools.

THIOKOL CORP., 780 N. Clinton Ave., Trenton, N. J.
PERSONNEL: B. L. Longstreth, Pres. & Gen. Mgr.; J. C. Patrick, V. Pres.; H. A. Richards, Secy.; J. W. Crosby, Sales Mgr.; J. C. Campbell, Pur. Agt.
PRODUCTS: Gaskets; Life saving equipment; Oil seals; Paints, varnishes and finishes; Rubber parts; Miscellaneous.

THOMPSON AIRCRAFT PRODUCTS CO., Euclid, O.
PERSONNEL: F. C. Crawford, Pres.; L. M. Clegg, Exec. V. Pres.; J. D. Wright, V. Pres., Secy. & Gen. Mgr.; A. T. Colwell, V. Pres.; J. H. Coolidge, Treas.; G. V. Sevald, Sales Mgr.; H. D. Myers, Pur. Agt.; R. S. Livingstone, Pers. Dir.; F. R. Witt, Pub. Dir.; H. D. Bubb, Chief Engr.
PRODUCTS: Bushings; Fasteners; Aluminum and steel parts; Propeller parts; Fuel and booster pumps; Sub-assemblies; Engine valves and valve parts.

THE HENRY G. THOMPSON & SON CO., 227 Chapel St., New Haven, Conn.
PERSONNEL: D. W. Northup, Pres.; T. A. Hyde V. Pres.; A. W. Tucker, Secy. & Sales Mgr.; D. C. Smyth, Treas. & Pur. Agt.; M. J. Radecki, Chief Engr.
PRODUCTS: Tools.

THE THOMPSON GRINDER CO., 1534 W. Main St., Springfield, O.
PERSONNEL: C. Baldenhofer, Pres., Treas. & Gen. Mgr.; W. G. Baldenhofer, V. Pres.; R. M. McDonough, Secy.; J. C. Wilson, Sales Mgr.; Pub. Dir. & Chief Engr.; R. L. Powers, Pur. Agt. & Pers. Dir.
PRODUCTS: Machine tools.

THOMPSON PRODUCTS, INC. 8354 Wilcox Ave., Bell, Calif.
PERSONNEL: F. C. Crawford, Pres.; L. M. Clegg, V. Pres.; J. D. Wright, Secy.; J. H. Coolidge, Treas.; W. H. Carhart, Sales Mgr.; D. M. Cameron, Pur. Agt.; C. L. Millman, Pers. Dir.; R. M. Rogers, Chief Engr.
PRODUCTS: Rod ends; Special steel bolts; Engine valves and valve parts.

THOMPSON PRODUCTS, INC., 2196 Clarkwood Rd., Cleveland, O.
PERSONNEL: F. C. Crawford, Pres.; L. M. Clegg, Exec. V. Pres.; A. T. Colwell, W. M. Albaugh, T. O. Duggan, V. Pres.; J. D. Wright, Secy.; J. H. Coolidge, Treas.; G. V. Sevald, Sales Mgr.; H. D. Myers, Pur. Agt.; R. S. Livingstone, Pers. Dir.; F. R. Witt, Pub. Dir.; H. D. Bubb, Chief Engr.
PRODUCTS: Bushings; Fasteners; Misc. engine equipment; Aluminum and steel parts; Propellers and propeller parts; Pumps; Sub-assemblies; Engine valves and valve parts.

THOMSON-GIBB ELECTRIC WELDING CO., Lynn, Mass.
PERSONNEL: G. A. Cutter, Pres.; W. T. Ober, Gen. Mgr.; I. C. Brown, Sales Mgr.
PRODUCTS: Welding equipment.

THORDARSON ELECTRIC MFG. CO., 500 W. Huron St., Chicago, Ill.
PERSONNEL: C. H. Thordarson, Pres.; R. E. Onstad, V. Pres. & Gen. Mgr.; O. W. Storey, Secy.; L. G. Winney, Treas.; C. W. Hahane, Sales Mgr.; C. A. Schmitz, Pur. Agt.; H. J. Hubenthal, Pers. Dir.; E. J. Rehfeldt, Pub. Dir.; W. C. Howe, Chief Engr.
PRODUCTS: Wave filters; Transformers; Amplifiers; Radio transformers and chokes.

W. HARRIS THURSTON-THURSTON CUTTING CORP., 40 Worth St., New York, N. Y.
PERSONNEL: W. H. Thurston, Pres.; J. G. Bausher, Sales Mgr., Dir. Airwing Prod.
PRODUCTS: Basic materials and fabrications.

THE THRESHER VARNISH CO., 1100 E. Monument Ave., Dayton, O.
PERSONNEL: C. L. Sullivan, Jr., Pres., Gen. Mgr. & Pur. Agt.; E. H. Kessler, Sales Mgr.; P. W. Blue, Pers. Dir. & Pub. Dir.; J. E. Heller, Chief Engr.
PRODUCTS: Paints, varnishes and finishes.

TIDE WATER ASSOCIATED OIL CO., 17 Battery Pl., New York, N. Y.
PERSONNEL: W. F. Humphrey, Pres.; W. J. Burker, Secy.; K. R. Hankinson, Treas.; J. D. Collins, Sales Mgr.; A. Jungdahl, Pur. Agt.; S. W. Candee, Pers. Dir.; G. J. Murray, Jr., Pub. Dir.
79 New Montgomery St., San Francisco, Calif.
PERSONNEL: W. F. Humphrey, Pres.; W. J. Burker, Secy.; K. R. Hankinson, Treas.; P. E. Allan, Sales Mgr.; A. P. MacKillop, Pur. Agt.; C. R. Brown, Pers. Dir.; I. G. Reed, Chief Engr.
PRODUCTS: Fuels and lubricants.

TIETZMANN ENGINEERING CO., Englewood, O.
PERSONNEL: C. Tietzmann, Pres.; W. A. Tietzmann, V. Pres., Gen. Mgr., Sales Mgr., Pur. Agt. & Pub. Dir.; D. Randolph, Secy.; M. Tietzmann, Treas.; A. Hocker, Pers. Dir.; J. A. Anderson, Chief Engr.
PRODUCTS: Aircraft armament; Cowlings; Switches; Misc. electrical equipment; Engine mounts; Hose clamps and hose fittings; Instruments; Machine tools; Misc. hardware; Misc. engine equipment; Propellers and propeller parts; Shims; Stampings; Sub-assemblies; Tools; Miscellaneous.

THE TIMKEN ROLLER BEARING CO., Canton, O.
PERSONNEL: W. A. Umstattd, Pres.; L. M. Klinedinst, V. Pres.; R. C. Brower, Treas.; D. A. Bessmer, Asst. Pur. Dir.; R. P. Kelley, Adv. Mgr.
PRODUCTS: Bearings; Tubing.

TIMM AIRCRAFT CORP., 117 W. Ninth St., Los Angeles, Calif.
PERSONNEL: O. W. Timm, Pres. & Chief Engr.; J. P. Davies, V. Pres. & Sales Mgr.; G. Shrader, Secy. & Treas.; C. R. Howe, Dir. Pur.; W. Silsby, Pers. Dir. & Pub. Dir.
PRODUCTS: Ammunition boxes and counters; Collector rings, cowls, streamlines; Covers; Cowlings; Cylinder deflectors, baffles, brackets; Fittings; Panels; Aluminum, magnesium and steel parts; Stampings; Sub-assemblies; Tail wheel assemblies; Tanks.

TINGLEY RELIANCE RUBBER CORP., 903 Ross St., Rahway, N. J.
PERSONNEL: W. McCollum, Pres. & Sales Mgr.; P. N. Furber, V. Pres.; D. Armstrong, Secy.; W. Rand, Treas., Gen. Mgr. & Pur. Agt.; H. Peins, Chief Engr.
PRODUCTS: Rubber and neoprene bushings and gaskets; Oil seals; Rubber and synthetic parts; Miscellaneous.

TINNERMAN PRODUCTS, INC., 2038 Fulton Rd., Cleveland, O.
PERSONNEL: A. H. Tinnerman, Pres. & Treas.; G. A. Tinnerman, V. Pres. & Gen. Mgr.; A. T. Buttriss, Secy.; J. M. Stofer, Sales Mgr.; G. J. Schad, Pur. Agt.; W. M. Buttriss, Pub. Dir.
PRODUCTS: Clamps; Fasteners.

TITANINE, INC., Morris & Elmwood Aves., Union, N. J.
PERSONNEL: E. G. Davis, Pres., Treas. & Gen. Mgr.; T. A. J. Ward, V. Pres., Secy. & Pur. Agt.; W. Bagley, Sales Mgr.
PRODUCTS: Paints, varnishes and finishes.

TITEFLEX METAL HOSE CO., 500 Frelinghuysen Ave., Newark, N. J.
PERSONNEL: E. E. Husted, Pres. & Gen. Mgr.; E. A. Robertson, V. Pres.; P. L. Proctor, V. Pres., Secy. & Treas.; V. C. Bonardel, Contract Mgr.; C. E. Lane, Pur. Agt.; R. B. Breder, Pers. Dir.; E. W. Allen, Jr., Pub. Dir.; D. Ingalls, Chief Engr.
PRODUCTS: Radio and ignition shielding.

THE TOBRIN TOOL CO., Plantsville, Conn.
PERSONNEL: W. F. Thomson, Pres. & Treas.; D. S. Blakeslee, V. Pres.; R. H. Brannin, Secy.; E. L. Barlow, Sales Mgr.
PRODUCTS: Screw-drivers.

DOUBLE SPRING TENSION LOCK

Speed Nut System

PATENTED

conquers vibration loosening

High-frequency vibration never made a nut hold firmer. Speed Nuts are made to grip the bolt or screw with a double spring-tension lock to absorb vibration and prevent loosening.

The harder the jam, strain or pull to separate two assembled parts, the firmer the Speed Nut prongs grip into the roots of the threads. That is what makes them about 4 times tougher than other lock nuts.

Over 1000 shapes and sizes have already been put into production. Every Speed Nut or Speed Clip has saved from 50% to over 80% in assembly time and weight. Already this has saved countless man-hours time and tons of material. Our Engineering Dept. will gladly assist you on the proper approved locations where Speed Nuts give maximum engineering advantages.

TINNERMAN PRODUCTS INC., ★ 2090 FULTON RD., CLEVELAND, O.

IN CANADA
Wallace Barnes Co., Ltd., Hamilton, Ontario

IN ENGLAND
Simmonds Aerocessories, Ltd., London

THE FASTEST THING IN FASTENINGS!

TOLEDO SCALE CO.,
Telegraph Rd., Toledo, O.
PERSONNEL: H. D. Bennett, Pres.; W. A. Fink, V. Pres. & Treas.; G. R. Bennett, V. Pres. & Gen. Mgr.; C. O. Marshall, Secy.; M. E. Holmes, Sales Mgr.; G. S. Yost, Pur. Agt.; R. H. Herron, Pers. Dir.; L. Ellingwood, Pub. Dir.; F. W. Gilchrist, Chief Engr.
PRODUCTS: Fuel and oil consumption testing equipment; Dynamometer scales; Airplane weighing scales; Measuring, testing and classifying devices; Dial scales and weight printing scales.

THE TOLEDO STANDARD COMMUTATOR CO., 2242 Smead Ave., Toledo, O.
PERSONNEL: E. D. Moon, Pres.; W. D. Moon, V. Pres.; H. R. Moon, Secy. & Treas.; A. G. Ollivier, Gen. Mgr. & Chief Engr.; F. E. Rigney, Pur. Agt.
PRODUCTS: Controls; Dynamotors; Auxiliary motors; Generators; Misc. electrical equipment; Landing gears; Propellers and propeller parts; Pumps; Starters.

TRANSUE & WILLIAMS STEEL FORGING CORP., Alliance, O.
PERSONNEL: J. R. Gorman, Pres.; J. C. Redmond, V. Pres.; H. C. Senour, Secy. & Treas.; E. M. Cook, Sales Mgr.; H. C. Martin, Pur. Agt.; G. Williams, Chief Engr.
PRODUCTS: Castings and forgings; Stampings.

TRIPLETT ELECTRICAL INSTRUMENT CO., Harmon Rd., Bluffton, O.
PERSONNEL: R. L. Triplett, Pres. & Treas.; C. A. Biery, Secy.; N. A. Triplett, Gen. Mgr. & Sales Mgr.; W. H. Wirries, Pur. Agt.; A. R. Baker, Pers. Dir. &. Pub. Dir.; F. J. Lingel, Chief Engr.
PRODUCTS: Electrical measuring instruments; Radio testing equipment.

TRIPPE MANUFACTURING CO.,
564 W. Adams St., Chicago, Ill.
PERSONNEL: G. Trippe, Pres.; S. H. Moss, Secy.; J. B. Namest, Pur. Agt.; G. W. Otto, Chief Engr.
PRODUCTS: Landing and navigation lights.

TROYER AIRCRAFT,
742 Bridge St., Grand Rapids, Mich.
PERSONNEL: K. R. Troyer, Pres. & Chief Engr.
PRODUCTS: Control sticks; Floats, skiis; Propellers and propeller parts.

TUBE-TURNS, INC.,
224 E. Broadway, Louisville, Ky.
PERSONNEL: W. H. Girdler, Sr., Pres.; R. E. Fritsch, V. Pres.; C. J. Hodapp, V. Pres. & Gen. Mgr.; O. O. Funk, Secy. & Treas.; R. J. Dilger, Pur. Agt.; W. H. Girdler, Jr., Pers. Dir. & Pub. Dir.; W. J. Burton, Chief Engr.
PRODUCTS: Cylinder forgings; Pistons and heads forgings; Landing gears; Misc. engine equipment; Aluminum and steel parts.

TUBING SEAL-CAP, INC.,
215 W. Seventh St., Los Angeles, Calif.
PERSONNEL: R. A. Livingston, Pres.; F. W. Livermont, V. Pres. & Chief Engr.; R. L. Ames, V. Pres. & Sales Mgr.; L. Cole, Secy.; C. Rowe, Asst. Treas.
PRODUCTS: Hydraulic controls and assemblies; Tubing protectors.

TUBULAR RIVET AND STUD CO.,
Weston Ave., Wollaston, Mass.
PERSONNEL: L. P. Worcester, V. Pres.; M. F. Pray, Gen. Sales Mgr.
PRODUCTS: Fasteners; Machine tools; Aluminum parts; Stampings; Rivets; Riveting machines.

TUCKER AVIATION CO.,
110 N. Park St., Ypsilanti, Mich.
PERSONNEL: P. T. Tucker, Pres. & Sales Mgr.; W. M. Harris, Secy.; M. R. Diggs, Treas.; E. E. Schaffer, Gen. Mgr.; F. W. Glatt, Pur. Agt.; C. N. Hazlewood, Chief Engr.
PRODUCTS: Aircraft armament.

TURBO ENGINEERING CORP.,
Hancock & Lalor Sts., Trenton, N. J.
PERSONNEL: G. E. Besler, Pres.; R. Birmann, V. Pres., Secy. & Chief Engr.; L. S. Rice, Treas.; P. Doxey, Works Mgr.; E. J. Schwarz, Pur. Agt.; F. Jarrell, Pers. Dir.
PRODUCTS: Engine superchargers.

TURCO PRODUCTS, INC.,
6135 S. Central Ave., Los Angeles, Calif.
PERSONNEL: S. G. Thornbury, Pres. & Treas.; R. Sanders, V. Pres., Gen. Mgr. & Sales Mgr.; E. S. Harrington, Secy.; J. C. Walker, Pur. Agt.; D. M. LeVasseur, Pers. Dir.; S. E. Goldsmith, Pub. Dir.; C. A. Stine, Chief Engr.
PRODUCTS: Cleaners and cleaning compounds.

TUTHILL SPRING CO.,
760 Polk St., Chicago, Ill.
PERSONNEL: H. T. Moore, Pres.; W. S. Van Bergen, V. Pres.; J. H. Schmidt, Secy.; O. C. Nuss, Treas.
PRODUCTS: Steel parts; Spring steel tail skids.

TWIN CITY TOOL CO., 2520 Marshall St., N. E., Minneapolis, Minn.
PERSONNEL: S. J. Leba, Pres. & Gen. Mgr.; J. J. Leba, Secy., Treas. & Chief Engr.
PRODUCTS: Basic materials and fabrications; Cameras; Cylinder deflectors, baffles, brackets; Switches; Terminals; Gaskets; Aluminum, cork, felt, fibre, leather, plastic and steels parts; Shims; Stampings.

TYSON ROLLER BEARING CORP.,
Massillon, O.
PERSONNEL: R. H. Maxson, Pres. & Gen. Mgr.; E. R. Earnest, V. Pres. & Secy.; J. K. Colgate, Treas.; H. J. Deal, Sales Mgr.; L. W. Weddell, Pub. Dir.; W. Rastetter, Chief Engr.
PRODUCTS: Brackets; Engine mounts; Aluminum and steel parts.

U

UNIFORM HOOD LACE CO.,
1609 College Ave., Indianapolis, Ind.
PERSONNEL: J. L. Anthony, Pres. & Gen. Mgr.; L. I. Mitchell, V. Pres.; B. J. Artman, Secy. & Treas.; J. R. Brown, Sales Mgr.; O. A. Morrison, Pur. Agt.; R. Williamson, Pers. Dir.; H. N. Noel, Pub. Dir.; C. Jacks, Chief Engr.
PRODUCTS: Webbing.

UNION AIRCRAFT PRODUCTS CORP.,
380 Second Ave., New York, N. Y.
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PRODUCTS: Fittings; Aluminum parts; Radio and ignition shielding; Stampings.

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2929 Santa Fe Ave., Los Angeles, Calif.
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PRODUCTS: Machine tools.

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PRODUCTS: Instruments.

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PRODUCTS: Machine tools.

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V

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PRODUCTS: Aircraft armament; Airport equipment; Ammunition boxes and counters; Basic materials and fabrications; Bomb racks; Bushings; Clamps; Collector rings, cowls, streamlines; Controls; Control sticks and wheels; Covers; Cowlings; Cylinder deflectors, baffles, brackets; Terminals; Misc. electrical equipment; Engine mounts; Exhaust manifolds; Fasteners; Filters and strainers; Fire extinguishers; Fittings; Floats, skiis; Gaskets; Heaters; Hose clamps and hose fittings; Hydraulic controls and assemblies; Manifolds; Misc. hardware; Misc. engine equipment; Panels; Seats; Radio and ignition shielding; Shims; Sub-assemblies; Gas and oil tanks; Tools; Tubing.

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PRODUCTS: Hydraulic controls and assemblies; Pumps; Control valves.

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PRODUCTS: Ammunition boxes and counters; Basic materials and fabrications; Bomb racks; Fittings; Misc. hardware; Panels; Plastic and plywood parts; Seats; Sub-assemblies; Tanks.

WEEMS SYSTEM OF NAVIGATION, Randall House, Annapolis, Md.
PERSONNEL: M. T. Weems, Pres.; A. A. Illyne, Exec. Secy.; F. D. Johnson, H. R. Rich, Secys.
PRODUCTS: Navigation books and equipment.

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PRODUCTS: Manifolds.

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THE WELLMAN BRONZE & ALUMINUM CO., 2525 E. 93rd St., Cleveland, O.
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PRODUCTS: Castings; Aluminum and magnesium parts; Patterns.

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PRODUCTS: Electronic controls; Engine mounts; Landing gears; Radios; Stampings.

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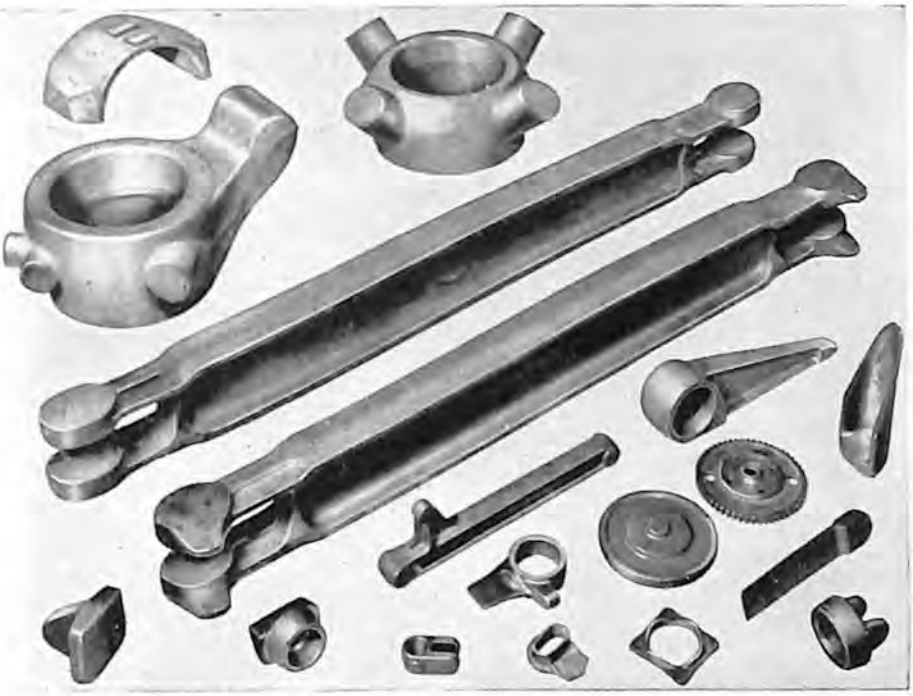

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Naval Affairs

David I. Walsh	(D)	Allen J. Ellender	(D)
Millard E. Tydings	(D)	Scott W. Lucas	(D)
Ellison D. Smith	(D)	James J. Davis	(R)
Richard B. Russell	(D)	Hiram W. Johnson	(R)
Homer T. Bone	(D)	W. Warren Barbour	(R)
Harry Flood Byrd	(D)	Alexander Wiley	(R)
Peter G. Gerry	(D)	Ralph O. Brewster	(R)
Charles O. Andrews	(D)	Charles W. Tobey	(R)
Guy M. Gillette	(D)	Raymond E. Willis	(R)

Post Offices and Post Roads

Kenneth McKellar	(D)	John L. McClellan	(D)
Carl Hayden	(D)	Clyde M. Reed	(R)
Josiah W. Bailey	(D)	William Langer	(R)
Dennis Chavez	(D)	C. Douglass Buck	(R)
Allen J. Ellender	(D)	Harlan J. Bushfield	(R)
James M. Mead	(D)	Homer Ferguson	(R)
Sheridan Downey	(D)	E. H. Moore	(R)
W. Lee O'Daniel	(D)	Edward V. Robertson	(R)
James G. Scrugham	(D)	George A. Wilson	(R)
James O. Eastland	(D)		

CONGRESSIONAL COMMITTEES INTERESTED IN AVIATION (Continued)

House of Representatives

Appropriations

Clarence Cannon	(D)	Jamie L. Whitten	(D)
Clifton A. Woodrum	(D)	Thomas J. O'Brien	(D)
Louis Ludlow	(D)	James M. Curley	(D)
Malcolm C. Tarver	(D)	John Taber	(R)
Jed Johnson	(D)	Richard B. Wigglesworth	(R)
J. Buell Snyder	(D)	William P. Lambertson	(R)
Emmet O'Neal	(D)	D. Lane Powers	(R)
James M. Fitzpatrick	(D)	J. William Ditter	(R)
Louis C. Rabaut	(D)	Albert E. Carter	(R)
Joe Starnes	(D)	Charles A. Plumley	(R)
John H. Kerr	(D)	Everett M. Dirksen	(R)
George H. Mahon	(D)	Albert J. Engel	(R)
Harry R. Sheppard	(D)	Karl Stefan	(R)
Butler B. Hare	(D)	Francis Case	(R)
Albert Thomas	(D)	Frank B. Keefe	(R)
Joe Hendricks	(D)	Noble J. Johnson	(R)
Michael J. Kirwan	(D)	Robert F. Jones	(R)
John M. Coffee	(D)	Ben F. Jensen	(R)
W. F. Norrell	(D)	H. Carl Andersen	(R)
Albert Gore	(D)	Henry C. Dworshak	(R)
Elmer H. Wene	(D)	Walter C. Ploeser	(R)
Clinton P. Anderson	(D)		

Interstate and Foreign Commerce

Clarence F. Lea	(D)	Richard F. Harless	(D)
Robert Crosser	(D)	John P. Newsome	(D)
Alfred L. Bulwinkle	(D)	Charles A. Wolverton	(R)
Virgil Chapman	(D)	Pehr G. Holmes	(R)
Lyle H. Boren	(D)	B. Carroll Reece	(R)
Martin J. Kennedy	(D)	Charles A. Halleck	(R)
Donald L. O'Toole	(D)	Carl Hinshaw	(R)
Lindley Beckworth	(D)	Clarence J. Brown	(R)
Thomas D'Alesandro, Jr.	(D)	Evan Howell	(R)
Francis J. Myers	(D)	Harve Tibbott	(R)
J. Percy Priest	(D)	Leonard W. Hall	(R)
Oren Harris	(D)	Thomas D. Winter	(R)
George G. Sadowski	(D)	Joseph P. O'Hara	(R)

Military Affairs

Andrew J. May	(D)	Bolivar Pagan	(D)
R. Ewing Thomason	(D)	Walter G. Andrews	(R)
Matthew J. Merritt	(D)	Dewey Short	(R)
John M. Costello	(D)	Leslie C. Arends	(R)
Overton Brooks	(D)	Charles R. Clason	(R)
John J. Sparkman	(D)	J. Parnell Thomas	(R)
Paul J. Kilday	(D)	Paul W. Shafer	(R)
Carl T. Durham	(D)	Thomas E. Martin	(R)
Clifford Davis	(D)	Charles H. Elston	(R)
E. C. Gathings	(D)	Forest A. Harness	(R)
John Edward Sheridan	(D)	Ivor D. Fenton	(R)
Robert L. F. Sikes	(D)	J. Leroy Johnson	(R)
Philip J. Philbin	(D)	Clare Boothe Luce	(R)
Paul Stewart	(D)	Joseph R. Farrington	(R)
Anthony J. Dimond	(D)		

Naval Affairs

Carl Vinson	(D)	Anthony J. Dimond	(D)
Patrick H. Drewry	(D)	Bolivar Pagan	(D)
Leonard W. Schuetz	(D)	Melvin J. Maas	(R)
Warren G. Magnuson	(D)	James W. Mott	(R)

CONGRESSIONAL COMMITTEES INTERESTED IN AVIATION
(Continued)

Naval Affairs (Continued)

Lyndon B. Johnson	(D)	W. Sterling Cole	(R)
Michael J. Bradley	(D)	George J. Bates	(R)
Beverly M. Vincent	(D)	William E. Hess	(R)
Ed. V. Izac	(D)	John Z. Anderson	(R)
Lansdale G. Sasscer	(D)	James Wolfenden	(R)
James J. Heffernan	(D)	William W. Blackney	(R)
L. Mendell Rivers	(D)	William H. Wheat	(R)
F. Edward Hebert	(D)	Ward Johnson	(R)
John E. Fogarty	(D)	Robert A. Grant	(R)
Winder R. Harris	(D)	Margaret Chase Smith	(R)
Cameron Morrison	(D)	Joseph R. Farrington	(R)

Post Offices and Post Roads

Thomas G. Burch	(D)	Fred A. Hartley, Jr.	(R)
B. Frank Whelchel	(D)	Noah M. Mason	(R)
David J. Ward	(D)	John Jennings, Jr.	(R)
George D. O'Brien	(D)	Fred J. Douglas	(R)
Samuel A. Weiss	(D)	John C. Butler	(R)
James H. Fay	(D)	Thomas Byron Miller	(R)
Charles E. McKenzie	(D)	William J. Miller	(R)
Chet Holifield	(D)	Chester E. Merrow	(R)
Tom Murray	(D)	William C. Cole	(R)
Emory H. Price	(D)	Ed Rowe	(R)
Ray J. Madden	(D)	Charles B. Hoeven	(R)
Harold C. Hagen	(F.L.)		

U. S. FOREST SERVICE
DEPARTMENT OF AGRICULTURE

Washington, D. C.

Claude R. Wickard, Secretary of Agriculture

Chief of the Forest Service: Lyle F. Watts

Northern Region	Headquarters, Missoula, Mont.
	Evan W. Kelley, Regional Forester
Rocky Mountain Region	Headquarters, Denver, Colo.
	Allen S. Peck, Regional Forester
Southwestern Region	Headquarters, Albuquerque, N. M.
	Frank C. W. Pooler, Regional Forester
Intermountain Region	Headquarters, Ogden, Utah
	C. N. Woods, Regional Forester
California Region	Headquarters, San Francisco, Calif.
	S. B. Show, Regional Forester
North Pacific Region	Headquarters, Portland, Ore.
	(Acting) Horace J. Andrews, Regional Forester
Eastern Region	Headquarters, Philadelphia, Pa.
	R. M. Evans, Regional Forester
Southern Region	Headquarters, Atlanta, Ga.
	Joseph C. Kircher, Regional Forester
North Central Region	Headquarters, Milwaukee, Wis.
	Jay H. Price, Regional Forester
Alaska Region	Headquarters, Juneau, Alaska
	B. Frank Heintzleman, Regional Forester

Flying Facts and Figures

SUMMARY OF AIR CARRIER OPERATIONS

Air Lines in the United States

Corrected by U. S. Civil Aeronautics Administration
Calendar Years

Year	*Operators*	*Planes in Service*	*Miles Flown*	*Total Passengers Carried*	*Total Passenger Miles Flown*	*Express Carried (pounds)*	*Mail Pound Miles Flown*[1]
1926	11	([2])	4,258,771	5,782	([2])	3,555	([3])
1927	16	128	5,779,863	8,661	([2])	45,859	([3])
1928	31	268	10,400,239	47,840	([2])	210,404	([3])
1929	34	442	22,380,020	159,751	([2])	249,634	([3])
1930	38	497	31,992,634	374,935	84,014,572	359,523	([3])
1931	35	490	42,755,417	469,981	106,442,375	788,059	6,280,409,884
1932	29	456	45,606,354	474,279	127,038,798	1,033,970	5,402,249,740
1933	24	408	48,771,553	493,141	173,492,119	1,510,215	5,135,897,406
1934	22	417	40,955,396	461,743	187,858,629	2,133,191	4,922,822,780
1935	23	356	55,380,353	746,946	313,905,508	3,822,397	8,265,416,188
1936	21	272	63,777,226	1,020,931	427,740,253	6,958,777	11,482,872,622
1937	17	282	66,071,507	1,102,707	476,603,165	7,127,369	13,396,460,117
1938	18	253	69,668,827	1,343,427	557,719,268	7,335,967	14,845,719,671
1939	17	265	82,571,523	1,876,051	749,787,096	9,514,299	17,170,021,595
1940	16	358	108,800,436	2,959,480	1,147,444,048	12,506,176	20,071,275,685
1941	17	359	133,022,679	4,060,545	1,491,734,671	19,209,671	25,800,809,091
1942	16	176	110,102,860	3,532,950	1,474,783,656	40,101,657	39,221,554,805[4]

[1] Mail pound miles flown are for domestic services and Hawaiian Airlines, Ltd., which company holds a domestic air mail contract.
[2] Not available prior to 1930.
[3] Air mail pound miles have been computed by the Post Office Department commencing with January, 1931, and are not available prior to that date.
[4] Estimated.

STATUS OF AIR CARRIER OPERATIONS

Compiled by U. S. Civil Aeronautics Administration

January 1, 1943

Route Miles Operated		36,442
With United States Mail	35,641	
With Passengers	35,168	
With Express	36,442	
Airplane Miles Scheduled Daily (Average)		111,026
With United States Mail	109,424	
With Passengers	108,768	
With Express	111,026	
Number of Services in Operation		111
With United States Mail	104	
With Passengers	98	
With Express	111	
Number of Domestic Air Carriers		16

MONTHLY AIR CARRIER OPERATIONS

Domestic Air Lines in the U. S.

Compiled by U. S. Civil Aeronautics Administration

1940	*Miles Flown*	*Passengers*	*Passenger Miles*	*Mail*[1] *Pound-Miles*	*Express Pounds*
January	7,271,154	150,102	61,355,485	1,534,408,814	817,633
February	6,672,914	139,816	58,937,141	1,499,673,303	697,385
March	7,930,038	195,062	80,686,124	1,680,965,576	894,581
April	8,331,759	224,852	88,061,683	1,627,442,686	871,317
May	9,266,687	258,451	100,044,047	1,682,136,183	941,810
June	9,549,109	286,272	110,839,615	1,597,006,626	981,884
July	10,120,569	296,539	112,376,882	1,633,804,555	1,056,590
August	10,223,149	320,990	121,602,029	1,718,622,237	1,201,990
September	10,084,445	310,293	118,533,626	1,673,399,938	1,184,249
October	10,635,210	334,386	125,924,103	1,866,008,205	1,329,843
November	9,573,378	239,858	90,697,083	1,667,748,879	1,205,261
December	9,142,024	202,859	78,387,130	1,890,058,683	1,323,615
Total	108,800,436	2,959,480	1,147,444,948	20,071,275,685	12,506,176
1941					
January	8,946,038	197,854	78,339,567	1,761,226,024	1,116,025
February	8,842,795	218,163	84,639,781	1,813,348,177	1,110,098
March	10,017,862	245,924	96,661,662	2,018,484,815	1,215,671
April	10,606,486	308,644	114,748,987	2,061,880,065	1,353,437
May	11,738,282	363,954	133,979,048	2,105,826,655	1,464,029
June	11,537,883	380,990	141,905,987	2,083,039,596	1,545,248
July	12,178,479	398,434	147,418,618	2,212,783,024	1,764,372
August	12,471,701	447,316	158,068,167	2,255,297,699	1,842,858
September	12,127,483	455,647	158,151,061	2,216,527,714	1,962,284
October	12,200,352	420,393	150,919,895	2,366,448,757	1,760,770
November	11,500,667	324,546	115,825,169	2,230,666,784	1,689,093
December	10,854,651	298,680	111,076,729	2,675,279,781	2,385,786
Total	133,022,679	4,060,545	1,491,734,671	25,800,809,091	19,209,671
1942					
January	11,126,776	300,900	113,134,990	2,593,528,302	2,531,162
February	9,978,889	286,435	104,219,667	2,552,948,641	2,169,543
March	11,352,252	371,398	139,060,782	3,018,933,335	2,560,255
April	11,339,905	428,153	158,217,575	2,995,738,918	2,883,891
May	10,846,781	369,776	144,947,151	3,156,110,855	3,075,985
June	7,353,270	240,916	109,253,326	3,129,665,458	3,096,877
July	8,079,138	262,715	116,104,036	3,442,923,698	3,533,980
August	8,451,428	283,145	127,393,405	3,661,421,999	3,926,991
September	8,098,555	273,022	125,327,381	3,870,283,599	4,374,884
October	8,407,566	273,162	128,328,838	3,600,000,000[2]	4,340,553
November	7,776,768	240,705	112,488,033	3,600,000,000[2]	3,973,689
December	7,291,532	202,623	96,308,472	3,600,000,000[2]	3,633,847
Total	110,102,860	3,532,950	1,474,783,656	39,221,554,805[2]	40,101,657

[1] Includes Hawaiian Airlines, Ltd.
[2] Estimated.

UNITED STATES AIR TRANSPORT ROUTES

Compiled by U. S. Civil Aeronautics Administration

January 1, 1943

Routes	Airway miles	Schedule (round trips)	Daily mileage	Operator
DOMESTIC				
Pittsburgh-Huntington via Elkins and Charleston, W. Va.	313	1 time daily	626	All American Aviation, Inc.
Pittsburgh-Philadelphia	371	1 time daily	742	"
Pittsburgh-Huntington via Parkersburg	313	1 time daily	626	"
Pittsburgh-Williamsport	202	1 time daily	404	"
Pittsburgh-Jamestown	178	1 time daily	356	"
New York-Washington	214	3 times daily	1,284	American Airlines, Inc.
New York-Los Angeles via Washington, Nashville, Memphis and Dallas	2,705	3 times daily	16,230	"
New York-Los Angeles via Washington, Nashville, Little Rock, Dallas and Big Spring	2,736	1 time daily	5,472	
New York-Los Angeles via Washington, Nashville and Dallas or Fort Worth	2,704	2 times daily	10,816	"
Dallas-Los Angeles	1,306	1 time daily	2,612	"
New York-Chicago via Buffalo and Detroit	760	6 times daily	9,120	"
New York-Chicago via Buffalo and South Bend	763	1 time daily	1,526	"
New York-Buffalo via Syracuse	328	1 time daily	656	"
New York-Cleveland via Syracuse and Buffalo	521	1 time daily	1,042	"
Boston-New York via Hartford and Providence	204	5 times daily	2,040	"
Boston-New York via Hartford	186	3 times daily	1,116	"
Boston-New York via Providence	192	2 times daily	768	"
Boston-New York (direct)	184	3 times daily	1,104	"
Washington-Chicago via Cincinnati	653	3 times daily	3,918	"
Washington-Chicago via Elkins, Huntington and Cincinnati	683	1 time daily	1,366	"
Cleveland-Nashville via Cincinnati	488	2 times daily	1,952	"
Detroit-Chicago (direct)	247	1 time daily	494	"
Detroit-Chicago via South Bend	250	1 time daily	500	"
Chicago-Fort Worth via St. Louis and Oklahoma City	926	2 times daily	3,704	"
Dallas-Fort Worth	30	4 times daily	240	"
El Paso-Los Angeles	743	1 time daily	1,486	"
Fort Worth-Laredo	394	1 time daily	788	"
Chicago-Brownsville via Kansas City, Dallas and San Antonio	1,461	1 time daily	2,922	Braniff Airways, Inc.
Chicago-San Antonio via Kansas City and Dallas	1,207	3 times daily	7,242	"
Dallas-Houston (direct)	241	2 times daily	964	"
Houston-Corpus Christi	185	1 time daily	370	"
Amarillo-Dallas	335	1 time daily	670	"
Chicago-New Orleans	859	2 times daily	3,436	Chicago & Southern Airlines
Chicago-Houston	1,176	1 time daily	2,352	"
Denver-El Paso	579	1 time daily	1,158	Continental Air Lines, Inc.
Denver-El Paso via Roswell and Carlsbad	739	1 time daily	1,478	"
Denver-Tulsa	640	1 time daily	1,280	"
Wichita-Tulsa	131	1 time daily	262	"
Savannah-Fort Worth via Atlanta	976	1 time daily	1,952	Delta Air Corporation
Charleston-Fort Worth via Atlanta	1,084	1 time daily	2,168	"

United States Air Transport Routes (January 1, 1943)—Continued

Routes	Airway miles	Schedule (round trips)	Daily mileage	Operator
Atlanta-Cincinnati via Knoxville	383	2 times daily	1,532	Delta Air Corporation
New York-Miami via Orlando	1,213	1 time daily	2,426	Eastern Air Lines, Inc.
New York-Miami via West Palm Beach	1,197	4 times daily	9,576	"
New York-Miami via Washington and Jacksonville	1,197	1 time daily	2,394	"
New York-Brownsville via Atlanta, and New Orleans	1,856	1 time daily	3,712	"
New York-San Antonio via Washington, Atlanta and New Orleans	1,809	1 time daily	3,618	"
New York-Houston via Washington, Atlanta, and New Orleans	1,616	1 time daily	3,212	"
New York-Birmingham via Washington and Atlanta	927	1 time daily	1,854	"
New York-Atlanta via Washington	775	1 time daily	1,550	"
Chicago-Miami via Nashville, Jacksonville and Orlando	1,267	2 times daily	5,068	"
Chicago-Miami via Nashville and Jacksonville	1,254	1 time daily	2,508	"
Atlanta-Tampa via Tallahassee	432	1 time daily	864	"
Denver-Great Falls	573	1 time daily	1,146	Inland Airlines, Inc.
Cheyenne-Denver	96	1 time daily	192	"
Cheyenne-Huron	559	1 time daily	1,118	"
Minneapolis-Kansas City	680	1 time daily	1,360	Mid - Continent Airlines, Inc.
Minneapolis-St. Louis via Des Moines	519	1 time daily	1,038	"
Kansas City-Tulsa	215	1 time daily	430	"
Omaha-Kansas City	167	1 time daily	334	"
Des Moines-Kansas City	182	1 time daily	364	"
Jacksonville-Miami via Orlando and Tampa	385	2 times daily	1,540	National Airlines, Inc.
New Orleans-Jacksonville	510	3 times daily	3,060	"
Boston-Bangor	217	2 times daily	868	Northeast Airlines, Inc.
Boston-Caribou	383	1 time daily	766	"
Chicago-Seattle via Minneapolis and Helena	1,811	1 time daily	3,622	Northwest Airlines, Inc.
Chicago-Seattle via Minneapolis and Butte	1,828	1 time daily	3,656	"
Chicago-Minneapolis (direct)	337	1 time daily	714	"
Chicago-Minneapolis via Milwaukee	384	1 time daily	768	"
Chicago-Fargo	607	1 time daily	1,214	"
Minneapolis-Duluth	145	1 time daily	290	"
Norfolk-Detroit via Pittsburgh	547	3 times daily	3,282	Pennsylvania-Central Airlines
Washington-Detroit	402	2 times daily	1,608	"
Washington-Pittsburgh	185	1 time daily	370	"
Pittsburgh-Buffalo	215	2 times daily	860	"
Detroit-Milwaukee via Muskegon	260	1 time daily	520	"
Pittsburgh-Knoxville	473	1 time daily	946	"
Knoxville-Birmingham	222	1 time daily	444	"
New York-Los Angeles via Pittsburgh, St. Louis and Kansas City	2,541	2 times daily	10,164	Transcontinental & Western Air
New York-Los Angeles via Pittsburgh, Chicago, Kansas City and Windslow	2,563	3 times daily	15,378	"
New York-Los Angeles via Pittsburgh, Kansas City and Boulder City	2,573	1 time daily	5,146	"
New York-Kansas City via Philadelphia, Pittsburgh and Cincinnati	1,182	1 time daily	2,364	"
New York-Kansas City via Pittsburgh and St. Louis	1,119	2 times daily	4,476	"

United States Air Transport Routes (January 1, 1943) -Continued

Routes	Airway miles	Schedule (round trips)	Daily mileage	Operator
New York-Chicago via Philadelphia, Dayton, Columbus and Fort Wayne	819	1 time daily	1,638	Transcontinental & Western Air
New York-Chicago via Pittsburgh	724	1 time daily	1,448	"
Boulder City-San Francisco	446	1 time daily	892	"
Detroit-Cincinnati	241	2 times daily	964	"
New York-Chicago via Cleveland	738	3 times daily	4,428	United Air Lines, Inc.
New York-Chicago via Philadelphia	757	2 times daily	3,028	"
New York-Chicago via Allentown and Toledo	738	1 time daily	1,476	"
New York-Chicago via Youngstown	738	1 time daily	1,476	"
New York-Chicago via Akron	737	1 time daily	1,474	"
Chicago-San Francisco via Omaha and Salt Lake City	1,876	2 times daily	7,504	"
Chicago-San Francisco via Omaha and Denver	1,899	1 time daily	3,798	"
Chicago-San Francisco via Omaha and Cheyenne	1,876	1 time daily	3,752	"
Chicago-San Francisco via Omaha, Denver and Reno	1,899	1 time daily	3,798	"
Chicago-Seattle via Cheyenne and Boise	2,085	1 time daily	4,170	"
Chicago-Seattle via Denver and Salt Lake City	2,108	1 time daily	4,218	"
Chicago-Salt Lake City	1,294	1 time daily	2,588	"
Cheyenne-Denver	96	2 times daily	384	"
Seattle-Los Angeles via Medford and San Francisco	1,008	1 time daily	2,016	"
Seattle-Los Angeles via Sacramento and San Francisco	1,031	2 times daily	4,124	"
Seattle-Los Angeles via Medford, San Francisco and Bakersfield	1,044	1 time daily	2,088	"
San Francisco-Los Angeles (direct)	327	3 times daily	1,962	"
San Francisco-Los Angeles via Del Monte and Santa Barbara	352	1 time daily	704	"
San Francisco-Los Angeles via Fresno and Bakersfield	358	1 time daily	716	"
Lethbridge-Salt Lake City via Great Falls	646	1 time daily	1,292	Western Air Lines, Inc.
Salt Lake City-Los Angeles	590	3 times daily	3,540	"
Los Angeles-San Diego	123	2 times daily	492	"
Total Domestic Routes	36,442		111,026	

U. S. DOMESTIC AIR CARRIER OPERATIONS

And Accident Statistics for the Calendar Years 1940, 1941, and 1942

	1940	1941	1942
Miles Flown	108,800,436	133,022,679	110,102,860
Total Passengers Carried	2,959,480	4,060,545	3,532,950
Total Passenger Miles	1,147,444,948	1,491,734,671	1,474,783,656
Fatal Accidents	3	4	5
Fatal Passenger Accidents	3	4	5
Passenger Fatalities	35	35	55
Crew Fatalities	10	9	16
Miles Flown per Fatal Accident	36,266,812	33,255,670	22,020,572
Miles Flown per Fatal Passenger Accident	36,266,812	33,255,670	22,020,572
Passenger Miles Flown per Passenger Fatality	32,784,141	42,620,991	26,814,248
Miles Flown per Crew Fatality	10,880,044	14,780,298	6,881,429

CIVIL AERONAUTICS ADMINISTRATION FUNDS

APPROPRIATIONS FOR FISCAL YEARS 1940, 1941 AND 1942

	1940	1941	1942
General administration	.....	$ 1,078,200	$ 990,000
Maintenance of air navigation facilities	.....	11,896,550	16,323,720
Technical development	.....	557,000	520,000
Technical development 1942-1943	.....	.....	223,702
Enforcement of safety regulations	.....	2,484,453	2,906,000
Establishment of air navigation facilities	$ 7,000,000	7,356,280	12,036,000
Establishment of air navigation facilities 1942-1943	.....	.....	9,732,290
Civilian Pilot Training	4,000,000	36,814,504	25,000,000
Maintenance and operation, Washington National Airport	.....	255,650	377,645
Development of landing areas	.....	40,000,000	100,477,750
Development of landing areas 1942-1943	.....	.....	59,115,300
Construction of hangars	.....	2,700,000	(1)
Emergency relief, Commerce, administrative expenses	250,000	175,000	(2)
Printing and binding, Commerce	72,900	72,900	(2)
Salaries and expenses, Civil Aeronautics Authority	14,144,065	.....	.....
Total	$25,466,965	$103,390,537	$227,702,407

[1] 1941 funds carried over to 1942.
[2] Funds to be allotted from Commerce Department Budget.

U. S. AIR MAIL SERVICE

From report of the Postmaster General for fiscal year 1942

Mileage and cost of service on Government-operated and private-carrier-operated domestic air mail routes and amount of annual appropriation, for the fiscal years 1918 to 1942, inclusive.

Fiscal Year	*Revenue Miles Flown*	*Cost of Service*	*Average Cost per Mile*	*Appropriation*
Government operation:				
1918	16,009	$13,604.00	$ .850	$100,000
1919	160,066	717,177.00	4.481	100,000
1920	549,244	1,264,495.00	2.302	850,000
1921	1,554,985	2,653,882.00	1.707	1,375,000
1922	1,537,927	1,418,146.00	.922	1,425,000
1923	1,590,637	1,897,151.00	1.193	1,900,000
1924	1,522,763	1,498,674.00	.984	1,500,000
1925	2,076,764	2,743,750.00	1.321	2,750,000
1926	2,256,137	2,782,422.00	1.233	2,885,000
1927	2,329,553	2,255,919.00	.968	2,650,000
1928	173,987	166,314.00	.956	2,150,000
Operation by private carriers:				
1926	396,345	89,753.71	.226	500,000
1927	2,805,781	1,363,227.82	.486	2,000,000
1928	5,585,224	4,042,777.16	.724	4,500,000
1929	10,212,511	11,169,015.13	1.094	12,430,000
1930	14,939,468	14,618,231.50	.978	15,000,000
1931	21,381,852	16,943,605.56	.792	18,000,000
1932	32,202,170	19,938,122.61	.619	20,000,000
1933	35,909,811	19,400,264.81	.540	19,460,000
1934	29,111,474	[1]12,129,959.64	.417	15,000,000
1935	31,148,693	8,834,732.43	.284	[2]12,003,291
1936	38,700,643	12,177,682.47	.315	12,247,500
1937	39,958,771	13,165,574.73	.329	13,239,000
1938	46,166,192	14,741,249.42	.319	14,831,403
1939	52,048,627	[1]16,767,934.50	.322	17,240,000
1940	59,177,525	[1]18,855,305.82	.319	19,489,303
1941	75,255,208	[1]20,513,541.56	.273	20,614,199
1942	[1]89,410,021	[1]22,775,781.00	.255	22,894,422

[1] Subject to final adjustment.

[2] $3,291 of this amount was a special appropriation for the purpose of salary restoration.

Statistical report showing the total mileage of domestic air mail routes, the miles of service scheduled and actually flown, and the cost of air mail service for the fiscal years 1926–42.

Fiscal Year	*Miles of Route*	*Miles of Service*		*Percentage of Performance*	*Cost of Service*
		Scheduled	*Actually Flown*		
1926	3,597	411,070	396,345	96.42	$89,753.71
1927	5,551	3,092,016	2,805,781	90.74	1,363,227.82
1928	10,932	5,999,948	5,585,224	93.09	4,042,777.16
1929	14,406	11,032,508	10,212,511	92.57	11,169,015.13
1930	14,907	16,228,453	14,939,468	92.06	14,618,231.50
1931	23,488	22,907,169	21,381,852	93.34	16,943,605.56
1932	26,745	34,509,483	32,202,170	93.31	19,938,122.61
1933	27,679	38,114,425	35,909,811	94.22	19,400,264.81
1934	28,820	31,223,641	29,111,474	93.24	[1]12,129,959.64
1935	28,884	33,770,909	31,148,693	92.24	8,834,732.43
1936	29,198	40,802,141	38,700,643	94.85	12,177,682.47
1937	29,622	42,051,957	39,358,771	95.02	13,165,574.73
1938	33,655	48,735,120	46,166,192	94.73	14,741,249.42
1939	37,080	54,188,438	52,087,028	96.12	16,781,496.25
1940	37,943	60,812,957	59,177,525	97.31	[1]18,855,305.82
1941	43,411	79,708,380	75,255,208	94.41	[1]20,513,541.56
1942	44,623	[1]93,872,974	[1]89,410,021	95.25	[1]22,775,781.00

[1] Subject to final adjustment.

U. S. AIR MAIL SERVICE

From report of the Postmaster General for fiscal year 1942

Domestic air mail pound-miles flown by months for fiscal years 1939 to 1942 inclusive

	1939	1940	1941	1942
July	1,199,405,168	1,385,499,649	1,633,813,933	2,212,783,024
August	1,272,873,777	1,485,990,995	1,718,622,237	2,255,626,391
September	1,235,017,708	1,421,434,001	1,673,399,938	2,216,527,714
October	1,299,263,414	1,509,325,589	1,866,008,205	2,366,448,757
November	1,251,886,341	1,472,644,377	1,667,748,879	2,230,666,784
December	1,430,568,176	1,771,255,973	1,890,058,683	2,675,279,781
January	1,243,868,119	1,535,184,033	1,761,226,024	2,593,528,302
February	1,220,711,135	1,500,226,200	1,813,348,177	2,552,948,641
March	1,447,382,546	1,681,791,500	2,018,484,815	3,018,933,335
April	1,355,973,784	1,628,338,205	2,061,880,065	2,995,738,918
May	1,434,681,315	1,682,614,516	2,105,826,655	3,156,110,855
June	1,426,985,889	1,597,062,402	2,083,004,549	[1]3,129,539,582
Total	15,818,617,372	18,671,367,440	22,293,422,160	31,404,132,084

[1] Subject to final adjustment.

U. S. FOREIGN AIR MAIL

From report of the Postmaster General for fiscal year 1942

Air mail service to foreign countries during fiscal year 1942

Route	*Service Scheduled*	*Service Performed*	*Percentage of Performance*	*Compensation*
	Miles	*Miles*		
1. New York to Montreal	449,406.0	427,027.0	95.02	$256,216.20
5. Miami to Canal Zone (direct)	124,540.8	123,259.1	98.97	255,132.72
Miami to Barranquilla	260,276.8	260,276.8	100.00	511,082.60
Miami to Havana	123,168.0	121,264.0	98.45	218,446.49
Barranquilla to Canal Zone	39,431.4	39,431.4	100.00	70,976.52
San Salvador to Canal Zone	270,508.1	269,869.1	99.76	484,272.64
Port of Spain to Paramaribo	230,200.3	230,181.8	99.99	398,472.81
Barranquilla to Port of Spain	200,389.2	200,381.7	99.99	360,880.32
6. Miami to San Juan	580,868.2	579,680.6	99.80	1,057,262.71
San Juan to Port of Spain	279,469.5	279,469.5	100.00	412,899.33
7. Miami to Nassau[1]	26,142.0	25,573.5	97.83	31,966.90
8. Brownsville to Mexico City	338,282.0	338,203.6	99.98	608,762.56
Mexico City to San Salvador	248,133.6	248,037.8	99.96	446,459.24
9. Canal Zone to Buenos Aires	1,946,981.0	1,939,340.1	99.61	2,918,222.37
10. Paramaribo to Buenos Aires	1,456,091.7	1,456,081.9	99.99	2,109,741.42
14. San Francisco to Hong Kong/ Singapore	1,014,739.0	1,005,993.0	99.14	[3]
15. Juneau to White Horse	17,482.4	17,077.2	97.68	38,992.92
16. Fairbanks to White Horse	51,136.8	51,022.2	99.78	64,691.57
17. New York to Hamilton, Bermuda[1]	6,966.0	6,966.0	100.00	[3]
18. New York to Lisbon/Foynes[1]	499,885.0	388,761.0	77.77	[3]
19. San Francisco to Auckland	246,108.0	246,108.0	100.00	[3]
20. Seattle to Juneau	485,616.0	395,922.0	81.53	[4]
21. Bangor, Maine, to Moncton	295,698.0	208,363.0	70.46	83,022.60
Salaries, etc., Cali, Colombia, Agency[2]	.....	.....	.....	5,481.00
Clerk service at Canal Zone	.....	.....	.....	6,000.00
Total	9,191,519.8	[5]8,858,290.3	[5]96.37	.....

[1] One way. [2] Agency discontinued—January 31, 1942. [3] No compensation shown as rate of payment is subject to adjustment by Civil Aeronautics Board. [4] No compensation shown as rate of payment is yet to be fixed by the Civil Aeronautics Board. [5] Subject to final adjustment.

PROGRESS OF CIVIL AERONAUTICS IN THE UNITED STATES

(All statistics are as of Dec. 31 each year)

Compiled by Civil Aeronautics Administration

	1940	1941	1942
SCHEDULED AIR-CARRIER OPERATIONS			
Airplanes:			
In service and reserve (domestic)	358	359	176
Airways (domestic):			
Services in operation	164	189	111
Express mileage	41,054	47,703	36,442
Mail mileage	40,461	45,454	35,641
Passenger mileage	41,054	47,703	35,168
Total mileage (domestic)	41,054	47,703	36,442
Accidents:			
Domestic:			
Number of accidents	42	33	31
Miles flown per accident	2,590,487	4,030,990	3,551,705
Fatal Accidents	3	4	5
Miles flown per fatal accident	36,266,812	33,255,670	22,020,572
Fatal accidents per 1,000,000 miles flown	0.03	0.03	.05
Pilot fatalities	3	3	5
Miles flown per pilot fatality	36,266,812	44,340,893	22,020,572
Copilot fatalities	3	3	5
Crew fatalities (other than pilot and copilot)	4	3	6
Passenger fatalities	35	35	55
Passenger miles flown per passenger fatality	32,784,141	42,620,991	26,814,248
Ground crew and third party fatalities	0	0	0
Passenger fatalities per 100,000,000 passenger miles flown	3.05	2.35	3.73
Total fatalities	45	44	71
Fatalities per 1,000,000 miles flown	0.41	0.33	0.64
Express and freight carried:			
Pounds (domestic)	12,506,176	19,209,671	40,101,657
Miles flown (revenue):			
Domestic routes	108,800,436	133,022,679	110,102,860
Passenger-miles flown (1 passenger carried 1 mile):			
Domestic, revenue	1,041,173,558	1,369,584,231	1,398,042,146
Domestic, revenue and non-revenue	1,147,444,948	1,491,734,671	1,474,783,656
Passengers carried:			
Domestic, revenue	2,727,820	3,768,892	3,349,134
Domestic, revenue and non-revenue	2,959,480	4,060,545	3,532,950
Passenger seat-miles flown (domestic)	1,797,329,431	2,316,205,507	1,937,672,755
Passenger load factor:			
Domestic revenue (per cent)	57.93	59.13	72.15
PRIVATE FLYING OPERATIONS (All domestic)			
Airplanes in operation (certificated and uncertificated)	16,903	24,124	22,329
AIRPORTS AND LANDING FIELDS			
Airports:			
Commercial	860	930	1,069
Municipal	1,031	1,086	1,129
Intermediate—C. A. A.—lighted	289	283	273
Intermediate—C. A. A.—unlighted	0	0	0
Private and miscellaneous airports	151	185	78
Total airports in operation	2,331	2,484	2,549
Lighted, total	776	662	700

PROGRESS OF CIVIL AERONAUTICS IN THE UNITED STATES —Continued—

	1940	1941	1942
FEDERAL AIRWAYS SYSTEM AND AIDS TO AIR NAVIGATION			
Communication:			
Radio broadcast stations	111	125	120
Radio range beacon stations	281	312	280
Radio marker beacons	12	18	5
Weather reporting airway and airport stations			
Weather Bureau and C. A. A. operated, longline teletypewriter equipped	176	188	142
Traffic control stations teletypewriter equipped	120	130	26
Miles of weather reporting teletypewriter service	28,052	33,208	32,018
Miles of traffic control teletypewriter service	12,260	12,021	9,008
Airway lighting:			
Beacons:			
Revolving	2,045	2,110	2,080
Flashing	216	164	141
Beacons—privately owned and certified	720		
Intermediate landing fields, lighted	280	279	267
Mileage lighted	30,480	32,070	33,407
Miles under construction at close of year	496	780	1,363
CERTIFICATES			
Certificated (active):			
Airplanes	17,351	24,836	22,904
Gliders	30	65	104
Instructors, ground	1,948	4,815	7,604
Mechanics	11,177	14,047	18,007
Pilots, airplane	63,113	100,787	110,510
Pilots, glider	138	160	211
Riggers, parachute	444	618	1,004

U. S. WEATHER BUREAU APPROPRIATIONS

Fiscal Years 1940, 1941 and 1942

Project	*Appropriations*		
	1940	*1941*	*1942*
General Administrative expenses	$ 145,000	$ 145,000	$ 146,280
General forecasts and warnings	1,272,353	1,750,766	1,038,820
Climatology	1,024,207	1,241,075	1,205,041
River and flood service	211,852	217,228	244,017
Aviation weather service	3,481,604	3,477,384	4,238,214
New methods and improved technique in weather forecasting	32,773	34,011	117,460
Improvements in instrumentation and methods of observation	3,561	1,003	23,543
Investigations of climatic variations	1,520	3,033	10,437
Total appropriations	$6,172,870	$6,880,900[1]	$7,084,730[2]

[1] Includes $500,000 appropriated in the "First Supplemental Civil Functions Appropriations Act, 1941"; and $50,000 appropriated in the "Second Deficiency Appropriation Act, 1940."
[2] Includes $560,580 appropriated in the "Third Supplemental National Defense Appropriation Act, 1942."

AMERICAN AIRPLANES IN SERVICE WITH OR IN ANNOUNCED PRODUCTION FOR THE UNITED STATES AND BRITISH AIR FORCES

April 1, 1943

Manufacturer	*Plane Name*	*U. S. Army*	*U. S. Navy*	*British*
Heavy Bombers (4 engine)				
Boeing[1]	Flying Fortress	B-17	.....	Fortress
Consolidated[2]	Liberator	B-24	PB4Y	Liberator
Douglas*	.....	B-19	.....	.....
Medium Bombers (2 engine)				
Douglas[3]	Bolo	B-18	.....	Digby
Douglas[3]	Dragon	B-23	.....	.....
Martin	Marauder	B-26	.....	Marauder
North American	Mitchell	B-25	PBJ-1	Mitchell[4]
Vega	Ventura	B-34	PV	Ventura
Light Bombers (2 engine)				
Douglas	Havoc	A-20	BD	Boston & Havoc
Lockheed	Hudson	A-29	PBO	Hudson
Martin	.....	A-30	.....	Baltimore
Martin[3]	.....	.....	.....	Maryland
Light Bombers (1 engine)				
Brewster	Buccaneer	A-34	SB2A	Bermuda
Curtiss	Helldiver	A-25	SB2C	.....
Douglas[3]	Devastator	.....	TBD	.....
Douglas	Dauntless	A-24	SBD	.....
Grumman[6]	Avenger	.....	TBF	.....
North American	Mustang	A-36	.....	.....
Chance Vought	Vindicator	.....	SB2U	Chesapeake
Vultee[5]	Vengeance	A-31	.....	Vengeance
Vultee	.....	A-35	.....	.....
Fighters (2 engine)				
Lockheed	Lightning	P-38	.....	Lightning
Fighters (1 engine)				
Bell	Airacobra	P-39	.....	Airacobra[4]
Brewster[3]	Buffalo	.....	F2A	Buffalo
Curtiss	Warhawk	P-40 series	.....	Tomahawk-[4] Kittyhawk I & II
Curtiss[3]	Mohawk	P-36	.....	Mohawk
Grumman[7]	Wildcat	.....	F4F	Martlet
North American	Mustang	P-51	.....	Mustang
Republic[3]	Lancer	P-43	.....	.....
Republic[8]	Thunderbolt	P-47	.....	.....
Chance Vought	Corsair	.....	F4U	.....
Vultee	Vanguard	P-66	.....	Vanguard (To China)
Patrol Bombers (4 engine) Flying Boats				
Consolidated	Coronado	.....	PB2Y	.....
Patrol Bombers (2 engine) Flying Boats				
Consolidated	Catalina	.....	PBY	Catalina
Martin	Mariner	.....	PBM	.....
Naval Reconnaissance Seaplanes (1 engine)				
Curtiss	Seagull	.....	SO3C	Seamew
Chance Vought	Kingfisher	.....	OS2U	Kingfisher

AMERICAN AIRPLANES IN SERVICE WITH OR IN ANNOUNCED PRODUCTION FOR THE UNITED STATES AND BRITISH AIR FORCES—Continued

Manufacturer	*Plane Name*	*U. S. Army*	*U. S. Navy*	*British*
Transports & Cargo (4 engine)				
Consolidated	Liberator Express	C-87	.....	.....
Douglas	Skymaster	C-54	R5D	C-54
Lockheed	Constellation	C-69	.....	.....
Martin*	Mars	.....	PB2M	.....
Chance Vought	Excalibur	.....	JR2S	.....
Transports (2 engine)				
Beech[8]	Voyager	C-45	JRB	.....
Cessna	.....	C-78	.....	.....
Curtiss	Commando	C-46	R5C	.....
Curtiss	Caravan	C-76	.....	.....
Douglas	Skytrain	C-47	R4D-1	Dakota I
Douglas	Skytrooper	C-53	R4D-3	Dakota II
Grumman	Goose	.....	JRF	Goose
Grumman	.....	.....	J4F	.....
Lockheed	Lodestar	C-60	R-50	Lodestar
Transports (1 engine)				
Beech	Traveler	C-43	GB	.....
Fairchild	Forwarder	C-61	GK	Argus I
Grumman	.....	.....	J2F	.....
Howard	.....	.....	GH-1	GH-1
Vultee[3]	.....	C-81	.....	.....
Liaison & Communication (1 engine)				
Aeronca	Grasshopper	L-3	.....	.....
Curtiss[3]	.....	O-52	.....	.....
Interstate	.....	L-6 & 8	.....	.....
North American[3]	.....	O-47	.....	.....
Piper	Grasshopper	L-4	.....	.....
Vultee	Vigilant	L-1	.....	.....
Vultee	Sentinel	L-5	.....	.....
Universal Molded Prod.	.....	L-7	.....	.....
Taylorcraft	Grasshopper	L-2	.....	.....
Primary Trainers (1 engine)				
Boeing	Caydet	PT-13 & 17	N2S I & II	.....
Fairchild[10]	Cornell	PT-19 & 23	.....	Cornell (Canada)
Howard	.....	.....	NH-1	.....
Naval Aircraft[3]	.....	.....	N3N	.....
Piper	.....	.....	NE-1	Cub
Ryan	Recruit	PT-21 & 22	NR	.....
Ryan	.....	PT-25	.....	.....
Spartan	.....	.....	NP	.....
Timm	.....	.....	N2T	.....
Basic Trainers (1 engine)				
Fleetwings	.....	BT-12	.....	.....
North American[3]	.....	BT-9 & 14	.....	Yale
Vultee	Valiant	BT-13 & 15	SNV	.....
Advanced Trainers (1 engine)				
Curtiss	Falcon	.....	SNC	.....
North American	Texan	AT-6	SNJ	Harvard
Vultee	Reliant	AT-19	.....	Reliant

AMERICAN AIRPLANES IN SERVICE WITH OR IN ANNOUNCED PRODUCTION FOR THE UNITED STATES AND BRITISH AIR FORCES—Continued

Manufacturer	*Plane Name*	*U. S. Army*	*U. S. Navy*	*British*
Advanced Trainers (2 engine)				
Beech	Navigator	AT-7	SNB-2	.....
Beech	Wichita	AT-10	.....	.....
Beech	Kansas	AT-11	SNB-1	.....
Boeing	Crewmaker	AT-15	.....	.....
Cessna	Bobcat	AT-8 & 17	.....	Crane
Curtiss	Jeep	AT-9	.....	.....
Fairchild	Yankee Doodle	AT-13 & 14	.....	.....
Lockheed	.....	AT-18	.....	.....

NOTE:

[1] Also made by Douglas and Vega. [2] Also made by Douglas and Ford. [3] Not in production. [4] To Russia under Lend-Lease. [5] Also made by Northrop. [6] Also made by Eastern Aircraft Div. of General Motors. [7] Also made by Eastern Aircraft Div. of General Motors. [8] Also made by Curtiss. [9] Also made by Naval Aircraft Factory. [10] Also made by Aeronca, Howard, St. Louis Aircraft Co. * Experimental. Only one built.

AIRCRAFT LABOR STATISTICS

Average Weekly Hours, Average Hourly Earnings, and Average Weekly Earnings of Wage Earners in the Aircraft Manufacturing Industry by Months, January 1941 to December 1942, Inclusive, Based on Reports Supplied by Cooperating Establishments.

Source: U. S. Bureau of Labor Statistics, Division of Employment Statistics, March 9, 1943.

Month and Year	*Airframes and Parts, Including Propellers*			*Engines*		
	Average Weekly Earnings	*Average Weekly Hours*	*Average Hourly Earnings (cents)*	*Average Weekly Hours*	*Average Hourly Earnings (cents)*	*Average Weekly Earnings*
1941						
January	$34.13	44.7	77.6	47.2	89.2	$42.16
February	35.14	45.5	78.4	45.4	87.1	39.59
March	35.02	45.2	78.3	46.0	89.6	41.19
April	35.15	45.1	78.8	42.2	91.8	38.76
May	35.84	45.4	79.4	46.9	96.9	45.42
June	35.63	45.0	79.7	47.0	100.2	47.12
July	36.57	44.8	81.2	46.8	102.6	48.06
August	38.08	45.6	84.5	47.0	106.1	49.92
September	38.23	45.5	84.7	47.8	105.0	50.17
October	39.29	45.2	87.2	47.2	109.2	51.55
November	39.85	44.4	90.3	48.0	114.7	55.04
December	42.42	46.3	91.8	48.5	114.5	55.48
1942						
January	46.72	48.7	96.3	50.8	121.4	61.66
February	44.99	47.7	95.1	49.4	117.5	58.02
March	45.18	47.6	95.6	50.1	120.0	60.13
April	45.90	47.3	97.1	48.7	119.8	58.34
May	46.22	47.7	98.3	48.2	119.3	57.51
June	46.67	47.2	99.3	48.4	118.5	57.35
July	46.01	46.6	99.1	48.2	121.6	58.57
August	46.24	46.7	99.3	48.6	121.7	59.12
September	46.55	46.3	101.1	48.1	125.3	60.31
October	45.75	46.3	99.1	48.9	123.0	60.18
November	46.53	46.8	99.7	47.5	123.9	58.89
December	46.68	47.2	100.3	47.7	122.6	58.49

LICENSED GROUND INSTRUCTORS IN THE UNITED STATES

January 1, 1943

Compiled by Civil Aeronautics Administration

State	Men	Women	Total
Alabama	79	5	84
Arizona	56	1	57
Arkansas	79	2	81
California	807	48	855
Colorado	115	10	125
Connecticut	62	5	67
Delaware	9	1	10
District of Columbia	33	1	34
Florida	176	9	185
Georgia	114	1	115
Idaho	32	3	35
Illinois	249	9	258
Indiana	131	4	135
Iowa	150	6	156
Kansas	188	4	192
Kentucky	43	1	44
Louisiana	90	4	94
Maine	71	4	75
Maryland	74	6	80
Massachusetts	311	10	321
Michigan	171	9	180
Minnesota	97	3	100
Mississippi	59	2	61
Missouri	294	11	305
Montana	73	2	75
Nebraska	117	3	120
Nevada	20	1	21
New Hampshire	42	2	44
New Jersey	262	8	270
New Mexico	58	2	60
New York	783	35	818
North Carolina	72	5	77
North Dakota	31	0	31
Ohio	268	7	275
Oklahoma	230	9	239
Oregon	48	1	49
Pennsylvania	471	10	481
Rhode Island	47	2	49
South Carolina	61	3	64
South Dakota	51	3	54
Tennessee	114	3	117
Texas	534	34	568
Utah	42	0	42
Vermont	38	2	40
Virginia	75	1	76
Washington	140	5	145
West Virginia	69	5	74
Wisconsin	100	7	107
Wyoming	26	2	28
Alaska	4	0	4
Canada	11	0	11
Canal Zone	1	0	1
Hawaiian Islands	10	0	10
Mexico	0	0	0
Philippine Islands	0	0	0
Puerto Rico	5	0	5
Foreign, Miscellaneous	0	0	0
Total	7,293	311	7,604

AIRPORTS AND LANDING FIELDS

January 1, 1943

Compiled by Civil Aeronautics Administration

State	Municipal	Commercial	Intermediate	Miscellaneous, Government	Private	Total	Lighted
Alabama	21	10	4	0	0	35	16
Arizona	20	26	10	1	1	58	20
Arkansas	14	15	3	0	0	32	7
California	59	80	14	7	2	162	54
Colorado	25	12	3	0	1	41	9
Connecticut	7	12	1	0	0	20	4
Delaware	3	8	0	0	0	11	1
District of Columbia	1	0	0	0	0	1	3
Florida	78	21	6	0	1	106	33
Georgia	29	9	12	0	0	50	24
Idaho	24	7	6	7	1	45	12
Illinois	18	56	6	0	0	80	18
Indiana	13	34	6	0	0	53	16
Iowa	24	25	4	0	3	56	11
Kansas	29	18	4	0	0	51	10
Kentucky	9	10	3	0	0	22	6
Louisiana	16	10	4	0	0	30	13
Maine	12	2	0	0	0	14	8
Maryland	3	22	0	0	1	26	5
Massachusetts	13	30	1	1	2	47	6
Michigan	88	31	1	3	5	128	19
Minnesota	29	16	2	0	1	48	8
Mississippi	23	9	7	0	0	39	14
Missouri	13	25	13	0	0	51	20
Montana	41	2	15	13	1	72	22
Nebraska	30	10	5	0	0	45	12
Nevada	5	11	8	2	0	26	11
New Hampshire	8	6	0	0	0	14	5
New Jersey	9	34	0	0	0	43	6
New Mexico	27	19	11	2	0	59	22
New York	30	81	6	1	1	119	23
North Carolina	17	27	2	0	0	46	11
North Dakota	22	0	9	0	0	31	10
Ohio	30	60	9	0	3	102	24
Oklahoma	29	30	7	0	0	66	16
Oregon	20	7	6	1	0	34	13
Pennsylvania	36	92	5	0	1	134	26
Rhode Island	3	2	0	0	1	6	1
South Carolina	13	9	3	0	2	27	9
South Dakota	14	8	2	0	0	24	4
Tennessee	11	6	8	0	0	25	15
Texas	83	86	29	2	4	204	53
Utah	16	4	9	0	0	29	14
Vermont	8	2	0	0	0	10	1
Virginia	17	33	8	0	0	58	17
Washington	31	13	6	4	0	54	19
West Virginia	10	13	2	0	0	25	3
Wisconsin	23	25	3	1	0	52	10
Wyoming	25	1	10	1	1	38	16
Total	1,129	1,069	273	46	32	2,549	700

AVIATION GASOLINE TAXES, REFUNDS AND EXEMPTIONS

Summary—February 15, 1943

Compiled by American Petroleum Industries Committee

States	Tax Rate on Motor Fuel	Refund Aircraft	Refund Other Than Use on Highways	Exemption Aircraft	Tax Aircraft Fuel	Allocation of Funds (Consult Statutes for Details)
Alabama	6				6	Highway purposes
Arizona	5		x			
Arkansas	6½			*		*
California	3		x			
Colorado	4	x				
Connecticut	3		x			
Delaware	4	x				
District of Columbia	3	x				
Florida	7			*		
Georgia	6			*	6	Highways, roads and education
Idaho	5*				2½	Aeronautics Fund
Illinois	3		x			
Indiana	4	x				
Iowa	3	x				
Kansas	3			*		
Kentucky	5	x*				
Louisiana	7				7	Highway purposes
Maine	4					Aeronautical Fund
Maryland	4	x				
Massachusetts	3		x			
Michigan	3	*			3	Aeronautics Fund
Minnesota	4		x			*
Mississippi	6		5		1	Highway purposes
Missouri	2		x			
Montana	5	x				
Nebraska	5	*			5	20% to State Asst. Fund; 80% to Aviation Fund
Nevada	4		x			
New Hampshire	4		x			*
New Jersey	3	x				
New Mexico	5		*			
New York	4		x			
North Carolina	6			*		
North Dakota	4				*	
Ohio	4	3			1	General Revenue Fund
Oklahoma	5½			x		
Oregon	5	4			1	State Board of Aeronautics
Pennsylvania	4				4	Highways and relief
Rhode Island	3				3	General Fund
South Carolina	6	*			6	State Aviation Fund
South Dakota	4				4	State Aeronautics Fund
Tennessee	7				7	Aviation purposes
Texas	4	x				
Utah	4				4	State Aeronautics Fund
Vermont	4				4	*
Virginia	5	2 or 5			*	Aviation purposes
Washington	5		x			
West Virginia	5	*				
Wisconsin	4	x				
Wyoming	4	*			2	*

* See Notes accompanying name of state on following page.

NOTES ON GASOLINE TAX SUMMARY

ARKANSAS—Aircraft fuel having a rating of not less than 80 octane is not taxed. Regular gasoline when used in airplanes is taxed 6½ cents per gallon and the funds are used for highway purposes.

FLORIDA—Aviation fuel testing 78 octane or higher is not taxed.

GEORGIA—No tax on motor fuel used in planes owned by the U. S. Government in which cadets in the service of the U. S. are trained, irrespective of whether said motor fuels be purchased by a governmental agency or a private agency. (Laws 1941, H. R. 44–239B).

IDAHO—Tax of 1 mill per gallon of motor fuel stored, sold, distributed or used for consumption in the state. (Laws 1939, Chap. 223, Sec. 8).

KANSAS—40 gallons or more, for any purpose other than operating or propelling motor vehicles on public highways.

KENTUCKY—Dept. of Revenue authorized to refund full tax on gasoline used in operation of aircraft for transportation of persons and property in interstate commerce upon filing bond of $1,000 before applying for refund and filing claim before 15th of month for fuel purchased in preceding month and conforming to other statutory requirements. (Laws 1942 [H. B. 330] eff. 6–2–42.)

MICHIGAN—A refund of 1½¢ per gallon is made to airline operators operating interstate on schedule operation.

MINNESOTA—Tax money collected on gasoline used for aviation purposes and for which a refund claim is not made shall be expended on marking highways with navigation markers, constructing strip landing fields near highways, and for the maintenance and support of the Aeronautics Commission. (Laws 1941, H. B. 942)

NEBRASKA—4¢ refunded on aircraft fuel used only in aircraft in connection with any school of flying instruction approved by the United States Government. (Laws 1935, Chap. 3, Sec. 17).

NEW HAMPSHIRE—Any balance of unrefunded tolls on fuels used in aircraft is credited to the commission having jurisdiction over the navigation of aircrafts to be used for the promotion of the safety of such navigation.

NEW MEXICO—50 gallons or more purchased at one time.

NORTH CAROLINA—Gasoline designed for and sold and used exclusively in aircraft motors.

NORTH DAKOTA—Under ruling of State Auditor aviation gas is sold tax exempt and must be purchased through a registered dealer.

SOUTH CAROLINA—Tax refunded on gasoline sold to any Army Primary Aviation School to be used in planes owned by the U. S. and used by such school in the training of cadets, students or trainees actually enlisted in the United States Air Corps and used under supervision of the army. (Laws 1941, H. B. 155).

VERMONT—Law 1939 Appropriation No. 125 p. 156 provides that $2,000 is appropriated annually for aeronautical purposes.

VIRGINIA—Grants full refund to interstate operators of aircraft. Intrastate consumption and gasoline used for that part of interstate trips which flight logs show to have been within Virginia will qualify only for the 2¢ refund previously allowed. (Laws 1942, Chap. 206, [H. B. 158] eff. 3–13–42.)

WEST VIRGINIA—Refunds on quantities of 25 gallons or more when used in aircraft. (Laws 1939, Chap. 125)

WYOMING—2¢ per gallon refund on purchases in excess of 10,000 gallons per month, Law of 1935. Funds paid to city, town or county where airfield is located (and from which tax was collected) for maintenance of such airfield.

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