



planes

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'PLANES AND BUTTER' ABSURD -- VINSON

Huge Presses Will Expedite Plane Output

Mammoth forging presses, ranging in size from 50,000 to 25,000 tons, and extrusion presses, ranging from 25,000 to 8,000 tons, soon will save the American taxpayer millions of dollars by turning out huge single-piece metal sections for U. S. military aircraft.

Formerly created by complex machining of small bits and pieces, big aircraft parts will be made by compressing and squeezing giant pieces of aluminum, magnesium and steel to meet exacting production requirements.

Replaces "Bits and Pieces"

By substituting single operations and large sections for the "bit and piece" construction now required in many aircraft, it is anticipated that millions of milling machine hours and subsequent long fabrication time will be saved. Substantially lower aircraft production costs should result, and the new forged and extruded parts also will give future aircraft additional structural strength.

First step in a program for securing these heavy presses is a \$210 million Air Force project, in which the aircraft industry is cooperating. To assist the Air Force in gauging the extent of the program, the Aircraft Industries Association recently surveyed U. S. manufacturers to determine the industry's present, potential and future needs for the big presses.

Survey made by AIA

Aircraft builders reported on large forgings now being manufactured for existing aircraft, parts for current production aircraft which could be redesigned as forgings or extrusions if larger capacity presses were available, and parts for prototype designs which could be forged or extruded if presses of adequate capacity were made available.

To date, forging press builders have been given a go-ahead on two 50,000-ton presses, three 35,000-ton presses and three 25,000-ton presses. In addition, work is starting on one 25,000-ton, two 20,000-ton, four 12,000-ton and one 8,000-ton extrusion presses.

First result of the AIA survey, still being evaluated by the Air Force, was confirmation of a pre-

(See "PRESSES," Page 2)

WHY DEFENSE COSTS MORE

FOR EVERY
1 ENGINEERING
MAN-HOUR
ON A TYPICAL
WORLD WAR II
PLANE

THERE ARE
100
ENGINEERING
MAN-HOURS ON
TODAY'S TYPICAL
GUIDED MISSILE

"PLANES" SOURCE: Typical Aircraft Company.

Cost-Conscious Plane Builders Save Time, Money with Many New Methods

Despite the vast sums of money now required to build military airplanes, cost conscious aircraft manufacturers are continuing to accomplish substantial savings in production costs through improved manufacturing techniques and policing of budgets and waste.

The new methods have resulted also in savings of strategic materials in short supply and of vital time by cutting man hours. In some instances, they have lessened the industry's requirement for certain critical items.

Efficiency Constantly Improved Specially developed tools and processes, and more efficient use of plant space are some of the ways manufacturers are saving dollars.

One aircraft corporation is speeding production of a fighter plane by using electric powered assembly line. The new system is expected to cut man hours by 40 hours per plane and reduce work space 23 per cent.

The corporation also expects to cut the cost of its fighters, transports and bombers. New massive machinery, including the largest hydraulic metal-forming press of its type in the world, will make possible production of wing sections and other solid pieces as large as 10 by 30 feet.

These self-strengthened pieces will replace units now composed of scores of small parts welded

and riveted together. The resultant saving in man hours and simplified assembly procedures will ultimately mean a lowering of plane costs.

An inexpensive joggle machine, which notches and forms metals, has been developed by a large plane manufacturer on the west coast. The new manual joggle machine costs less than one-tenth that of any comparable machine in production. Since few subcontractors have the expensive special machines formerly required for joggling parts, the aircraft corporation licensed a Texas company to build its new machine for other firms.

Many Tooling Costs Cut 50%

The same aircraft manufacturer recently installed three new machines which will save up to \$24,000 per month. The devices are salvage machines which will speed up the job of reclamation of materials and help alleviate critical shortages.

In another case, a firm placed into use its first automatic certifying hardness tester. The machine's output of accurately tested and stamped small parts equals the work of five inspectors, and it has resulted in the saving of 400 man hours per week.

This firm also reports tooling costs have been cut about 50 per cent on many forming operations (See "COST CUTTING," Page 3)

What Congress Does Now Vital To '56, He Says

Written especially for PLANES

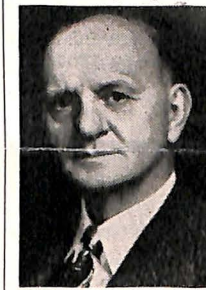
By

Hon. Carl Vinson, Democrat
Chairman, Committee on Armed Services
U. S. House of Representatives

"The Air Force we have today is the one we bought 3 and 4 years ago. The Air Force we need today is the one we failed to buy at that time." — Gen. Nathan F. Twining, Vice Chief of Staff, USAF.

Congress, in its present session, should heed closely this statement by one of our foremost aviation authorities, since this time factor is with us today and will be with us tomorrow. The actions of this Congress, in 1952, will determine whether we have adequate modern air power in 1956 and 1957.

There has never been a time more important than the present moment for an absolute and clear-cut decision that we—the Congress and the people—will not again let



Rep. Vinson

our air power lapse into a second rate category, or worse. In warfare today, air power and new weapons of mass destruction have changed the entire concept of strategy. While our air defense system has been vastly improved, nevertheless, we must face the unpleasant fact that no nation can completely defend itself against an air attack, and if the air battle is lost, the war is certain to be lost.

We have a long way to go to build the 143-wing force agreed upon by the Joint Chiefs of Staff as essential to safety. Our aircraft industry is accelerating its output and doing a highly commendable job, even in the face of inevitable shortages which stem from the superimposing of rearmament upon a booming civilian production program. While a philosophy of guns and butter is, in my opinion, unsound, a philosophy of planes and butter is absurd. It troubles

(See "VINSON," Page 4)

PLANES

Planes is published by the Aircraft Industries Association of America, Inc., the national trade association of the manufacturers of military, transport, and personal aircraft, helicopters, flying missiles and their accessories, instruments and components.

The purpose of *Planes* is to:

Foster a better public understanding of Air Power and the requirements essential to preservation of American leadership in the air;
Illustrate and explain the special problems of the aircraft industry and its vital role in our national security.

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ALL MATERIAL MAY BE REPRODUCED—MATS OF ALL CHARTS ARE AVAILABLE

Can't Have Business as Usual And Warplanes at Same Time

From the Annual Report of
DeWitt C. Ramsey (Admiral, U.S.N., Ret.)
President, Aircraft Industries Association

With the war in Korea continuing unabated and new situations of utmost gravity developing in other parts of the world, the Aircraft Industry continues to apply itself to rebuilding our air power to meet the emergency which has existed during the past year of our operations.

While some progress has been made toward this objective, there can be no question that we have fallen short of the production goals that were believed, a year ago, to be necessary to bring our military air establishment up to strength. Our principal gains have been in the number of facilities available for the production of military aircraft. This does not mean, unfortunately, that we have really expanded either our production base or our production capabilities to a satisfactory degree. The production base involves not only additional shelter and tools, but, more importantly, a going rate of production.

It is in this particular that we have been unable to fulfill the expectations of a year ago. Any sizeable expansion of production is attended by many obstacles. The length of the delays that result are dependent upon the time required to break the bottlenecks which develop. This has been a problem in other emergencies, but it is a much more difficult one today, for several reasons.

At the time the nation began its present program of rearmament, it was decided that America could support this industrial mobilization only through preservation of a strong civilian economy. This policy, wise though it be, has naturally aggravated our problems. It has not been possible to have our materials, machine tools and manpower when we needed them. Furthermore, the enormous complexity and resulting high cost of modern military aircraft have made every phase of our development, engineering and production many times more difficult than they were in World War II.

The cumulative effect of shortages and strikes has resulted in some downward adjustments of our delivery schedules. This is the first concrete evidence that we have already fallen short, and there is every reason to believe that there will be little appreciable improvement in the near future. Our Industry cannot shrug off such a portentous fact with the national safety at stake.

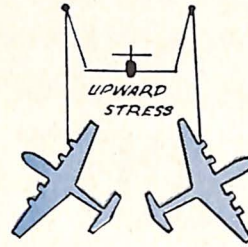
Far from quarreling with the policy of preserving a strong civilian economy concurrently with rearmament, our Industry has supported it heartily, and supports it today. But surely this is a matter of degree. We would be derelict if we failed to bring to the attention of the American public, to their representatives in Congress and to the officials and officers of Government the fact that preservation of a high-level civilian economy is in collision with the assigned task of air rearmament. If, as the military insists, the national safety depends largely on air power as the first line of defense, then the civilian economy must give way to whatever degree is necessary to achieve it.

It must be decided, and soon, whether and to what extent civilian production may be further affected if aircraft production goals (especially if the 140- or 150-wing Air Force program is adopted) are to be met. I deem it necessary to assert again that the nation cannot have business-as-usual, in the full sense of the term, and rapid rearmament at the same time.

It is fair to observe at this point that we would be much further advanced, in development, in capacity and in production potential, had the nation recognized earlier the importance of a sound, long-range air power policy. Many of our difficulties today are directly traceable to things we did not and could not do in 1945-46-47 when the Industry's

PLANE VIEWS

SO THIN—SO STRONG!

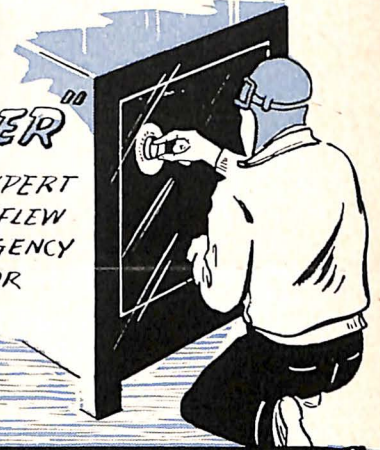


SO THIN THEY LOOK FRAGILE, THE WINGS OF ONE MODERN JET FIGHTER COULD EASILY SUPPORT TWO FULLY LOADED 4-ENGINE AIRLINERS—ALMOST 150 TONS OF DEAD-WEIGHT.

SUCH ENGINEERING IS MORE COSTLY.

"FLYING SAFECRACKER"

ROBERT TRIPE, LOCK EXPERT OF DENVER, LAST YEAR FLEW 10,000 MILES ON EMERGENCY CALLS TO OPEN SAFES OR STUBBORN LOCKS



HIGH COST OF STARTING

PROTOTYPE OF A CERTAIN WORLD WAR II FIGHTER (STARTED IN 1936)—INCLUDING INITIAL DEVELOPMENT, TOOLING, AND MANUFACTURING, COST

\$612,000.

PROTOTYPE OF ITS MODERN JET COUNTERPART (STARTED IN 1946) COST

\$5091,000

BY AIRCRAFT INDUSTRIES ASSOCIATION OF AMERICA

developmental, production and financial capacities were allowed to atrophy. It still takes from four to seven years, from development to service, to create a new aircraft type. It still takes from 18 to 24 months to place an approved type in production.

I take this occasion to clarify our position, as I interpret it, because it is incumbent upon our Industry and all its members to keep the record clear and to point constantly to those problems which must be evaluated if we are to achieve the urgent objectives of rearmament.

PRESSES

(Continued from Page 1)

vious Air Force decision to defer construction of a 75,000-ton forging press. Industry planners, who for several years have studied and encouraged construction of the heavy presses, point out that forging operators would have to spend two to three years in developing forging techniques with a 75,000-ton press. They also call attention to the fact that a number of somewhat smaller presses would be preferable to one or two of the mammoth presses.

Aircraft builders anticipate substantial savings in man-hours, machine hours, costs and materials when the heavy presses become available. In the case of an 18,000-ton press, it was shown, milling machine hours can be cut up to 50%—because of closer tolerances—a substantial saving in view of the some 30,000 milling machine hours now required for production of a typical jet fighter.

Aerial Spraying Saving Millions

Insecticide spraying, mostly from airplanes, saved more than \$5,000,000 worth of Oklahoma wheat in 1950.

This information was revealed by Dr. S. A. Rohwer, Assistant Chief of the Department of Agriculture's Bureau of Entomology and Plant Quarantine in a recent report.

Reporting annual savings for American farmers in nine figures through the use of new insecticides, Dr. Rohwer stated that mostly the new insect killer parathion was sprayed on 654,000 acres in Oklahoma in 1950 to control the wheat pest known as "greenbug."

He said most of the spraying was done from planes at a cost of \$1,307,000, and the result was 2,615,000 bushels of wheat worth two dollars a bushel.

MATERIALS USED IN A MODERN BOMBER (by weight)

ALUMINUM



51%

STEEL



29%

INSTRUMENTS AND ELECTRONICS



7%

RUBBER PRODUCTS



5%

MAGNESIUM



4%

GLASS AND PLASTICS



3%

MISCELLANEOUS



1%

ADDS UP TO:
137,600
SEPARATE
PARTS

These materials in countless sizes and shapes required for a certain type of patrol bomber must be ordered from thousands of suppliers and must be delivered on schedule to the aircraft manufacturers. To make just one plane, from one to two years of effort and cooperation by the aircraft industry and thousands of large and small manufacturers are required.

SOURCE: Manufacturer of Patrol Bombers

4,000 Varieties of Raw Materials Make Aircraft Inventories Complex

The aircraft industry's unique materials inventory problem, perhaps the most complex in today's mobilization economy, was recognized recently in a perceptive report of the Senate Small Business Committee. This has resulted in recognition by defense, mobilization and legislative leaders that aircraft builders cannot comply with government directives holding them to a 60-day supply of each item in their inventories.

Over 4,000 different sizes, shapes and kinds of raw materials go into a modern jet fighter, the Committee reported. From these 4,000 varieties of raw materials are fashioned, for example, the 137,600 parts in a typical new patrol bomber.

Complicated Planning

In the case of aluminum, materials workers in the aircraft industry must keep track of 150 different kinds and sizes of sheet, 50 kinds and sizes of plate, 396 aluminum castings, 264 aluminum forgings, 780 extrusions and rolled sections, 200 kinds and sizes of bar, 120 kinds and sizes of tube, and 200 miscellaneous items such as wire, strip and hinge.

Each of these thousands of materials must be ordered against future requirements, must be checked, warehoused, drawn out of inventory and spotted on production lines in one of the most complicated inventory operations in modern manufacturing.

Easy to Distort

The problems involved in keeping these items in balance were disclosed by the Small Business Committee when it reported:

"The measurement of the aluminum inventory on an over-all basis in the aircraft industry must make allowance for certain factors which, if not taken into consideration, may distort the inventory picture to such an extent as to prove it meaningless. . . . Any one or combination of these factors can cause a normal inventory on paper when in reality, the opposite may be true."

Continuing, the Committee pointed to the fact that materials inventories in the aircraft industry are subject to daily variations. Military orders are revised frequently depending upon fluctuating defense requirements. Design

changes are made by the hundreds, each causing a change in the pace at which individual materials are chewed up in the production process. Raw materials producers often are unable to meet promised delivery schedules, throwing certain items into long and others into short supply.

Try to Avoid 'Dead Money'

At other times, the Committee reported, military requirements for spare parts eat heavily—and unexpectedly—into inventories. And manufacturers constantly face the need for ordering in economical quantities—and of ordering according to minimum mill-runs set up by the materials producers.

Despite these constant problems, the Committee concluded, aircraft companies are maintaining a "strong drive to maintain inventories at the lowest practical level," and are "aware that money tied up in inventories is 'dead' money." The report emphasized "that the financial situation in the aircraft industry is sufficiently tight to maintain constant pressure against tying money in stocks beyond the immediate need."

COST CUTTING

(Continued from Page 1)

by the use of plastic tools. Drawing dies, spinning chucks, blocks for stretch forming, and tube-bending mandrels are some of the tools successfully made from plastic which are far cheaper than tools made of critical materials.

A leading builder of bombers is using plastics to conserve short supply metal stocks with the added advantage that the forming process for plastics requires a relatively small outlay of tooling . . . one of the most critical items for the defense production effort at this time.

Recently a group of production experts from one large aircraft manufacturing firm completed a nation-wide survey of eight other major firms in the plane industry as part of a program to study cost-reduction projects. The special manufacturing techniques developed by each of the companies involved were discussed, and a complete published report of these methods was planned for the industry.

This sort of planning and the free inter-change of manufacturing ideas is a good example of industry cooperation on mutual problems, and it gives assurance that cost-cutting in the building of military aircraft will continue as production increases.

Air Quotes

"In the long-lead-time items which are the heart of the military program—the complex new aircraft and tanks—little of this (1951) activity is yet reflected in delivery figures. Much of the work now being done will not appear in the delivery column until late 1952, 1953, and even later years. . . .



Wilson

"It is not easy to grasp the immensely complex job that is involved in producing an effective, modern mechanism of war such as a plane or tank. The higher speed,

increased size, and more versatile performance of modern aircraft have required a virtual revolution in production methods in the few years since World War II.

"Today's Navy or Air Force jet fighter, for example, weighs nearly as much as the old B-17 bomber. Automatic devices—many of them electronic—to provide the pilot with greater and more accurate fire power or bombing performance, more maneuverability, day and night combat capability, and a better chance of combat success, require tons of equipment in a plane where a few hundred pounds used to be enough. Stronger construction to withstand high-speed conditions demands tougher and heavier materials. . . .

"To produce planes like these on a volume basis is by far the most complicated, difficult, and precise mass production job ever tackled. And to a lesser degree, the same kind of production problems exist in the case of other major items of military equipment—tanks, weapons, and electronics."—Charles E. Wilson, Director of Defense Mobilization, Quarterly Report to the President, Jan. 1, 1952.

Improvements in one type of aircraft hydraulic pump increased its service without overhaul from 2400 hours to 14,000 hours within a period of two years.

PLANES QUIZ

Seventy per cent score on this quiz is excellent. Sixty per cent is good. Answers on Page four.

- The new airline tourist fares across the Atlantic will cut the cost one-way by (a) \$65; (b) \$100; (c) \$125?
- Without being changed, airplane engines now can actually take a plane around the world (a) three times; (b) five times; (c) seven times?
- Since volume production lowers airplane costs—if 100 planes cost \$100,000 each, what would you estimate as the cost each of 500 planes; 1,000 planes?
- Crop dusting pilots are considered so important they can be deferred from the military draft. True? False?
- A large U. S. troop transport can be converted into an aerial tanker (for refueling planes) in six hours. True? False?
- Research space required in some plants for military aircraft has increased since World War II (a) five times; (b) 12 times; (c) 20 times?
- Latest electronic equipment in a modern four-engined airliner weighs (a) 500 pounds; (b) 800 pounds; (c) 1,000 pounds?
- How much time is required to make an engine change in a jet fighter?
- Despite a much greater volume, the government is now paying far less for transportation of air mail than it did a year ago. True? False?
- How can the operators of crop dusting and other industrial type planes be most easily located when needed?



VINSON

(Continued from Page 1)

me to think that the delivery of a single jet fighter may be delayed because a part of its communication system has gone into a television set.

I am sure the great majority of the American people will give their full support to the Air Force and Naval air expansion program, even though it may mean a reduction in non-essential civilian production.

The Present Urgency

The urgency of the present situation should drive home to Congress and to all citizens the realization that creating and maintaining air power is not something that can be left to last minute herculean effort and hasty and frantic improvisation when danger looms on the horizon. On the contrary, it takes planning of the highest order. An airplane is the product of thousands of shops and factories and supply lines which provide its basic materials and its complex parts and components. It takes continuous research and development; otherwise we would quickly find our planes outmoded and surpassed by those of potential enemies—such as Russia, who never for a minute ceased to build up and improve her air power after World War II ended. And finally, it takes a highly skilled work team in the manufacturing industry—several hundred thousand men and women who cannot be assembled and trained overnight.

The Russian Advance

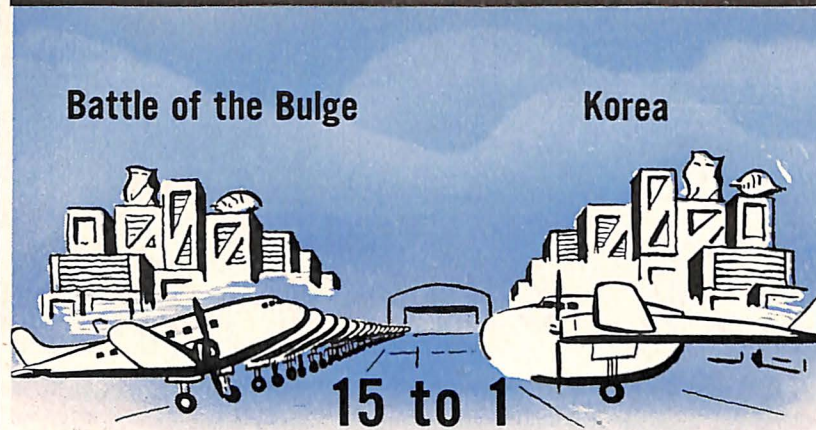
All this means that at long last Congress must lay down a firm policy for a long-range aircraft procurement program. In 1948 on the floor of the House I strongly advocated such a program as the only guarantee of adequate air power. Almost unanimously the Congress agreed. But subsequently, by administrative action, a vast amount of the funds we appropriated were frozen and instead of the then-proposed 70 groups we actually had cutbacks in the Air Force and Naval aviation.

Then came Korea, and we found ourselves fighting with obsolete piston-engine aircraft of World War II vintage. In recent months we have seen the emergence in significant numbers of high performance Russian-built jet fighters. Not only have the Russians pressed forward with plane improvement, but there is ample evidence that they have continued to expand and improve their large scale manufacturing techniques—*techniques which turned out 40,000 planes a year in the last three years of World War II.*

Since Korea, Congress provided in fiscal 1951 and 1952 appropriations in excess of \$25,000,000,000 for aircraft procurement. But it is important to realize that as of this date not a single *combat* aircraft has been delivered as a result of orders placed from these funds. Nor will many be delivered for some time to come.

It still takes from four to seven years to develop and procure an airplane. What the engineers call lead time—the period between the placing of an order and the time when all the intricate parts can be made and scheduled from all points of the compass into a complete airplane—cannot be reduced

Military Air Transport Capabilities Soar



1,000 aircraft were required to provide supplies during the Battle of the Bulge in World War II. The same tonnage has been delivered by 68 planes in the Korean War.

(Average distance is longer for Korea than in the Bulge operation. Bigger and better planes brought the improvement.)

"PLANES"

SOURCE: 315th Air Division, Combat Cargo Command, FEAF.

Low Volume Keeps Aircraft Costs Up, But Other Prices Have Risen Faster

substantially even if we were to go on an all-out mobilization basis.

It is natural in this country, as in all peace-loving countries, that our hopes and fears fluctuate up and down with news from the battlefield. But whatever the eventual outcome in Korea, it should be everlastingly clear that we would be foolish to let down our guard so long as the Russian threat remains a dominant influence in the world.

Need Orderly Procurement

Between World War II and Korea we let our air power wither on the vine. The great manufacturing industry that in March, 1944, had produced more than 9,100 military planes in that one month was whittled down by the summer of 1946 to less than 200 planes a month. Aeronautical research soon was on almost a starvation diet. Skilled production teams, of necessity, scattered far and wide into other industries.

Does not the present situation clearly show why in common sense we must, even if world tension should ease—and there is no indication it will—reach a sound and orderly basis for planning our development and production of aircraft? Few will dispute that for the foreseeable years ahead air power will be our first line of defense. For this future, then, let us put our production on a long-range basis instead of a hand-to-mouth, crisis-to-crisis existence. Not only will it be cheaper in dollars but it may well mean the difference between survival as a free nation, and utter destruction.

CARL VINSON
Chairman, House Committee
on Armed Services

While the cost of military aircraft construction is high—due to inflation and to the infinitely more complex high-performance planes being produced today—engineering, manufacturing and management efficiency of the aircraft industry has kept the cost-rise curve much lower than in many other essential activities.

One builder of outstanding military and commercial planes computes the cost of its aircraft at 250% more than in 1939. But by comparison, Army tanks now cost 733% more than in 1939. Navy destroyers cost 471% more. Home construction is up 257% in cost.

Such comparisons, however, do not tell all the story. In the aircraft industry, costs are much higher for low volume production and in the case of a typical manufacturer, production today is little more than 1/25th of the World War II peak. A modern plane requires fantastic amounts of engineering and tooling, whether the factory builds one plane or 1,000.

Volume production cuts this tooling cost per plane sharply. This company reports that in volume, with the same aircraft, tooling for 100 planes would cost \$15,000 per plane; for 500 planes it would be \$4,000 per plane, and for 1,000 planes tooling cost would be \$2,500 per plane.

One reason present aircraft costs seem particularly high, compared to costs at the end of World War II, is that big tooling and development costs of most World War II planes were written off long before war-end prices were reached. Today's costs include these expensive factors.

In addition, military contracts today often include extra design work and standby tooling, ready for big scale production in an emergency. While this is considered a wise policy by defense planners, the extra costs usually must be charged against the relatively few planes being built, forcing up unit costs from still another direction.

Railways Need Planes Today, Says Official

Use of private utility airplanes by the railroads to conduct many of their essential activities, is recommended by a railroad operating official whose endorsement illustrates the growing business uses of the airplane.

In an article in *Railway Age*, "Bible" of the railroad industry, Charles J. Miller, assistant roadmaster of the Western Pacific Railroad, said the airplane is a "reliable, usable machine" and should be used by the railroads "as another tool for railroad management in meeting different railroad operating and maintenance problems."

Among the uses he listed: delivery of messages or parcels, delivery of repair parts, last-minute payroll matters, flood or fire control, routine patrol of lines in difficult country, emergency travel, educating of equipment supervisors by more frequent visits to roadway equipment, more frequent attendance at conferences.

Miller said that in the category of "unpredicted" uses such as flying key men to the scene of wrecks, determining equipment needed, and conditions for re-routing of trains "an airplane may pay for itself many times over within a few hours."

Answers to Planes Quiz

- (c) Existing New York-London fare is \$395. After May 1 the tourist rate will be \$270 one-way and \$486 round-trip.
- (c) An engine on an Air Rescue Service plane recently completed 1,200 hours of flight time for a distance equivalent to seven trips around the world without being changed.
- Estimated on straight production with material costs, labor supply, etc., remaining constant: if 100 planes cost \$100,000 each, 500 planes would cost \$57,300 each; 1,000 planes would cost \$44,800 each.
- True. Pilots of crop dusting and forest fire control planes have been put on the Labor Department's list of critical occupations.
- True. Conversion has been made in six hours and 10 minutes.
- (c) One aircraft builder used 1.4% of plant space for research and testing at height of World War II; today more than 20% of the space is thus used.
- (c) 1,000 pounds.
- At Edwards AFB a jet fighter engine change has been made in 20 minutes and 50 seconds.
- True. In 1951 the government paid 16 domestic trunk lines about \$38,000,000 for carrying mail, compared to some \$46,000,000 in 1950—despite a 26% increase in volume handled.
- A revised list of agricultural and industrial aircraft operators is available free from General Flight Branch, Flight Operations Division, CAA, Washington.

A new electronic "brain" holds bombers at a predetermined altitude that varies not more than a yard at 40,000 feet, even though the weight is lessened by dropping the bombload.

Some of today's best jet fighter planes are coming off the assembly line factory-equipped for mid-air refuelling.