## PDHonline Course M642 (15 PDH)

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# Douglas DC-3: Queen of the Skies


*Instructor: Jeffrey Syken*


**2020**


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## Part 1

## Queen of the Sky

3

## Far Horizons

4

*"ON an early evening in late 1938, a gleaming American Airlines DC-3 departed Newark Airport, bound for Glendale, California. The takeoff, wrote a 'Fortune' magazine reporter aboard to record the still-novel experience of cross-country air travel, was effortless. 'Halfway along the runway,' he recounted, 'she left the ground so smoothly that none of the first fliers in the cabin realized what had happened until they saw the whole field rushing away behind them and the factory lights winking through the Jersey murk ahead'…"*
*smithsonianmag.com*, April 2013

5

Caption: "A Douglas DC-3 prepares for a revenue flight"

6

***"…By the time the flight crossed over Virginia, passengers had already polished off a dinner of soup, lamb chops, vegetables, salad, ice cream and coffee. After a refueling stop in Nashville, the DC-3 continued west. Beyond Dallas, the journalist added, 'visibility was limited only by the far horizons of the curving earth.' Despite head winds, the plane arrived on schedule at 8:50 a.m. Total time was 18 hours 40 minutes, including several ground stops…"***
***smithsonianmag.com,*** **April 2013**

7

**A Quantum Leap Forward**

8

***"…In 1934, the year before the introduction of the DC-3, a flight from New York to Los Angeles was a grueling ordeal, typically requiring 25 hours, more than one airline, at least two changes of planes and as many as 15 stops or so. Now, a single plane could cross the country, usually stopping only three times to refuel…"***
***smithsonianmag.com,*** **April 2013**
**RE: the first airline flight in the U.S. occurred in 1914 when a single passenger joined the pilot in a noisy, windy open-cockpit *Benoist* flying boat for a 23-minute hop across *Tampa Bay*. By the 1920s, the *Ford Trimotor* carried 13 passengers from coast-to-coast, but its limited range of 570 miles, slow cruising speed (100 mph) and modest instruments meant that the trip took 48 hours overall (not all of it was aboard the plane, part of the journey was by rail). In comparison to these earlier flights, the DC-3 was a quantum leap forward.**

9

**For Business and/or Pleasure**

10


WITH its schedule carefully designed to provide the maximum in frequency and convenience, Chicago & Southern offers you quick access to every important city in the Midwest and South – in the greatest comfort, security and luxury now available in modern transportation. This great new fleet of famous Douglas DC-3s has been made possible by the ever mounting popularity of the services offered by Chicago & Southern. Thousands of travelers have saved time and money flying "The Valley Level Route" on both business and pleasure – thousands more will do so, faster, and in greater comfort, during the years to come.

11

**A Genuine Pleasure**

12

***"…I would like to mention the flight I recently commanded in one of the Douglas Luxury airliners. It was one of a fleet of fourteen which Eastern Air Lines, Inc., was taking to place on their eight hour service between New York and Miami, as well as their service between Chicago and Miami, and New York and New Orleans…"***

***Capt. Eddie Rickenbacker***

**RE: excerpt from an article the WWI ace authored for the February 1935 issue of *Modern Mechanix* magazine entitled: "Around the World on the New Airways of the Seas"**

13


***"…Having received favorable weather reports, we left Burbank, Calif., after breakfast, at 5:42 a.m. on November 8, with three passengers, a crew of three, and additional gasoline tanks containing 360 gallons. We climbed to an altitude of approximately 12,000 feet at the rate of 400 feet-a-minute. Due to encountering cross-winds our speed was slackened and instead of refueling at Chicago, as we were following the Great Northern Circle route, we were forced to land at Kansas City for refueling. Due to the ability of the TWA personnel at Kansas City to render efficient and quick service, we were only on the ground 12 minutes for refueling with 650 gallons of gasoline and one gallon of oil, as well as changing the crystals in our radio for eastern frequencies…"***

***Capt. Eddie Rickenbacker,* February 1935**

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***"…After leaving Kansas City we climbed to an altitude of approximately 17,000 feet, in other words reaching the sub-stratosphere and with exceptionally good tail winds averaged 256 miles an hour for one hour. We were flying over the clouds from Terre Haute, Ind., until we were over Wilmington, Del. From there on we came down gradually until we landed at Newark Airport at approximately 8:46 p. m., exactly 12 hours, 3 minutes and 50 seconds after leaving Los Angeles, completing the first transcontinental transport trip with only one stop - breakfast in Los Angeles and a late dinner in New York City…"***

***Capt. Eddie Rickenbacker,* February 1935**

15

***"…With this new type of Douglas plane, air travel has become a genuine pleasure as at the end of the above trip we all felt fine and ready to turn around and go back. This feature was also proven in the London to Melbourne race as it is reported the pilots in the winning English plane were at the point of exhaustion on their arrival, whereas passengers and crew of the second place Douglas looked fine and quite refreshed…"***

***Capt. Eddie Rickenbacker,* February 1935**

**RE: KLM entered a 14-seat Douglas DC-2 called the "Uiver" in the 1934 London-to-Melbourne *MacRobertson Air Race.* Run as a commercial flight and completing the race's 22 stop-overs, the plane carried three passengers (two Dutch bankers; *Pieter Gilissen, Roelof Domenie* and German aviatrix and journalist *Thea Rasche*) and 25K letters.**

16


**Caption: "The KLM Uiver Douglas DC-2 crew. Left-to-right: Cornelis van Brugge (Radio Operator), Koene Dirk Parmentier (Pilot), Jan Johannes Moll (Co-pilot) and Bouwe Prins (Flight Engineer)"**

17

**Coming in for a Landing**

18

***"HIGH above a peaceful Illinois countryside, a TWA skyliner streaks eastward, its silver wings flashing in the morning sun. In the cabin a smiling stewardess moves down the aisle, arousing her fourteen dozing passengers. 'Fasten your seat belts, please,' she requests. 'We land at Chicago in ten minutes'…"***
***Popular Mechanics,*** **October 1936**

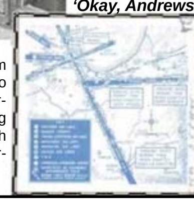
19

***"…Up front Capt. Harry N. Andrews and his mate prepare to encounter the heavy traffic of the world's busiest airport. The pilot glances at his instruments, then speaks into his radio-phone. 'Andrews in TWA 320,' he announces. 'Ten miles west of airport at 4,000. Arrive 10:58. Go ahead'…"***
***Popular Mechanics,*** **October 1936**

20

***"…His voice blares from one of several amplifiers in a tiny glass-enclosed tower atop the passenger station at the Chicago Municipal Airport. One of the two men in the control tower picks up a radiotelephone and makes an instant reply. 'WGEH to Andrews, TWA 320, ten miles west at 4,000,' comes the answer in Andrews' ear-phones. 'Two private planes are flying at 3,000 south of port. United's Trip 10 is taking-off and will take an eastern course at 6,000 feet. Wind southwest by west five, Kollsman barometer twenty-nine. Ceiling 2,500. Visibility three miles'…"***
***Popular Mechanics,*** **October 1936**

21



Talking by radio from tower to pilot about to land at Chicago airport, and map showing route followed by each line approaching airport

***"…'Okay, WGEH,' comes the voice of Pilot Andrews, 'wind southwest by west five.' A few minutes later the pilot again hears the voice of the control man. 'WGEH to Andrews, TWA 320,' comes the message. 'I see you southwest of the field. There is nothing around that section to bother you. Those two private planes are now several miles south of here. Okay to land. Use the southwest runway, please.' The big air liner swoops low and as its wheels roll over the runway. Pilot Andrews again hears the voice of the control man. 'Okay, Andrews, to turn right,' he is informed. 'One of those private planes is preparing to land at your left. Taxi to Gate three.' Such is the procedure today in handling traffic at the country's most congested airports…"***
***Popular Mechanics,*** **October 1936**

22

Pilots conversing with traffic control as they near Chicago. Below, air flaps on transport plane, and diagram showing application.


23

**The Changing Times**

24


The Douglas luxury airliner (above), which Capt. Eddie Rickenbacker commanded as a record breaking trans-continental flight, is capable of trans-oceanic air service, according to the noted flier. At right, Capt. Rickenbacker (in civilian clothes) is seen leaving the plane after flying from Los Angeles, California to Newark, New Jersey, in 12 hours, 3 minutes and 30 seconds.

***"…With the scientific improvement in instruments, radio equipment, radio beacons, and improved landing fields and facilities, there will, in my opinion, be an 8 to 10 hour regular transcontinental service available within the next three or four years, and in addition the planes operating on this service will be equipped as Pullman sleepers…"***
***Eddie Rickenbacker,*** **February 1935**

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***"…A few years ago traffic was no problem. Except for a few federal 'safety rules of the road,' pilots were allowed to pursue almost any course they pleased in landing and taking-off. Then, around busy airports, the air began to be full of planes. Within the last five years the number of ships making scheduled trips over the airways has about doubled. And the amount of time these same ships spend in the air has quadrupled, due to new instruments which virtually make all-weather flying possible, and to the development of ships and engines which require less time in the hands of maintenance crews…"***
***Popular Mechanics,*** **October 1936**

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## Cause for Concern

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***"…At the Chicago Municipal Airport, for instance, arrivals and departures average more than 150 per day or about 60,000 per year. From three to seven air lines use some of the large airports and arrivals and departures in many cases occur at approximately the same time. Pilots began to worry about the possibilities of trouble in these congested airport areas…"***
***Popular Mechanics,*** **October 1936**

**<u>Above</u>: *Chicago Municipal Airport* pioneered the dual runway system (it had dual runways in all directions) and was equipped with state-of-the-art GCA (*<u>G</u>round <u>C</u>ontrol <u>A</u>pproach*) equipment. From their glassed-in octagonal control tower (atop the modernist-style terminal building), a staff of twenty-five air traffic controllers kept air and ground traffic moving swiftly and safely.**

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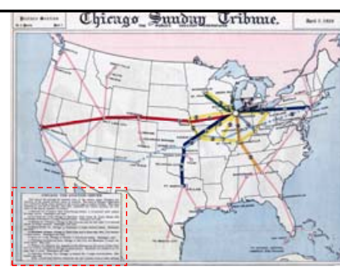
**<u>Above</u>: caption: "Chicago Municipal Airport, 1927. As proposed at the Chicago Airport Conference, December 12-15, 1927, Hotel Sherman."**
**<u>Left T&B</u>: caption: "Municipal Airport, 1929. Chicago Aerial Survey Company."**

29




This map of the principal air transport lines of the country shows Chicago's preeminence as the natural aviation center of America. Main lines operating in and out of Chicago, with their equipment and routine business, are indicated on the map by numbers, as follows:

① National Air Transport. New York-Chicago-Dallas: 6 tri-motored cabin planes: 30 single motors. Passengers and mall.
② Universa! Air Lines, Chicago to Cleveland. Twin Cities. St. Louis, Kansas City and Omaha; 8 tri-motors; 12 single motored planes. Passengers and mail.
③ Boeing Air Transport, Chicago to San Francisco and the west coast: 4 tri-motored planes: 29 single motored. Passengers and mail.
④ Embry-Riddle Co., Chicago to Cincinnati; 8 single motored planes. Passengers and mail.
⑤ Northwest Airways. Chicago to Twin Cities and to Green Bay. Wis.; 2 tri-motors; 3 single motors. Passengers and mail.
⑥ Stout Air Lines. Chicago to Detroit; 3 tri-motored planes. Passengers only.
⑦ Thompson Aeronautical Corp., Chicago to Bay City and Muskegon; 4 single motored planes. Mail only.
⑧ Western Air Express. Los Angeles and San Francisco by rail and air to New York with air transfer junctions to Chicago at several points. Equipment not completed as this page went to press. Passengera and mail.
⑨ Interstate Airlines, Inc., Chicago to Atlanta, Ga.; 4 aingle motored planes. Passengers and mail.

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## Law and Order

31

***"…As a result, the federal Bureau of Air Commerce and the commercial air line operators adopted a series of interline safety agreements, hard and fast regulations intended to prevent accidents or delays when a large number of ships are converging on the same airport simultaneously, particularly at night or under poor visibility conditions. Adoption of the agreements was followed by the appointment of a traffic coordinator for the Bureau of Air Commerce who is directing the formulation of regulations similar to the unofficial agreements, which eventually are expected to become a part of the air commerce laws…"***

***Popular Mechanics,*** **October 1936**

**RE: in 1929, fifteen airlines pooled $100K to set up the not-for-profit organization *Aeronautical Radio, Inc.* (ARINC), to serve as the single coordinator of aeronautical communications for the air transport industry, using a common network of ground stations. The Federal Government's *Bureau of Air Commerce* (BOC) established an ATC system in 1936 built, primarily, from the previous work of airline networks.**

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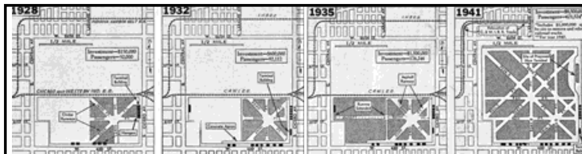
**A civil process was set forth to assure aircraft separation while flying in instrument conditions, including flight plans and position reporting. The transition to civil control from airline control opened the airways to include military/government and general aviation pilots with *Instrument Flight Rules* (IFR). The military was expected to provide equivalent certifications, while the general aviation pilots joined the commercial pilots. Stated objectives for ATC included:**

- **Flight in instrument flight conditions demand separation horizontally and vertically;**
- **Orderly sequencing for arrival;**
- **Air-traffic control operates continually even in favorable weather;**
- **Airplane reports departure, position, arrival;**
- **Position report when crossing over radio beacon;**
- **Filed flight plan including private and state aircraft;**
- **Departure clearance to first fix;**
- **15 minute position reporting, and;**
- **Using vertical separation, speed limits, and holding patterns to manage traffic.**

**Inflight position reporting was the cornerstone of separation, allowing the ground controller situational awareness of the traffic in each air corridor. Every fifteen minutes, the controller would move "shrimp boats" on a map to designate the position of each aircraft inflight. The airline dispatch office would arbitrate between communications with the aircraft and the controller (the controller had no way to talk to the aircraft directly).**

33





***"…Because conditions were different for each airport, it was necessary to draw up separate regulations for each of the busiest terminals. The most complicated of all was the Chicago safety agreement because seven lines center at the Chicago Municipal Airport…"***

***Popular Mechanics,*** **October 1936**

**Above: caption: "The Growth of Chicago Midway Airport: 1928-1941"**

**Left: caption: "An American Airlines stewardess holds sign bearing new name of Chicago Municipal." In December 1949, the name was officially changed to "Chicago Midway Airport."**

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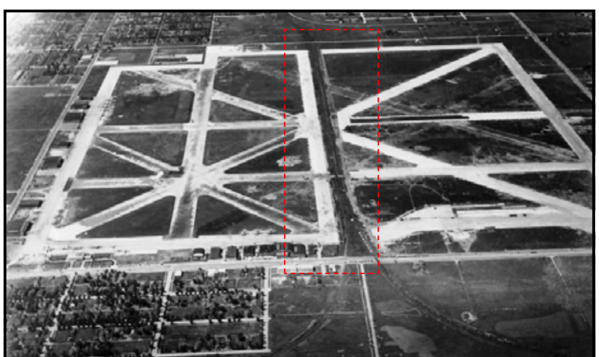

**Caption: "An aerial view of the Chicago Municipal Airport shows the old and new field bisected by railroad tracks. A passenger aboard a TWA Skyclub plane noticed a snail-like image crossing the center of the field. Upon landing, he learned that it was a freight train. Bewildered, the passenger left the depot wondering whether Chicago will have one useful airport or two useless ones."**

35


***"An exchange of legal papers between city representatives and officials of the Chicago and Western Indiana railroad yesterday gave Chicago title to a strip of land that has been a barrier since 1931 to enlargement of the city airport. The strip of land, approximately 75 feet wide and a mile long, was until yesterday a C.&W.I. right-of-way. A double line of tracks and an embankment still are on it. Today, during ceremonies in which railroad, city and aviation officials will join, work crews will commence tearing away these obstructions and joining the two halves of what soon will be a mile square landing field…"***

***Chicago Tribune,*** **May 1, 1941**

**Caption: "Photodiagram of the Chicago airport, a mile square section of land, showing how removal of tracks will double the present size and add runways. In the foreground is the new section and in the background is the present field. Both halves of the field are already equipped with concrete runways, drainage, landing lights, and fencing."**

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*"…The airport area now available is bounded by 55th and 63d streets, Cicero and Central avenues. The old right-of-way cut this in half along the line of 59th street. The city bought a new right-of-way in line with 54th street - 200 yards outside the airport's northern boundary - and built new railway tracks which the C.&W.I. accepted in exchange for the old. Today's ceremonies will include the driving of a golden spike by Mayor Kelly - to signify completion of the new tracks - and the removal of the test track and cross tie from the old tracks. The railroad will run a special train over the new tracks and serve luncheon to 150 guests. The title transfers yesterday took place in the office of Benjamin C. Kilpatrick, vice president of the American National Bank and Trust company…"*

***Chicago Tribune,*** **May 1, 1941**

**Caption: "A crowd gathers around Chicago Mayor Edward Kelly (not visible) as he drives a golden spike to complete the new railroad tracks on May 1, 1941, which made it possible for Chicago Municipal Airport to expand"**

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## Skyways

38

*"…The skyways traveled by commercial aircraft may be likened to broad highways traveled by automobiles, except that the skyways have a third dimension - that is, there are various levels at which ships may fly. Commercial ships follow routes marked by flashing light beacons on the ground and by radio range beacons emitting audible signals to keep pilots on course regardless of visibility of the light beacons…"*

***Popular Mechanics,*** **October 1936**

39

*"…Since the routes of all seven lines using the Chicago airport converge at that point, the vicinity of the airport is an area of heavy traffic for planes, just as several converging main highways would be an area of heavy traffic for automobiles. In each case, regulation is necessary to prevent traffic snarls and possible accidents…"*

***Popular Mechanics,*** **October 1936**

40

## Sky Cops

41

*"…The 'traffic officers' who regulate landings and take-offs from the Municipal airport in Chicago are housed in a little glass cubicle perched atop the passenger terminal. The control men issue their orders over WGEH, a fifteen-watt transmitter with a maximum range of about 100 miles under ideal conditions, although most communications involve distances of only fifteen or twenty miles. A localizer radio beam enabling pilots to determine when they are over the field and guiding them down also is operated from the tower…"*

***Popular Mechanics,*** **October 1936**

42

## Command and Control

43

*"…In the tower also are more than a dozen radio receivers, each with its own loud-speaker. Over these receivers the control men hear the reports of the pilots made to their own lines while the ships are still many miles from the airport…"*
***Popular Mechanics,*** **October 1936**

44

*"…In the case of Pilot Andrews, for instance, the control tower was not 'taken by surprise' when Andrews made his first call. The towermen knew Andrews had cleared Kansas City for Chicago, and under the safely regulations, Andrews reported to the TWA station in Chicago when 100 miles from the terminal, giving his position, altitude and estimated time of arrival. So the control tower men were anticipating the radio report from Andrews…"*
***Popular Mechanics,*** **October 1936**

45

*"…Red and green 'stop and go' lights atop the glass tower are used by the control men as visible signals in addition to the audible instructions transmitted by radio. The lights also are used to signal ships without radio equipment. The red light 'locks' the field to enable a plane to land, and no other ship can go out on the runways as long as the red light is on. Planes with radio receivers but no transmitters get their instructions by radio from the control tower and indicate they understand by dipping their wings or by some other signal requested by the towerman…"*
***Popular Mechanics,*** **October 1936**
**Caption: "Stop-and-go light on control tower"**

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*"…The control tower governs the take-off of planes as well as the landing. A pilot, before taking-off, must inform the control tower of his destination, the altitude he expects to fly, the estimated time of arrival and any other pertinent information about the trip. This is also a rule at other control towers and the information is relayed between points. Thus WGEH is informed in advance of every departure and anticipates every arrival…"*
***Popular Mechanics,*** **October 1936**
**Caption: "Keeping log of arrivals and departures in traffic control tower"**

47

## One Flew East, One Flew West

48

*"…With such an arrangement it is easy, for example, to control accurately the landing of two ships from the west and one from the east even if they are due at the same time. Perhaps favorable winds indicate it is best for the ship from the east to land first. The pilot would then be so advised. At the same time the other ships would be told by their own company radio stations of their relative positions to each other, and each would be assigned a definite altitude to hold. Then each plane would be brought in separately after the one from the east was down…"*
***Popular Mechanics,*** **October 1936**

49

*"…This close cooperation between the control tower and the radio stations and operations departments of the various air lines is made possible by an interphone system linking all together. If the control tower wishes to talk with TWA offices, the man in charge simply calls, 'Control tower to TWA.' This is audible to all stations through a loud-speaker, but when the TWA phone is picked up, the loud-speaker is disconnected, thus affording private conversation…"*
***Popular Mechanics,*** **October 1936**

50


*"…Included in the safety agreements is a provision that commercial planes be equipped with Kollsman altimeters adjusted to correspond to readings of the nearest ground station Kollsman barometer which is maintained at the sea-level altitude of the ground station. East bound planes on the radio range course are required to fly at even 1,000-foot levels - 2,000 feet, 4,000 feet and so on, while west-bound planes fly at odd 1,000-foot levels - such as 3,000 feet, and 5,000 feet…"*
***Popular Mechanics,*** **October 1936**

**RE: the barometric pressure setting window is a/k/a the "Kollsman Window" (named for its inventor *Paul Kollsman*). Pressure altitude is the indicated altitude when an altimeter is set to 29.92 (1,013.2 mb). It's the height above the standard datum plane; it can also be determined by applying a correction factor to the indicated altitude displayed when it's set to the reported altimeter setting. Pressure altitude is used by all aircraft in the U.S. and Canada at and/or above 18K-feet. Aircraft performance charts are usually based on pressure altitude (or sometimes density altitude). On that very rare "standard day," pressure altitude will equal true altitude.**

51

*"…Pilots crossing an airway must proceed at the 500-foot levels to be out of the way of planes using that airway, and must cross at an angle of forty-five degrees or more in order to make the crossing as quickly as possible. Of course all ships are required to 'keep to the right' of the radio beam along which they are proceeding…"*
***Popular Mechanics,*** **October 1936**

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**Similar, But Different**

53

*"…The take-off directions are quite similar to the landing instructions from the control tower. Pilot Andrews, for example, was scheduled to take-off for the east ten minutes after his landing at Chicago from the west. After calling the tower and reporting his trip, he was given his clearance by the ground dispatcher. The control tower then advised him to proceed to a certain runway, called his attention to other ships in the air or taking-off, and finally gave him the 'go ahead' to proceed down the runway…"*
***Popular Mechanics,*** **October 1936**

54

***"…Once in the air, he was further advised by the control tower of other ships flying nearby and of any he might encounter on his course. A final 'Okay, WGEH' from pilot Andrews indicated that he had cleared the airport district and was switching to the radio station of his own line."***
***Popular Mechanics,*** **October 1936**

55

## A Real Money-Maker

56

***"…Today, a legendary DC-3 hangs suspended in the Smithsonian National Air and Space Museum. The plane, says F. Robert van der Linden, the museum's curator of aeronautics, 'is widely considered to be the first airliner capable of making money just by carrying passengers'…"***
***smithsonianmag.com,*** **April 2013**
**Caption: "Douglas DC-3 – National Air and Space Museum"**

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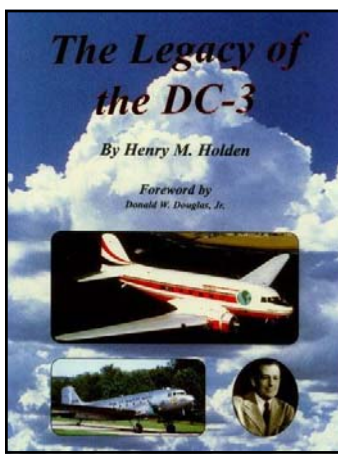
## Capturing the Imagination

59




***"…Built by Douglas Aircraft, founded in 1921, the DC-3 incorporated breakthroughs developed at Douglas and Boeing - super-charged 1,200-horsepower twin engines, cantilevered metal wings, retractable landing gear. But the plane's primary - and romantic – accomplishment, says Henry M. Holden, author of 'The Legacy of the DC-3,' is that it captured America's imagination…"***
***smithsonianmag.com,*** **April 2013**
**RE: Douglas built the "Douglas Commercial 3" based on the earlier DC-1 and DC-2. Building on the smaller, slower and narrower (by 2-feet) DC-2 (1933) and solitary prototype DC-1 (1932), the DC-3 made safe transcontinental flights possible.**

60

**The DC-3 married reliability with performance and comfort as no other airplane had before it, revolutioizing air travel and finally making airlines profitable. Designed and built by a *Douglas Aircraft Company* team led by *Arthur E. Raymond* (who later worked on the *Gemini* and *Apollo* space missions for NASA), the DC-3 went straight into production. Within a year, *Royal Dutch Airlines* (KLM) was flying a DC-3 service from Amsterdam to Sydney. The DC-3 was a truly forward-looking design. Because its cabin was unpressurized, the DC-3 never suffered from the kind of metal fatigue caused by "pressurization" whereby fuselages are forced to expand and contract with every take-off/landing cycle.**

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## The Only Way to Fly

62



***"…The journey became the destination. And with good reason: Passengers aboard the plane entered a cosseted world inconceivable to today's beleaguered air traveler. 'Once airborne,' Holden says, 'passengers were offered cocktails, followed by entrée choices such as sirloin steak or Long Island duckling, served on Syracuse China with Reed & Barton silverware. At cruising altitude, the captain on occasion would have strolled the aisle and chatted with passengers, who were called 'visitors' or 'guests'…"***

***smithsonianmag.com,* April 2013**

**Caption: "'Flying Pullman' Offers Air-Travel Luxury"**

63

***"…Recall, too, Holden adds, that 'transcontinental sleeper flights featured curtained berths with goose-down comforters and feather mattresses. Breakfast choices might have been pancakes with blueberry syrup and julienne-of-ham omelettes'…"***

***smithsonianmag.com,* April 2013**

**RE: the DC-3 had originally been designed as a luxury airliner for *American Airlines,* flying 14 to 16 sleeper berths (complete with dressing rooms, a "honeymoon cabin" and a galley serving hot meals) from New York to Chicago. Transcontinental trips from Los Angeles to New York could be made in about 15 hours (17 hours from NY to LA).**

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**New De Luxe Sleeper Planes**

THE day was, when to ride in an airplane was an adventure, and one which involved a degree of "roughing it." The newest plane design carries all the facilities of luxury and comfort afforded by any form of transportation; made possible by the great size of the new high-speed transports…(*Science and Mechanics,* March 1936)

65

…The new Douglas Sleeper Transports, of American Airlines, pictured here, have a wing span of 95 feet, an over-all length of 65 feet, and height of 17-1/2; feet; the gross weight is 24,000 pounds, and they can carry 24 passengers each as day planes, or 16 as night passengers, with sleeping accommodations. The maximum speed is 215 miles-an-hour at the altitude of 7,000 feet; the normal cruising speed, 190 miles; the landing speed, 65 miles-an-hour, or less. The cruising range is 1,100 miles with 24 passengers, or 1,400 miles with 16 passengers…(*Science and Mechanics,* March 1936)

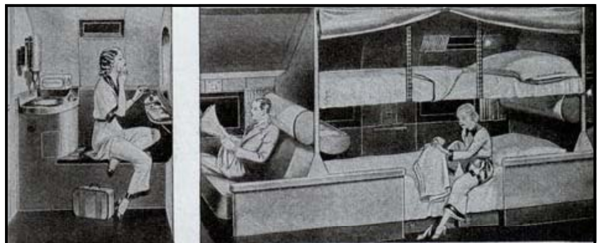
Upper: caption: "A new Douglas Sleeper Transport, of the American Airlines"

Lower: caption: "Diagram of the separate dressing rooms, showing arrangements"

66

…Power will be such that take-off and climb may be completed with either of the two 1,000 horsepower engines, and uninterrupted flight maintained with a single engine. Both are equipped with propellers which automatically adjust their pitch (by turning the blades) to maintain maximum efficiency under the varying atmospheric conditions encountered in take-off and flight (air is thinner above). The wheels, in flight, are completely retracted into the engine nacelles (housings); and a new type of landing gear gives unusual strength and smoothness of landing…(*Science and Mechanics,* March 1936)

67



…The cabin is the roomiest yet provided on an American air line. It has eight roomy sections which fold together to form as many upper and lower berths; each 6 feet 5 inches long. There will be two dressing rooms, for men and women passengers; and in front, a commissary for serving more elaborate meals, hot and cold, without the need of the previous thermos equipment universally used. Baggage and mail space is also provided, and complete radio equipment; as well as the "automatic pilot" which supplements the manual controls. (*Science and Mechanics,* March 1936)

Left: caption: "Ladies' dressing room of the sleeper plane"

Right: caption: "A seat section, and a pair of berths made up"

68

## A Bygone Era

69

***"…In that heady pre-World War II era when the nation began dreaming of air travel, the runaway appeal of the DC-3, whether fitted with berths or only with seats (like the museums' plane), convinced Americans to take to the skies in record numbers…"***

***smithsonianmag.com,* April 2013**

**Caption: "Looking to the rear of the passenger 21-seat cabin from the DC-3's cockpit bulkhead"**

70

***"…In 1940, more than two million Americans made trips by air; cost-per-mile for the consumer decreased from 5.7 cents in 1935 to .05 cents (round-trip, coast-to-coast flights were a pricey $300, the equivalent of $4,918 today, but business customers in particular flocked to take advantage of the time saving)…"***

***smithsonianmag.com,* April 2013**

71

## The Wright Stuff

72

*"…No less iconic a figure than Orville Wright became a booster. In the late 1930s, when TWA opened a route to Dayton, Ohio, the 65-year-old Wright was on hand to witness the arrival of the DC-3 at his hometown airport. 'They tell me that [the plane] is so sound-proof that the passengers can talk to each other without shouting,' Wright told reporter Douglas Ingells that day. 'This is a wonderful improvement. Noise is something that we always knew would have to be eliminated in order to get people to fly. Somehow it is associated with fear.' Wright had only praise for the plane bringing flight to the masses. 'They've built everything possible into this machine,' he said, 'to make it a safe and stable vehicle of the air.' Wright, however, declined an offer to be taken up for a spin in the DC-3 that day. He didn't give a reason. Perhaps he simply thought that the plane belonged to the next generation of pilots. …"*
***smithsonianmag.com,*** **April 2013**

73

## In Peace and in War

74

*"…Those fliers, of course, would soon take the DC-3 to war as the C-47, modified for cargo and troop transport. On D-Day, paratroopers dropped behind enemy lines were ferried to France aboard the C-47…"*
***smithsonianmag.com,*** **April 2013**
**RE: the onset of WWII saw the last civilian DC-3s built in early 1943. Most civilian DC-3s were pressed into military service and the *U.S. Army Air Force* (USAAF) C-47 (USN R4D) began rolling-off Douglas' Long Beach, Calif., assembly line in vast numbers. Easy-to-fly, simple to maintain and able to take-off and/or land in short distances from dirt strips and/or grass runways, the C-47 made for a versatile military transport, serving in every theater-of-war.**

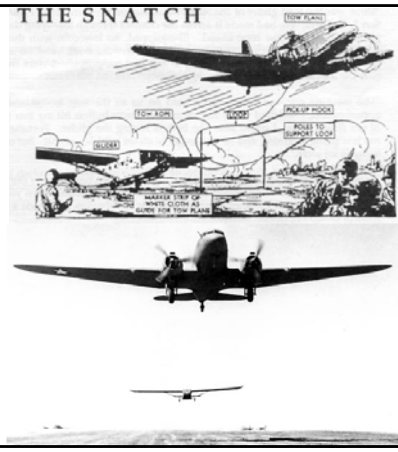
75

76

77

**Above: in many ways, the C-47 (lower) differed from the DC-3 (upper), including the addition of a cargo door and strengthened floor, a shortened tail cone (for glider-towing shackles) and a hoist attachment. In 1944, the USAAF converted a DC-3 into a glider (XCG-17) and it significantly outperformed the gliders towed by C-47s on D-Day.**

78

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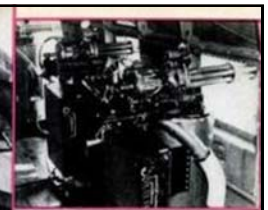


Military version of the DC-3 – the famed C-47 – carried everything from armored vehicles, artillery and troops to whole airplanes. They'd strap the wings of a P-40 under the fuselage and roll the fighter into the cargo hold. Where there was water but no landing strips, they stuck on floats (above) to give the transport amphibious operation. It flew paratroopers into battle – and ferried the wounded gently home. In Vietnam, some were even fitted out as gun platform (top right) with rows of multi-barreled guns firing out of windows that used to provide scenic vistas for pre-war Civilian passengers.

80

**Thanks Spooky!**

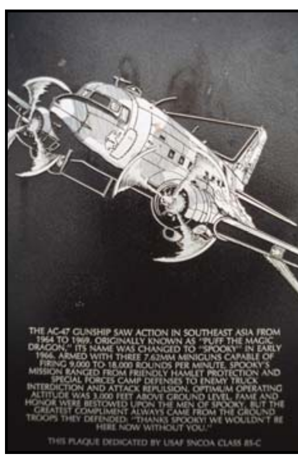
81

**In response to increased attacks by the *Viet Cong* on rural South Vietnamese outposts in 1963, American forces began assisting the defense of small villages at night by using their C-47 transport aircraft to fly in circles and drop illuminating flares, exposing the attackers to defending troops. This effective practice was the inspiration for the idea of fitting the C-47s with a powerful punch. Under "Project Gunship I," the USAF modified several C-47s by mounting three 7.62 mm *General Electric* miniguns to fire through two rear window openings and the side cargo door, all on the left (port) side of the aircraft (a gunsight was mounted in the left cockpit window).**

82

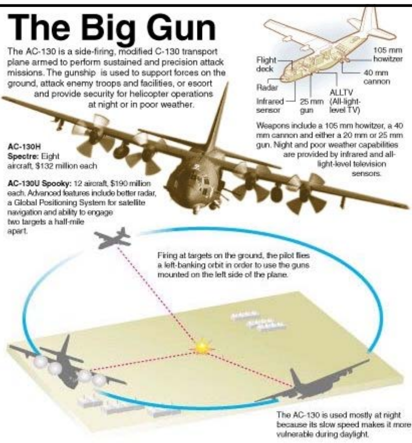
**Using side-firing weapons on aircraft can be traced back to 1927, when the concept was demonstrated by fixing a 0.30 caliber machine gun to the side of a biplane and flying a simple maneuver known as a "pylon turn." In 1963, in response to increased attacks by the *Viet Cong* on rural South Vietnamese outposts, American forces began assisting the defense of small villages at night by using their *C-47* transport aircraft to fly in circles and drop illuminating flares, exposing the attackers to defending troops. This effective practice was the inspiration for the idea of fitting the C-47s with a powerful punch. Under "Project Gunship I," the USAF modified several C-47s by mounting three 7.62 mm *General Electric* miniguns to fire through two rear window openings and the side cargo door, all on the left side (above L&R) of the aircraft. A gunsight was mounted in the left (port) cockpit window.**

83




**Orbiting a target at 3K-feet and 140 mph, the modified "AC-47" could put a bullet into every square-yard of a football field-sized target in three seconds. In December 1964, USAF Captain *Ron W. Terry*, a counter-insurgency warfare expert, led a team from the *4th Air Commando Squadron* that flew the first AC-47 missions. They were the first of many between late 1964 and early 1969, during which +6K hamlets and firebases came under the protective cover of AC-47s. Not one fell while the death-dealing aircraft was flying overhead. Another C-47, used as a leaflet-dropping, loud-speaker-equipped psychological warfare aircraft was unofficially referred to as the "Bullshit Bomber." After 1968, the AC-47s slowly began to be supplanted and replaced by both the *Lockheed AC-130 Spectre* ("Project Gunship 2") and *AC-119 Stinger* ("Project Gunship 3"). Once numbers of these aircraft were in theater, the AC-47 ranks grew smaller still until just a handful were serving into the 1970s, when they were withdrawn in favor of the Spectre. The AC-47 remained on active duty with the USAF until 2008, when it was finally retired.**

84




85

86

**Part 2**

**Conquest of the Air**

87

**Just Around the Corner**

88

**Giant dirigibles a mile in length, airplanes capable of flying at 500 miles an hour - these are only two amazing developments which Capt. Rickenbacker predicts are waiting just around the corner of the new air age in which we live. Being the greatest of America's war aces as well as a motor car engineer of national reputation, Capt. Rickenbacker's predictions are those of a recognized authority.**

***Modern Mechanics,*** **February 1929**
**RE: introduction to an article authored by *Capt. Eddie Rickenbacker,* commander of the famous 94th ("Hat-in-the-Ring") Squadron (left) and WWI "Ace of Aces" (having shot-down 26 enemy aircraft) entitled: "What Will Happen to Flying?"**

89

**The Future is Now**

90

*"MEN wonder today whether they will live long enough to see the day of airplanes. As matter of cold fact, that day is here now and we hardly realize it. We travel more commercial miles by air in this country than in all the rest of the world combined, covering 32,000 miles every twenty-four hours - a figure that will be doubled within three years…"*
***Capt. Eddie Rickenbacker,*** **February 1929**

91

**Awake to the Possibilities**

92

*"…Development of air transport will help to open vast areas of territory now unsettled. Such development requires no right-of-way. Tracks and highways are not needed. Only terminal facilities are required and these necessitate only a modest investment. Ten per cent of the annual maintenance cost of good roads in the United States would supply a fully equipped airport, one mile square, for every town of 500 population or more in the country…"*
***Capt. Eddie Rickenbacker,*** **February 1929**

93

**This Time Next Year**

94

*"…The latest report of the Aeronautics Division of the U.S. Department of Commerce lists 331 private and commercial airports, 256 intermediate landing fields, 62 Army and 17 Navy aviation fields, 326 marked auxiliary fields, and 754 proposed airports. By this time next year America will have more than 1,700 airports…"*
***Popular Science,*** **November 1928**

95

**Half-a-Day Wide**

96

***"…At the close of the Civil War, America was a continent more than three months wide; today, by the best trains, it is three days wide; in a few years it will be half-a-day wide. A few adventurers already have spanned the continent during daylight. It will be no wider than that for all of us when there are suitable airports in every American community…"***
***Popular Science,*** **November 1928**

97

**A Few of the Many**

98

***"…Lack of good airports is a brake that retards further development of aviation. A few of the many we have now are excellently designed and suitably located; but the majority are mere landing fields called 'airports' in a booster-spirit courtesy. But a landing field is not an airport…"***
***Popular Science,*** **November 1928**

99

**The Road to Everywhere**

100

INTERESTING FACTS ABOUT AVIATION

(Compiled by Francis X. Chauvin, M. A.)

The history of aviation takes us to the remotest times. Mythologists attributed to the spirits, the gods and their satellites the miraculous power to fly. Who has not heard of winged dragons, winged demons and flying horses?

Times have changed! We are now in the air age.

In transportation the milestones of progress are easily chronicled. It was first the stage coach, and the covered wagon of the early pioneers on their transcontinental treks to seek fame and fortune. Later came George Stephenson's "Puffing Billy", with it the world became steam-minded, and during the same period Robert Fulton startled the skeptics with his steam-propelled, ocean-going vessel. The twentieth century ushered in the era of the automobile, and now we have aviation—aircrafts speeding along the trackless paths of the sky, high above the boundless seas and blazing deserts, and even across the Arctic and Antarctic.

In view of the progress made by aviation, it is interesting to read the records of aviators through the centuries.

THE EARLY PERIOD

1335, B. C.—Dedalus and Icaris escape from the hands of King Minos by means of wings. Icaris' wings melted under the hot sun and he perished in the sea.

400-345, B. C.—Archytasis, famous Greek mathematician and astronomer, declares having constructed "a wooden pigeon that can fly."

1060, A. D.—The English monk Elmerus claims to have flown a furlong by throwing himself from the top of a tower.

1414 A. D.—Roger Bacon claims he can build dynamic flying machines and spreads the idea of an aerial vessel.

1495, A. D.—Leonard de Vinci studies aeronautics, makes models, tries a parachute and an helicopter, and dies leaving the plans for a flying machine.

1782, A. D.—Joseph Michel and Jacques Etienne Montgolfier build the first balloon, a paper craft.

1783, A. D.—Benjamin Franklin conceives the idea of a Montgolfier balloon propelled by motive power. This idea is the actual origin of the modern dirigible.

PERIOD OF REALITIES

1784, July 17—First balloon ascension in United States. Peter Carnes makes it at Baltimore.

1785, Jan. 7—First crossing of the English Channel in a free balloon. Dr. John Jeffries, accompanied by Blanchard, performs the feat.

1794—The French use balloons as means of observation in their war against Austria.

1843—Henson completes the plans for his steam vehicle. This is the predecessor of the modern airplane.

1896—Octave Chanute experiments on the shores of Lake Michigan. He publishes a book in which the records of his predecessors are scheduled. He and Sir Hiram Maxim, England, and Otto Lilienthal, Germany, revealed that man's best chance to fly lay in the development of the kite idea.

1897, July 11—Col. Andre, with two companions, flies from Spitsberg towards the North Pole in a balloon.

1898, Sept. 4—Santos-Dumont startles the world with his series of dirigible flights about Paris.

***"…Already some 11,000 Americans have learned enough about flying to apply for pilots' licenses. There are nearly ninety airplane models on the market, ranging in price from $1,065 to $60,000, and in horsepower from forty to 1,000. Tons of freight and hundreds of passengers are being transported through the air every day. The means for airplane transport are here; only the conveniences are lacking…"***
***Popular Science,*** **Nov. 1928**

101

1900, July 2—First voyage of a Zeppelin, the first practical aerial vessel ever invented.

1903, Oct. 7—Langley makes several experiments at Washington. Later his type of machine was improved by the famous Glenn H. Curtiss.

1903, Dec. 17—Orville and Wilbur Wright make a flight of 852 feet in North Carolina. The take-off was from rails and the machine was propelled by means of a catapult. Theirs is the first authentic flight of any duration in a heavier-than-air machine.

1909—Louis Bleriot crosses the English Channel in an airplane. This marks an important event in the progress of aviation.

CROSSING THE ATLANTIC

1919, May 18—Harry C. Hawker and Mackenzie Grieve make the first attempt to cross the Atlantic in an airplane. They fly 1200 miles in 14 hours, but fall in the ocean and are rescued by a ship.

1919, May 8—First crossing of the Atlantic to the Azores. Lt. Commander A. C. Reed is the pilot.

1919, June 14—First non-stop crossing. Capt. John Alcock and Lt. Arthur Brown start from St. John, Newfoundland, in a biplane. They spanned the distance to Clifden, Ireland,—1890 miles—in 16 hours and 12 minutes.

1919, July 26—The British Dirigible R34, commanded by Major C. H. Scott arrives at Mineola, N. Y., from East Fortune, Scotland, a distance of 3270 miles. The personnel comprised 10 officers, 17 men and 2 radio operators. The same dirigible returned to Pulham, England, in 75 hours, carrying, in addition to its original crew, Col. Wm. N. Hensley, of the Aviation Corps.

1924, Aug. 21-22—The "Round World Flyers," Lts. Lowell Smith, Leslie P. Arnold, Erick H. Nelson, John Harding, Leigh Wade and Henry H. Ogden, cross the Atlantic from Reykjavick, Ireland, to Icy Tickle, Newfoundland.

1924, Oct. 12-15—A German Dirigible crosses the Atlantic from Friedrichshafen to Lakehurst, N. J., a distance of 4010 miles. The crew consisted of 32 men, and was commanded by Dr. Hugo Eckener.

1927, May 20-21—First non-stop flight from New York to Paris. Distance 3620 miles; time 33.29.30 hours; hero: Charles A. Lindbergh.

1927, June 4-5—First trans-atlantic flight to Germany. Clarence D. Chamberlin and Charles A. Levine fly from New York to Eisleben, 3930 miles without a stop. Time 42 hours.

1927, Aug. 28—First trans-atlantic flight to England. Wm. F. Schlee and Wm. Brock take off from Havre de Grace, Newfoundland, and land at Croydon, England, a distance of 2350 miles, in 23.21.0 hours. This was the first lap of their flight to Japan.

1927, Oct. 24—First non-stop south trans-atlantic flight. Capt. Dieudonne Costes and Lt. Commander Joseph Lebrix fly from St. Louis, Senegal, in Africa, to Natal Brazil, a distance of 1980 miles in 19.20 hours. They flew around the world and covered 35,800 miles.

1928, Apr. 12—First non-stop flight across the Atlantic from East to West. It is performed by Baron G. Von Huenefeld, Capt. Herman Koehl and Major James Fitzmaurice. They flew from Baldonnel, Ireland, with New York as their objective. They landed on Greenly Island after having travelled 2,070 miles.

1928, June 17—Miss Amelia Earhart, Wilmer Stultz and Louis Gordon fly from Trepassy, Newfoundland, to Burry, Wales, in 20.40 hours.

IMPORTANT FLIGHTS

1919, Nov. 12—Sir Ross and Sir Keith Smith fly from London to Australia—14,350 miles.

1926, May 9—Lt. Commander R. E. Byrd flies to the North Pole in the Josephine Ford.

102


**Caption: "Across the sky, annihilating distance, the airplane wings DIRECT to its objective. In remote districts it supplants with an hour's flight weeks of labor on portage and trail. In settled territories it accellerates two and three-fold the transport of passengers, mail and express. Over great reaches of timber and pulpwood its watchful eye protects a national heritage from fire. It maps unpenetrated wilderness. It speeds prospectors to new Klondykes. At thrice the gait of an express train it brings succor to those in need. The qualities that won Canada eminence in military aviation assure equal eminence in commercial flight. Thanks to governmental foresight and individual and corporate enterprise, Canada is making an orderly and safe use of this new Road to Everywhere. And wherever man has need to fly, there Imperial service and Imperial quality are at his disposal. (*Imperial Oil, Ltd.* of Canada ad, ca. 1928)**

103


***"I'll be with You Next Week in my New Heath Parasol"***
**say thousands of new builders of America's most popular sport plane. Start building your Parasol now for only $12.00!**

This week, next week, every week — more and more Heath Parasols are in the air offering new thrills and new pleasures to countless thousands who never before could afford to fly. Some of these new flyers have long waited for a light plane offering complete safety with ease of handling. Others have been waiting for a truly dependable plane — at a cost they could afford. To both groups — the Heath Parasol now opens the airways of America for the first time in aviation history.

For the Heath Parasol is the easiest ship to fly ever built. It is off the ground in 4 seconds — and at the end of the field is higher than any plane ever created. Flyers who never before have soloed — have flown the Parasol with ease and complete safety. Its cost is utterly without parallel. Consider that it goes 40 miles on a gallon of gasoline. Observe that it requires no airport as it lands on any field or even a highway. Then you will understand why it can be flown at the amazingly low cost of 1 cent a mile!

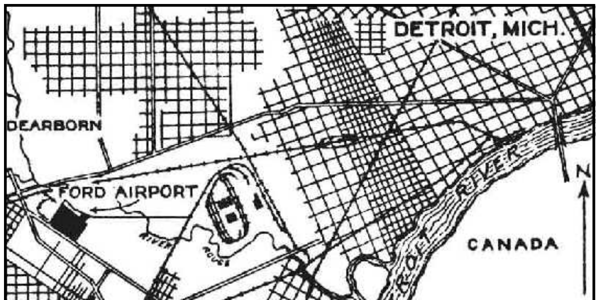
You, too, can build it Complete, the Parasol costs only $975 — ready to fly away. Or if you want, build it yourself, as hundreds have already done, for only $199. Heath plans are clear and easy to follow, and require no technical skill for their successful execution.

Parts are shipped in 11 convenient progressive groups. $12 brings the first shipment. Don't delay another day. Hours of flying pleasure await you! Mail the coupon today. (ad appearing in *Modern Mechanics and Inventions*, October 1930)

104

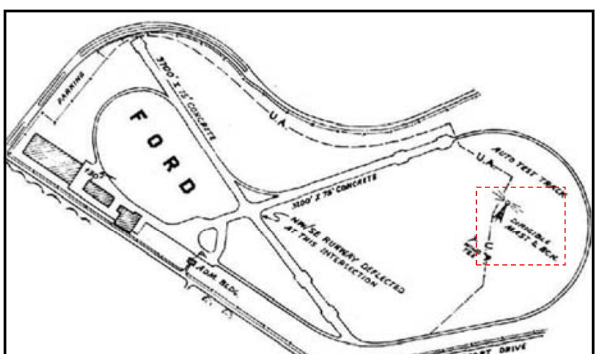
**A Model Airport**

105




***"…A real airport, though, requires much more than effective lighting. Eleven miles from Detroit is the Dearborn Airport, a Ford enterprise, called by aviators the most convenient and efficient aviation field east of the Mississippi. There 350 acres of field as level as a pool table are enclosed by a high wire fence…"***
***Popular Science,* November 1928**
**Caption: "Location of Ford Airport, as depicted on a 1927 DOC Airway Bulletin"**

106




**Above: this map shows Ford Airport's general layout, including the two runways, which were first grass and, when paved (in 1928-29), became the longest concrete runways in the world. Note the location of the dirigible mooring mast on the east-side of the field (highlighted).**

107


108

***"…From the sky the approaching flyers see a row of rectangular buildings, an airplane factory, an engineering laboratory, a power plant, and a hangar of steel and concrete that can shelter seventy-five planes…"***
***Popular Science,* Nov. 1928** 109

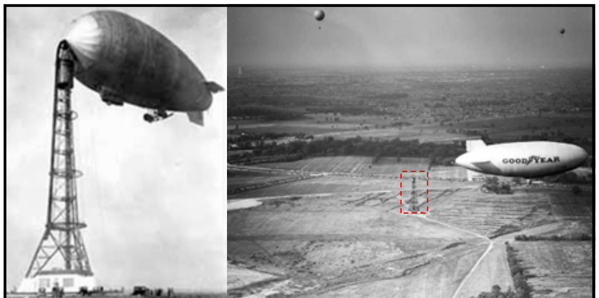
**Construction of the Dearborn, MI., buildings housing Ford Motor Company's *Experimental Department* took place in 1923-24. Designed by architect *Albert Kahn,* the experimental laboratory also contained the personal offices of both *Henry* and *Edsel Ford* and a dance hall (for Henry's "old-time" dances). The adjoining *Ford Airport* was built in 1924 and operated until 1947. The buildings were also designed by Kahn and featured the first passenger terminal, first concrete runways and the first scheduled passenger service in the county.**
**It was also the site of production for the *Ford Trimotor* aircraft.** 110
**Caption: "Photograph of an airshow held at Ford Airport, ca. 1930"**

**Above: two Ford Tri-motors (at left) are parked in front of Ford's *Stout Metal Airplane* division plant, where the aircraft were built. Part of this facility (at the northwest corner of the property) still exists, housing Ford's advanced power-plant and fuel cell labs. At right (in background), is the *Henry Ford Museum,* which was constructed a few years after the *Ford Airport.*** 111


**Caption: "In the foreground is shown the Ford Engineering Laboratory where all experimental work on Ford and Lincoln cars is carried on. In the rear may be seen the Ford Airport where Ford tri-motor air transports are manufactured"** 112

***"…In front of the buildings is a concrete apron 100-feet-wide and half-a-mile-long, and radiating from this are three concrete runways, two pointing to the southeast and one into the southwest. One is 3,500-feet-long; the other two about a thousand feet each. They provide ideal take-offs. In the space between them the ground has been grubbed free of heavy roots and stumps, harrowed, seeded, and rolled…"*** 113
***Popular Science,* November 1928**

***"…The Dearborn Airport has every modern appliance for rapid repairing and servicing of an airplane. Wings can be replaced, engines taken down and reassembled, new propellers applied, gas tanks filled and oil drained and changed with an economy of time that compares well with similar sort of service for automobiles along the highways…"***
***Popular Science,* November 1928**
**Above: caption: "Maintenance hangar at Ford Airport, Dearborn, MI."**
**Left: caption: "In 1925, Henry Ford erected the only privately-owned airship mooring mast in the world at Ford Airport in Dearborn, Mich."** 114




In 1925, ***Henry Ford*** had the world's tallest commercial dirigible mooring mast erected at the ***Ford Airport*** (above L&R). It was used only twice before it was torn down in 1946. By the early 1930s, Henry Ford's interest in aviation had waned (the last flight of the ***Ford Air Transportation Service*** was in 1932). Ford lost more than $10 million on his airplane division, which closed in 1933. By the late 1930s, the Detroit area and southeastern Michigan had a surplus of commercial airports, making Ford Airport redundant. The field was used sporadically for local flights until it closed in 1947.

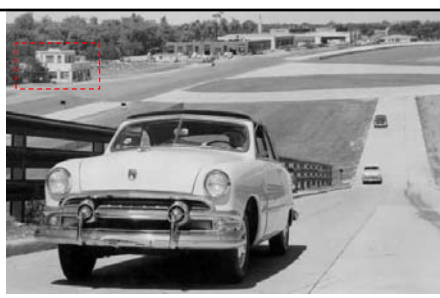
115


116

***"…When passengers from Chicago or elsewhere debark they find luxury-ious automobile buses waiting to carry them swiftly to Detroit hotels or railroad stations. Twenty planes arrive and depart from the Dearborn Airport every day except Sunday…"***
***Popular Science,*** **November 1928**
**Caption: "View looking north at the Ford Airport terminal, autogiro on the right"**

117


118



**No longer in use as a commercial airport, *Ford Airport* made a transfor-mation into the *Dearborn Proving Grounds* – a *Ford Motor Company* (FMC) vehicle testing facility. For several years the property served as bo-th airfield and test track. The passenger terminal (highlighted) was torn down in the early 1960s.**
**Caption: "A new 1951 Ford convertible climbing the carburetor grade at the Dear-born Proving Grounds. Old passenger terminal and airport buildings in background "**

119

## Hopes of Greatness

120

*"…It is recalled in Missouri today that St. Joseph, Mark Twain's town, adopted a high-hat attitude toward the first westward rail line. St. Joseph, as the terminus of the pony express, had been richer and larger than Kansas City. Kansas City, though, went after the railroad – and the railroads came to Kansas City. Today the comparative size of the two cities justifies the vision of the citizens of St. Joe's neighbor…"*
***Popular Science,* November 1928**
**Caption: "View of West Bottoms looking west, Kansas City, MO., 1891"**

121


*"…Then air lines were coming, even as the railroads had come. This time Saint Joe was not asleep. She bought 160 acres of land and built an airport; and Kansas City, forty miles away, lost the distinction of being a stop on the Chicago-Dallas air route…"*
***Popular Science,* November 1928**
**Above & Left: *Rosecrans Memorial Airport* is, presently, a joint-use *General Aviation* (GA) / military airport located three miles northwest of St. Joseph, MO., and thirty-five miles north of Kansas City, MO.**

122

***"…Rivalries of railroad building days are being revived in multitudes of communities. Hundreds of villages are stirring with freshened hopes of greatness…"***
***Popular Science,* November 1928**

123

## Seeing the Possibilities

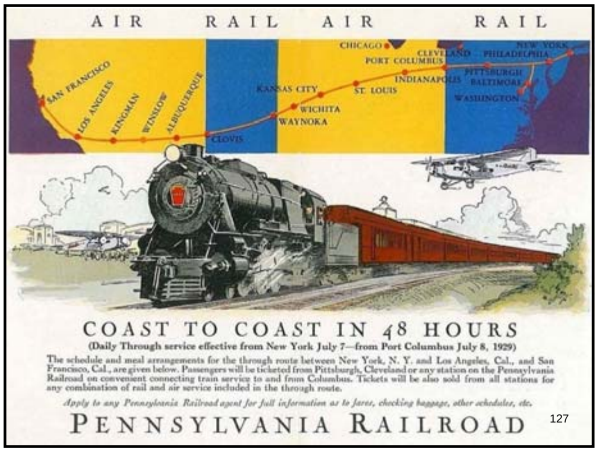
124

***"…Railroads will use the airplane. They lost short haul business by neglecting the bus in its early day, and they are not going to lose passenger travel, mail, express, parcel post, and light freight to the airplane. This sort of traffic will normally go through the air and would make up the biggest transportation industry in the world. The railroads see the possibility and are intent upon developing it…"***
***Capt. Eddie Rickenbacker,* February 1929**

125

***"…One feature of their plans is the combination of Pullman and plane service for cross-country travel. The New York Central will haul passengers from New York to Detroit over night. They will take a plane to Fargo, North Dakota, during the day and entrain for Spokane for second night's ride. The following day they will fly on to the coast. The Pennsylvania is organizing a similar service with changes at Columbus, Wichita, and Tuscon…"***
***Capt. Eddie Rickenbacker,* February 1929**

126




127

***"…Within a few years this combined service will be superseded by airplanes covering the entire route in twenty to twenty-five hours. These planes will have sleeping quarters, dining salons and all requisite travel comforts…"***
***Capt. Eddie Rickenbacker,*** **February 1929**

128

***"…All rail lines will be paralleled by air lines under the same management. Traffic is the railroad companies' business. They are awake to the possibilities of air transport and are not going to let new men take the business away from them. They will build their own systems and compete with newcomers or will buy them out…"***
***Capt. Eddie Rickenbacker,*** **February 1929**

129

## Commercial Warfare

130

***"…It may safely be predicted that passenger trains will pass out of use within fifteen years. Long hauls will be covered by air, short hauls by private cars and by public buses. Railroad yards will decked over and utilized as landing fields so that planes can alight in the hearts of the cities. Railroad traffic, in the meanwhile, will be handled by electric locomotives on the lower levels…"***
***Capt. Eddie Rickenbacker,*** **February 1929**

131

***"…These changes will come about because time demands them. Time cannot be saved up and used as needed in the future. It must be used now if at all, and the man who uses it most effectively has all the advantage in the commercial competition of today. That competition is pitiless - far more so than in military combat where all the resources of science are marshalled to the help of the injured. In commercial warfare, the man is soon eliminated who does not make the most effective possible use of his time…"***
***Capt. Eddie Rickenbacker,*** **February 1929**

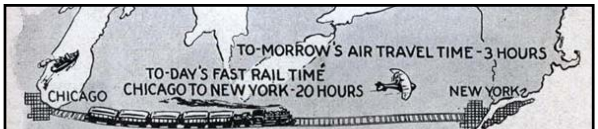
132

## Time and Distance

133

*"…The present transport plane is as obsolete as a five-year-old car. Cruising speeds of 100 to 150 miles-an-hour for transport planes are perfectly feasible. With such planes the Pacific Ocean, in hours of travel, would be brought as close to New York as Detroit is now, and Detroit would be four hours from New York instead of the fourteen hours required by the fastest trains. Air transport would thus, in effect, reduce the size of the United States to the size of the state of Texas. The fastest train across Texas requires twenty-four hours…"*
***Capt. Eddie Rickenbacker,*** **February 1929**

134




*"…At an average speed of 150 miles a plane crosses the continent in less time than that. It is very difficult to conceive of speed in terms of the future. The Spad plane as used by me during the World War travelled 125 miles an hour and was the fastest thing in the world. Single seater planes have been built capable of 350 miles an hour. It is only a matter of engineering to build a plane to go 500 miles an hour and someone will do it somewhere on earth within three years…"*
***Capt. Eddie Rickenbacker,*** **February 1929**
**Caption: "Twenty hours by rail between New York and Chicago is considered fast time today. With airplanes traveling at 500 miles-an-hour – as Capt. Rickenbacker predicts they will within three years – the 1,500-mile journey will be merely a pleasure jaunt between breakfast and luncheon."**

135

## Air-Rail

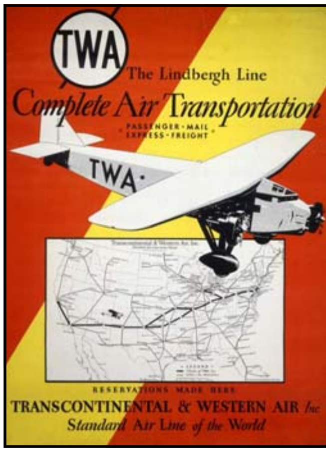
136

**Recent inauguration of regular 48-hour New York to Los Angeles or San Francisco air-rail service by the Transcontinental Air Transport, Inc., in which the Pennsylvania railroad is financially interested, is interpreted as the outstanding commercial aviation development of 1929 in the United States**
***Modern Mechanics,*** **November 1929**
**RE: introduction to an article entitled: "Air-Rail Line Spans America in 48 Hours"**

137

## By Comparison

138




"*THE 48-hour trip by air-rail across the continent is compared to the 81-hour trip by fastest all-rail routes. And scarcely had the T.A.T. been launched than plans were under way for reducing the time. The T.A.T. is expecting to offer a supplementary service which will be all air from Columbus to the Pacific Coast…"*
***Modern Mechanics,* November 1929**
**RE: founded in 1928 by aviation entrepreneur *Clement Melville Keys,* a leading player in the development of air travel in the U.S., *Transcontinental Air Transport* (TAT), decided to break into the passenger market by offering cross-country service using rail, by night, and air, by day,**
**Left: TAT spawned what eventually became *Transcontinental & Western Air* (TWA),**

139

## The Train-to-the-Plane

140

"***…Patrons of the T.A.T. can now board the 'American,' a de-luxe limited train of the Pennsylvania railroad, in New York in the early evening, spending the night in a sleeping car. In the morning they are transferred to a waiting airplane in Columbus, Ohio, and a daylight flight is made to Dodge City, Kansas. Stops are planned en route at Indianapolis, St. Louis, Kansas City and Wichita. After dinner at Dodge City an Atchison, Topeka & Santa Fe trail takes the passengers on another night journey in a sleeper. At Las Vegas, N.M., the final lap by air either to Los Angeles or San Francisco, arriving late that afternoon…"***
***Modern Mechanics,* November 1929**
**RE: in July 1929, TAT launched the first coast-to-coast commercial passenger flights in the U.S. Three legs of the route were actually accomplished via luxury rail cars. The complete "Air-Rail" journey from New York to Los Angeles (or San Francisco) initially took about 51 hours, but was soon trimmed down to 48 hours.**

141


**Caption: "The route of the Transcontinental Air Transport, Inc., air and rail service which carries passengers from New York to the Pacific Coast in 48 hours is shown above. The dark areas indicate territory covered in railway sleeping cars and the light areas, the distance spanned in the air. The speediest all-train time for this cross-continent tour is 81 hours – 33 hours longer than the two-day air-rail trip. An all-air service from Columbus to the Pacific is now being planned."**

142

## Time and Money

143

"***…Efficient terminals have been established along the route, motor-car tenders effect the transfers from trains to airplanes. The ships are the tri-motored Wasp-powered Fords. And these ships are piloted by a corps of 34 pilots. The first pilots secured for the corps all had at least 3,000 hours in the air with at least 500 hours on tri-motored planes, and relief pilots had nearly as good records. The service is expected to prove valuable to businessmen and others to whom time is money."***
***Modern Mechanics,* November 1929**

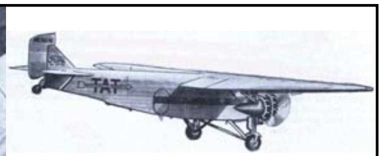
144


***Charles Lindbergh*** **became Chairman of the *TAT Technical Committee,* which designed the coast-to-coast air route (above). Lindbergh chose the *Ford Trimotor* because it had more power and was easier to maintsin than any other commercial aircraft available, at the time. The technical Committee chose ten cities spaced between the east and west coast/s (TAT bought or rented sites for airports). Between June 20 and July 6, 1929, TAT tested the schedule (left), making several practical trips and training with teams and personnel. Prior to the first revenue passenger boarded a TAT trimotor, nearly 50K test miles had been recorded, including taking 261 passengers through the various sections of the route.** 145


WHEN the secretary of The Philadelphia Club of Advertising Women recently sent out notices to members that reservations were being made to attend a convention in Washington by airplane, her return mail brought 33 definite reservations from women. This appeared to be startling news to conservative old Philadelphia!

Comparison with other cities and other places brought forth the astounding fact that now the cost of air travel on most of the established lines is no more on average than train travel, suddenly the crowd has turned skyward.

Since the reduction in Air-Rail rates by T.A.T.–Maddox between New York and St. Louis, from $97.43 to $68, planes have been carrying capacity loads . . . Almost every transport line reports the same extraordinary upward trend in air travel!... 146



**The aircraft of choice for TAT was the *Ford Trimotor*. A product of the *Stout Metal Airplane Division* of FMC, the all-metal airliner was engineered by *William B. Stout,* who later designed the *Stout Scarab* automobile. *Henry* and *Edsel Ford* took a keen personal interest in the Trimotor effort, which occupied the northwest corner of *Ford Dearborn Airport,* later to become Ford's *Dearborn Proving Grounds*. In the late 1920s, FMC was ranked as the largest commercial aircraft builder in the U.S. While the "Tin Goose," as it was known, was rendered obsolete as a first-tier commercial airliner by the early 1930s, it played a critical role in the development of passenger air travel.**

**Left: caption: "Mrs. Lindbergh, Mary Pickford, and Colonel Lindbergh, standing beside the T.A.T. Ford airplane which Miss Pickford christened"**
**Right: caption: "Colonel Charles E. Lindbergh, accompanied by his wife, flying the first lap of the first east-bound T.A.T. Ford"** 147


**Above: the *Ford Trimotor* was a pioneer of the airline industry, flying from coast-to-coast in 1929 with TAT, one of the earliest passenger carriers. The original Ford Trimotor production aircraft (model 4-AT) was typically powered by three *Wright Whirlwind* radial engines, carried a crew of three (pilot, co-pilot and steward) and could accommodate up to fifteen passengers, depending on configuration.** 148

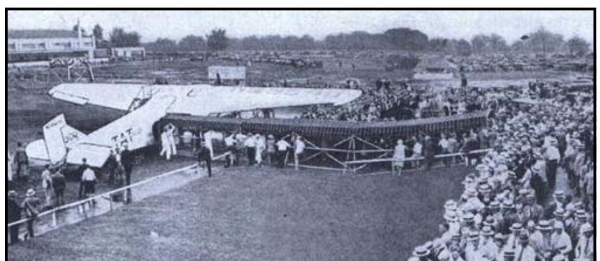

***The Ford Plane***

The Ford plane is planned, constructed and operated as a commercial transport. Built of corrugated aluminum alloys, it has great structural strength, unequaled durability, and is most economical to maintain in operation. The uniformity of its material is determined by scientific test. All planes have three motors in order to insure reserve power to meet and overcome all emergencies. The engines may be Wright, Pratt & Whitney or Packard Diesel, totaling from 675 to 1275 horse-power. Ford planes have a cruising range of from 580 to 650 miles and a speed range of 55 to 135 miles per hour. Loads may be carried weighing from 3630 to 6000 pounds.

The capacity of these planes is 9 to 15 passengers and a crew of two (pilot and assistant). Planes can be equipped with a buffet, toilet, running water, electric lights, adjustable chairs.

The price of the Ford tri-motored, all-metal plane is exceptionally low - $40,000 to $50,000 at Dearborn.

Ford branches will be glad to give you information on all Ford tri-motored, all-metal planes. 149



**Caption: "Scene at the Grand Central Air Terminal at Glendale, near Los Angeles, California, when Mary Pickford christened the first east-bound ship of the T.A.T. system, just before Lindbergh took-off. A canopy is stretched from the terminal to the ship to shelter the passengers gong aboard the plane. Time required for the transcontinental trip is practically cut in two by the new T.A.T. service."** 150


151

**Ships in an Ocean of Air**

152

***"…Big as present planes are, they are mere kites in comparison to the ones to be used in the future. The biggest thing we know of on earth is the ocean of air in which our earth floats. No one has ever conceived how vast this ocean is, and upon it every city and town is a port. The possible size for a plane or dirigible is therefore limitless, and we must expect them to increase largely in size because the ratio of pay load increases with the size of the unit. Size is now merely an engineering problem of control…"***
***Capt. Eddie Rickenbacker,*** **February 1929**

153

***"…A plane is now being built in Germany that will carry 100 passengers. It is powered with 12 engines of 500 horsepower each, giving a total of 6,000 horsepower, and will fly at full load with any seven of these engines. It will have a cruising radius of 5,000 miles…"***
***Capt. Eddie Rickenbacker,*** **February 1929**

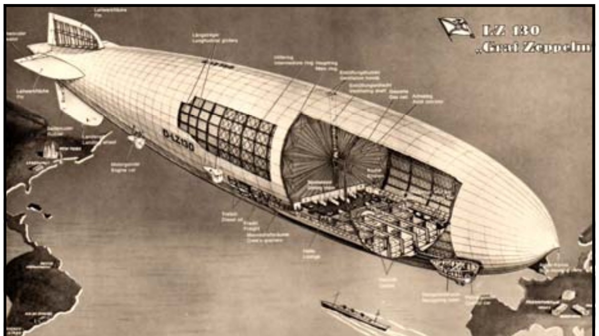
154

***"…Cruising radius is merely a matter of supplies. When planes and dirigibles can carry reserve supplies of oil and fuel, they can go anywhere. Under present conditions, they must go straight ahead on their course. If ocean vessels had to operate the same way, they would lose 15% to 20% of their shipping every year through storms. But ships go around storms or lay by until the weather ahead has cleared. Very soon aircraft will do the same…"***
***Capt. Eddie Rickenbacker,*** **February 1929**

155

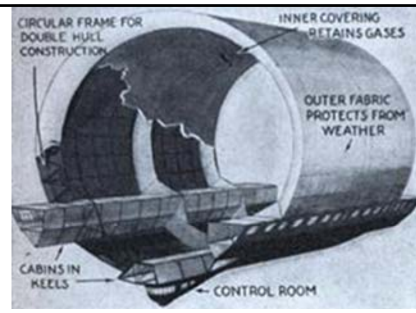
**Biggest Birds That Ever Flew**

156




*"…In fact, the Graf Zeppelin abundantly proved the value of cruising radius in crossing to Lakehurst. It travelled far south to avoid a storm, was delayed a full day, yet arrived after 6,000 miles with sixty-five hours of fuel still in the tanks. The Graf Zeppelin with its 3,600,000 cubic feet capacity is now the biggest dirigible in the world…"*
***Capt. Eddie Rickenbacker,*** **February 1929**

157

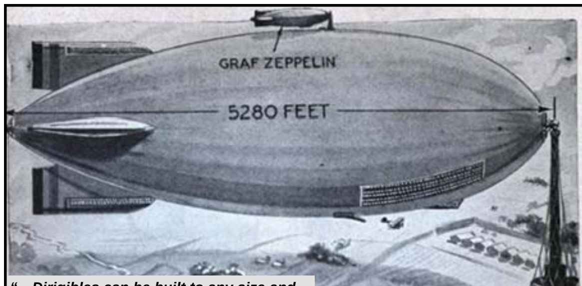



*"…But the United States Government has signed a contract with the Goodyear Tire and Rubber Company for two dirigibles of 6,500,000 cubic feet capacity - a 100% increase in size between models…"*
***Capt. Eddie Rickenbacker,*** **February 1929**
**Caption: "Sectional view of one of the new dirigibles ordered by the U.S. Government, to be the largest yet constructed. It will have a double covering of fabric, the outer for weather protection and the inner for retaining the gas cells."**

158

*"…England is building two dirigibles of 5,000,000 cubic feet which are equipped with dining rooms for fifty people, dance floors, promenade decks, showers in passengers' cabins. One of these will go into passenger, mail, and express service between London and Sydney, Australia, going always from west-to-east with the prevailing winds and thus circling the globe on each round trip. The other is expected to go into service between London and Buenos Aires. This trip, which now requires thirty days by the fastest boat connections, will then be made in three and one-half days…"*
***Capt. Eddie Rickenbacker,*** **February 1929**

159




*"…Dirigibles can be built to any size and May eventually be a mile in length and of 25,000,000 to 30,000,000 cubic feet capacity. Such ships would be capable of staying in the air five or even ten years, making repairs en route and taking on new supplies without stopping…"*
***Capt. Eddie Rickenbacker,*** **February 1929**
**Caption: "Immense as it is with its length of 750 feet, the Graf Zeppelin is a mere pygmy moored atop one of the mile-long dirigibles of the future. These huge ships will never land, but will take on supplies and passengers from smaller ships which rest on its back, and by planes carried inside the bag and shot out from launching platforms. A city full of people can live inside the cabin in the fins."**

160

*"…The dirigible would therefore go continually on its way around the world. As it approached a city another ship would go out to meet it and dock on its decks. It would unload supplies, exchange cargoes and passengers, and possibly relieve the crew, then take-off again and return to its home city…"*
***Capt. Eddie Rickenbacker,*** **February 1929**

161

## At Both Ends

162

***"…It is worthy of note that the airplane would be largely useless without the automobile. No one would use aircraft if he had to travel by horse and buggy from the airport to the heart of the city. There must be cars at both ends of the airline, which increases the use of cars and means increased business for automobile makers…"***
***Capt. Eddie Rickenbacker,* February 1929**

163

## The Idea of Flying

164

***"…Private ownership of planes is coming through the keen interest of the younger generation. The motor car was developed in precisely the same way. It was commercialized by the generation succeeding the one which created it. Older men have responsibilities which restrain them from developing the new to its utmost extent. The youngsters, who grow up with it, make full use of it…"***
***Capt. Eddie Rickenbacker,* February 1929**

165


**Coming Generation Is Growing Naturally Into the Idea of Flying**

WASH tubs, wheel barrows, newspapers - in fact anything young children can lay their hands on - are being converted into transport planes, fighters and gliders of the queerest shapes and designs. Youngsters have accepted aviation as a permanent fixture and are preparing for it in their own way. Instead of playing policeman, cowboy or house, both boys and girls are pretending they are pilots, guiding a ship through the sky. (*Modern Mechanics,* August 1929)
Caption: "Youngster has equipped his 'plane' with a single-tubed radio"

166


**Wind Tunnel and Model Plane in Aviation School**

A NEW instruction device has been installed for student airplane pilots by Professor Roland Spaulding, aeronautics expert at New York University who is shown above giving members of the first women's aviation school a few pointers on flying. One of the girl pupils sits in the chair "cockpit" and works the controls which in turn manipulate the model Curtiss Robin plane. The plane is in front of a wind tunnel and responds to the air currents just as a full-sized plane would respond up among actual currents of air. The pupil can bank and zoom the model plane without any actual risk to herself. With this device the instructor is able to make many points clear to pupils that would otherwise have to be shown in the air at risk to the pilot and pupil. A mistake in the air often costs life and property but a mistake at the controls of the instruction device can be corrected adequately without danger. Intelligent confidence on the part of the student pilot is also built up with this device. (*Modern Mechanics,* February 1930)
Caption: "The girl at the stick is controlling the model airplane riding in the wind roaring out of the wind tunnel at the right in order to gain a clear idea of what is required when taking a ship into the air"

167

**Airplane Radiator Caps Popular**

POPULARITY of the airplane is being felt in automobile accessory circles as evidenced by the increasing number of airplane radiator ornaments and caps. Among the popular models being shown are the hydroplane with electric lights beaming from the cabin windows and propeller that whirls as the car moves. (*Modern Mechanics,* February 1930)

168

## Social Radii

169

*"…Twenty-five years ago the social radius was five miles and the commercial radius not to exceed ten miles. The automobile extended the social radius to twenty-five miles and the truck increased the commercial radius at a very conservative estimate, to fifty miles. Now aircraft extends these limits to 75, 100, 150 miles and puts cars to work at both ends of the line…"*
*Capt. Eddie Rickenbacker,* February 1929

170

## Seeing-at-a-Distance

171

*"…These amazing developments in transportation are equalled, if not even surpassed, by improvements in communicating ideas. Here radio and television are supreme. And so rapidly is it being developed, that very soon important advertisements will be dispatched by television to the newspapers of the country the night before insertion. Last winter an advertisement of a bond issue was televisioned across the ocean to Paris and was on the streets there within three hours of its release in New York. Three days before last Easter, a milliner in New York received from Paris a television showing in colors a new hat, copied it in his designing department, and had it on sale within three hours of its showing in Paris…"*
*Capt. Eddie Rickenbacker,* February 1929

172

## The Lindbergh Effect

173

*"…It is the clear obligation of the present generation to develop these possibilities nationally and internationally and devote them to world understanding and world peace. We have already proved what a wealth of good will can be gained from transportation and communication by our glorious apostle of youth - Lindbergh. We should send a thousand Lindberghs every day with messages of good will and with merchandise. A better world wide understanding will result, and will eliminate the jealousies, intrigue and envy that have caused wars…"*
*Capt. Eddie Rickenbacker,* February 1929

174

## Civilization in Jeopardy

175

*"…We must do it before the next generation comes to manhood and womanhood. We must turn all these mighty forces to the service of mankind. If we fail to do it, civilization is in jeopardy…"*
***Capt. Eddie Rickenbacker,*** **February 1929**

176

## War in Heaven

177

*"…When wars are fought in the air, there will be no 'No Man's Land' but every man's house top will be the front. Aircraft of today will carry bombs of 5,000 pounds. They can be built to carry them of 10,000 pounds, 20,000 pounds - large enough to lay waste whole city areas, wrecking the buildings and destroying the people. It is possible for planes to use giant burning lenses weighing tons with which they could focus the rays of the sun upon a city and melt it…"*
***Capt. Eddie Rickenbacker,*** **February 1929**

178

*"…These deadly weapons could thus be used for the destruction of mankind. But they need not be so used. It is the part of wisdom to turn them into economic blessings and angels of peace."*
***Capt. Eddie Rickenbacker,*** **February 1929**

**RE: after passage of the *Air Mail Act of 1925,* Rickenbacker joined *Reed Chambers,* a *94th Aero Squadron* alumnus, as a silent partner in *Florida Airways.* This venture lasted less than a year. In January 1928, he took a job as assistant general manager for sales at *General Motors.* In June 1929, Rickenbacker moved GM into the aeronautics industry with the acquisition of the *Fokker Aircraft Corporation of America.* In 1932, he resigned from his position at GM. He then moved to *American Airways,* but only for one year. In 1933, he moved back to GM as VP for public relations for its *Aeronautics Division,* which then included *Eastern Air Transport* (later *Eastern Air Lines*). He was appointed general manager of EAL on January 1, 1935. By 1938, he had turned EAL into a successful venture for GM. When he learned that GM planned to sell EAL, in just one month's time, Rickenbacker raised $3.5 million in order to purchase EAL. Rickenbacker resigned as president of EAL in 1953 in order to become EAL's Chairman of the Board. He served as Chairman until December 31, 1963, when he officially retired from EAL.**

179

180

## Part 3

## What Dreams May Come

181

**According to Henry…**

182

**Those who assume that we have reached the true industrial age are doubtless in line for a big surprise, says Henry Ford in this remarkable interview in which he declares the real industrial age is just dawning, and advances valuable information on needed inventions of today and tomorrow, such as a revolutionary airplane engine**
***Modern Mechanics,*** **December 1929**
**RE: introduction to an article written by *M.K. Wisehart,* author of *Marvels of Science,* entitled: "Henry Ford Tells What to Invent"**

183

**The Needs of Today and Tomorrow**

184

***"…'Just what inventions would you say we are most in need of today to further this ideal industrial age?' I asked. Let me say at once that Mr. Ford did not answer this question directly. Rather, he pointed out the needs of today and tomorrow by discussing the opportunities for inventiveness which confront our generation, our geniuses and all who are of an inventive turn of mind; and he spoke as though much might be expected from the young mind, the unconventional mind…"***
***Modern Mechanics,*** **December 1929**

185

***"…'If the young man of today wants to tie up with something that has a great future, he will go digging after the airplane,' said Mr. Ford. 'He will need lots of help. The first thing he ought to do is to find out what has been done to bring the airplane to its present phase'…"***
***Modern Mechanics,*** **December 1929**

186

***"…'The fact is that today there is no such thing in existence as an airplane engine.' 'Just what do you mean by that?' I asked. 'Boys who are thinking about airplanes now do so without even knowing what kind of engine the airplane ought to have. It reminds me of the time when I was starting in. I was then thinking in terms of steam because steam was in use in locomotives'…"***
***Modern Mechanics,* December 1929**

187

**Steamship of the Skies**

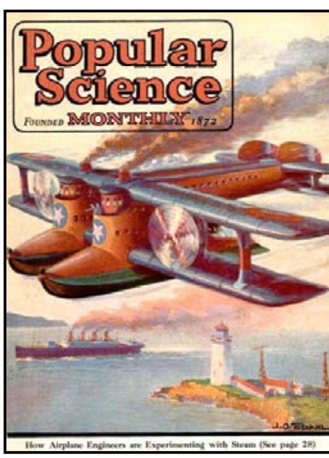
188

***"…The airplane of today bears scant resemblance in outward features to the first successful machine of the Wright brothers; new types of wings, propellers and bodies have been devised; but the motive power still is furnished by an internal combustion engine – an improved engine, of course, but one which still retains the element of un-reliability…Aeronautical engineers have long recognized that the development of a motor that will combine lightness of weight with high power efficiency but that will lack the uneven performance of the present internal combustion engine probably is the principle problem confronting them in pushing the commercial possibilities of aircraft…"***
***Popular Science,* August 1923**

189

***"…From Germany, however, comes a report of the development of a steam driven airplane…The engine is an adaptation of the Diesel engine…It burns a combination of crude oil and other oils, which is broken up under a forced air feed and sprayed against the boiler. Here it ignites, giving terrific heat considering the relatively small quantity of oil consumed in the operation…"***
***Popular Science,* August 1923**

190




***"…Ten gallons of oil are said to be sufficient to run the plane's 750 horse-power engine for eight hours…only 1,000 pounds of water are said to be used in a flight of 95 hours…The water used to generate steam in the new plane is carried in the metal wings, in compartments so arranged that the water may be shifted to 'trim ship' if desired. The steam is condensed after exhaust and conveyed back to the wings in the form of water…"***
***Popular Science,* August 1923**
**Caption: "The new steam-propelled airplane, developed in Germany, which is arousing the interest of American aeronautical engineers seeking to develop better engines"**

191

**Engine Follows Function**

192

***"…'It was only after much experimenting that I turned to the gas engine. It's perfectly natural that boys should think that airplanes must be run with gas engines. They think so because automobiles are run by gas engines. But some day a boy will come along who will discover that gas engines are not the thing at all'…"***
***Modern Mechanics,*** **December 1929**

193

***"…'What we now call airplane engines are really automobile engines in all their fundamental principles. Some of our experiments here at Dearborn may help discover what an airplane engine should be like. At present, we are giving our attention to the Diesel engine. The outlook is fairly promising'…"***
***Modern Mechanics,*** **December 1929**

194

## Luft Diesel

195

**Many Diesel-engine planes are now in use in Europe and their number is rapidly increasing every year**
***Popular Mechanics,*** **August 1938**
**RE: introduction to an article written by *Paul H. Wilkinson,* author of *Diesel Aircraft Engines,* entitled: "The DIESEL in the AIR"**

196

## 50K-miles-a-week

197

***"THIS change-over from the gasoline engine started in 1931, when a plane equipped with a Junkers Diesel was tried out by Deutsche Lufthansa, Germany's national air line. That year, only 1,634 miles were flown, but from that small beginning, Diesel mileage has increased steadily. Last year, at least 25,-000 miles a week were flown with Diesel-engined craft and this year, from all indications, the mileage will be near the 50,000-mile-a-week mark…"***
***Popular Mechanics,*** **August 1938**

198

## Jumo-Powered

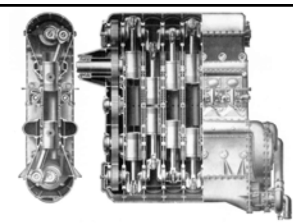
199

***"…The engine making these flights possible is the Junkers' 'Jumo' Diesel. Development work commenced as far back as 1912, so many years elapsed before success was attained. Now, the importance of the Diesel can be judged from the fact that a huge new factory near Dessau has been built to produce these 'Jumo' power plants. The current production model is the 'Jumo' 205, which has power ratings ranging from about 600 to 700 horsepower…"***

***Popular Mechanics,* August 1938**

**RE: the *Junkers Jumo 205* aircraft engine was the most famous of a series of diesel engines that were the first, and for more than half-a-century, the only successful aircraft diesel engines. The *Jumo 204* first entered service in 1932. Later engines in the series were; *Jumo 206, Jumo 207* and *Jumo 208*. They differed in stroke and bore and supercharging arrangements. In all, more than nine-hundred of these engines were produced.**

200



**Above: all Jumo diesel aviation engines used a two-stroke cycle with six cylinders and twelve pistons in an opposed piston configuration with two crankshafts; one at the bottom of the cylinder block and the other at the top, geared together. The pistons moved towards each other during the operating cycle. Intake and exhaust manifolds were duplicated on both sides of the block. There were two cam-operated injection pumps per cylinder, each feeding two nozzles, for four nozzles-per-cylinder total. All of the accessories (i.e. fuel pumps, injectors and the scavenging compressor) were run from the lower shaft, meaning over half of its power was already used up. What was left over was then geared to the upper shaft, which ran the propellers. In all, about 75% of the power to the propellers came from the upper crankshaft. In theory, the flat layout of the engine could have allowed it to be installed inside thick wings of larger aircraft, such as airliners and bombers. Details of the oil scavenging system suggest this was not possible and the engine had to be run vertically, as it was on all designs that used it.**

**Caption: "Junkers Jumo 205-cm engine cut-away sectional views"**

201


***"…Deutsche Lufthansa uses Diesel-engined planes on many of its routes in Germany, and on routes to Holland. Switzerland, Poland and Denmark. Swiss Air, too, employs the Diesel on its air lines between Zurich and Vienna. The plane in which the engine is most extensively used is a product of the same concern which builds the engines.…"***

***Popular Mechanics,* August 1938**

202

**Caption: "Air liner in Swiss Air service is driven by Diesels"**


***"…This is the Junkers Ju 86, a modern all-metal, ten-passenger air liner similar in appearance to the twin-engined Lockheed in this country. Powered with two 600-horsepower 'Jumo' 205 Diesels, it cruises at 175 miles per hour and has a range of about 1,000 miles…"***

***Popular Mechanics,* August 1938**

**RE: the *Ju 86* was designed, from the outset, to take diesel engines. However, the *Jumo 205* engine was not yet available when the prototype was first flown in November 1934. Instead, it was fitted with two *Siemens SAM 22* nine-cylinder radial engines. The third prototype flew in March 1935 with the radial engines and was later fitted with the Jumo 205 diesel engines.**

**Left: caption: "German air liner powered with water-cooled Diesel engines"**

**Right: caption: "In 1934 Junkers Flugzugbeau at Dessau received a specification for a new type known as the Ju-86, to be developed as both a commercial transport and as a bomber"**

203

***"…Versatility of the engines on these planes was demonstrated a short time ago when one of them visited Kabul, in Afghanistan. In that remote region, Diesel fuel was unobtainable but there was plenty of kerosene available, so the plane was tanked up and continued on its way, 950 miles to its next port of call, without difficulty…"***

***Popular Mechanics,* August 1938**

204

***"…The 'Jumo' Diesel is also utilized for military purposes. The military version of this plane is the Ju 86 fighter-bomber extensively used by the German Air Corps. These planes have special turbo-super-charged engines which develop their rated power of 700 horsepower at an altitude of 20,000 feet. Many squadrons of these bombers are in service, and the engine is being tried out on other types of fighting craft…"***

***Popular Mechanics,* August 1938**

205

**Caption: "Junkers 86K fighter-bombers are Diesel powered"**

## Two Continents as One

206

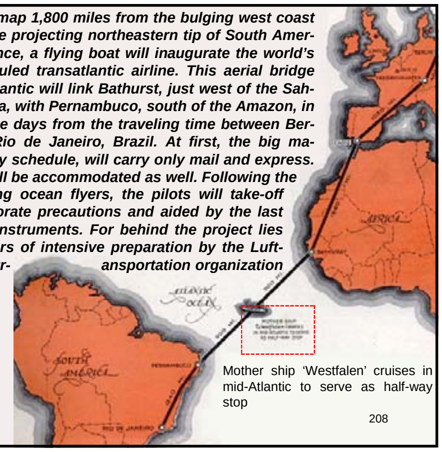
***"…On air-mail routes, the Diesel has some fine flights to its credit. Outstanding was the 3,600-mile non-stop flight of a Junkers Ju 86 mailplane with its crow of three from the factory at Dessau, to Bathurst in British Gambia, on the west coast of Africa. This flight was first accomplished in 1936 at an average speed of 180 miles-per-hour. Since then, it has been repeated frequently. The maximum range of these planes, carrying 1,000 pounds of mail, is about 4,000 miles…"***

***Popular Mechanics,* August 1938**

207

***"SLIDING down the map 1,800 miles from the bulging west coast of upper Africa to the projecting northeastern tip of South America, a few weeks hence, a flying boat will inaugurate the world's first regularly-scheduled transatlantic airline. This aerial bridge across the South Atlantic will link Bathurst, just west of the Sahara, in British Gambia, with Pernambuco, south of the Amazon, in Brazil. It will clip nine days from the traveling time between Berlin, Germany, and Rio de Janeiro, Brazil. At first, the big machines, on a biweekly schedule, will carry only mail and express. Later, passengers will be accommodated as well. Following the trail blazed by daring ocean flyers, the pilots will take-off surrounded by elaborate precautions and aided by the last word in navigation instruments. For behind the project lies more than three years of intensive preparation by the Lufthansa, the great air transportation organization of Germany…"***

***Popular Science,***
**February 1933**



Mother ship 'Westfalen' cruises in mid-Atlantic to serve as half-way stop

208

## Seaborne

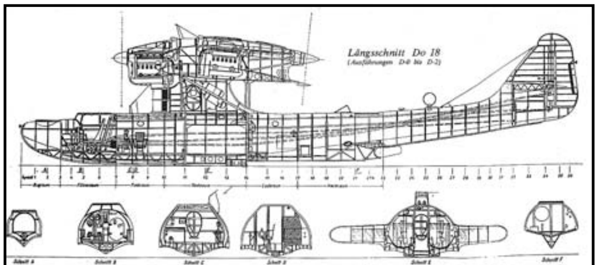
209

***"…From Bathurst, Deutsche Lufthansa operates a fleet of four Dornier Do 18 flying boats across the 1,900-rnile stretch of the South Atlantic to Natal, in Brazil. These planes are named the 'Aeolus,' the 'Zephir,' the 'Pampero' and the 'Zyklon.' Their engine installation is noteworthy in that it consists of two 600-horsepower 'Jumo' 205 Diesels mounted in tandem, back-to-back, along the axis of the plane…"***

***Popular Mechanics,* August 1938**

210

**Caption: "Dornier Do 18 in-flight"**

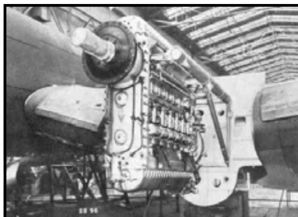



*"…This makes possible excellent streamlining of the engine nacelle, and as the propellers then revolve in opposite directions, their torque is neutralized. The Do 18 carries a crew of four, has a cruising speed of 125 miles per hour, and can carry a 1,000-pound payload a distance of 2,400 miles…"*
***Popular Mechanics,*** **August 1938**
**Caption: "Dornier Do 18 sectional views"**

211

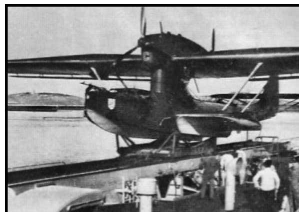
*"…The 'Aeolus' and the 'Zephir' will be remembered for their survey flights across the North Atlantic in 1936, when they made eight scheduled flights between New York and the Azores. So well did their engines perform over the 2,400 miles between these points, that two larger planes with similar power plants were ordered by Deutsche Lufthansa for their 1937 flights…"*
***Popular Mechanics,*** **August 1938**

212




*"…These powerful Hamburg HA 139 seaplanes, the 'Nordmeer' and the 'Nordwind,' were equipped with four 600-horsepower engines. Once again, they demonstrated the reliability of the Diesel by making fourteen trips over the same route…"*
***Popular Mechanics,*** **August 1938**
**Left: caption: "Inboard port Junkers Jumo 205 Diesel engine mounted to wing of an HA 139 seaplane**
**Right: caption: "Hamburg HA 139 'Nordmeer' ready for catapult launch (ca. 1934)"**

213




*"…Catapulting is used extensively for launching these Diesel-engined mailplanes, as Germany lacks bases from which to operate. Although this involves the use of catapult ships, it has the advantage that the plane can take to the air with full load without risking a take-off from a choppy sea. At present, catapulting is not suitable for passenger planes as the rate of acceleration is too rapid…"*
***Popular Mechanics,*** **August 1938**
**Above L&R: launch from catapult (left) and recovery by crane (right) from "Schleuderschiffe" (catapult ship) *Ostmark*, ca. 1936**

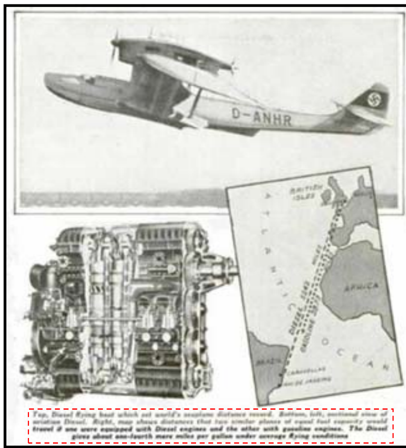
214

## Advantage: Diesel

215

*"…For long-range flights, the Diesel is particularly economical. This was demonstrated when a Dornier Do 18 flying boat made a 5,200-mile non-stop flight from the English Channel to Caravellas, in Brazil. This broke the worlds long-distance seaplane record by nearly 1,000 miles, thanks to the remarkable fuel economy of the Junkers 'Jumo' 205 engines…"*
***Popular Mechanics,*** **August 1938**

216




Top, Diesel flying boat which set world's seaplane distance record. Bottom, left, sectional view of aviation Diesel. Right, map shows distances that two similar planes of equal fuel capacity would travel if one were equipped with Diesel engines and the other with gasoline engines. The Diesel gives about one-fourth more miles-per-gallon under average flying conditions.

217


***"…A fuel saving of approximately twenty-three per cent, compared with gasoline operation, is now obtained under average conditions. Another advantage is the saving in fuel cost. Aviation gasoline costs about eleven cents a gallon at refinery, compared with five cents a gallon for Diesel fuel…"***

***Popular Mechanics,*** **August 1938**

**Caption: "Dornier Do-26A flying boat powered by four (two back-to-back pusher/puller arrangement) Junkers Jumo 205 Diesels, each with six double-ended cylinders and twelve opposed pistons achieving 600 hp per engine"**

218

***"…Perhaps the most important factor is that Diesel fuel does not give off inflammable vapor at ordinary temperatures like gasoline, so there is no danger of an explosion from this source…"***

***Popular Mechanics,*** **August 1938**

219

## One-HP/LB

220

***"…The Junkers factory is engaged in the type-testing of their 1,200-horsepower 'Jumo' 206 Diesel, and in the construction of a new type which is to develop 2,000 horsepower. The latter will not follow the six-cylinder, in-line construction of their other Diesels, but will be a 'square' engine with four banks of six cylinders and a crankshaft at each corner. So compact will the engine be, that its diameter will not exceed thirty-nine inches. Its weight will be about one pound per horsepower…"***

***Popular Mechanics,*** **August 1938**

221

## In the Running

222

***"…The United States, England, France, Japan and Russia are all working with the Diesel. Next year, huge flying boats carrying passengers and mail, powered with 2,000-horsepower Diesels, may take their place for transatlantic travel. Ultimately the Diesel may become the most popular power plant for long-distance flights."***
***Popular Mechanics,*** **August 1938**
**RE: although not offering a very good power-to-weight ratio, the fuel consumption of the diesel was markedly superior to contemporary petrol engines offering similar power output; important for transoceanic routes frequented by flying boats and/or seaplanes. The *Ju 86* was used by the *Luftwaffe* in the early years of WWII. Four Ju 86s were sent to Spain to test their capabilities in the *Spanish Civil War.* However, the diesel engines proved to be problematic, being highly sensitive to sudden changes in power settings thus, the type became unpopular with crews. Serviceability rates were low and production of the diesel-engined Ju 86 was ceased. The aircraft were purchased by the *Swedish Air Force* fitted with *Pratt & Whitney Hornet* radial engines.**

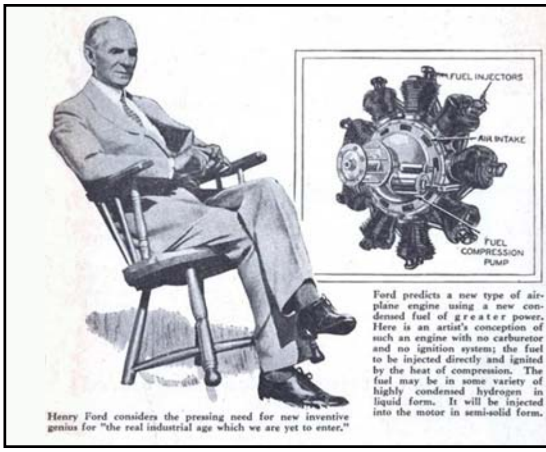
223

## Four Characteristics

224

***"…'No one knows now just what the airplane engine of the future will be like, but you can be pretty sure it will have four characteristics: first, slow speed; second, reliability; third, perfect balance; fourth, it will use a fuel that will be four or five times more powerful than our present fuel. By the time the engine that will meet these requirements is ready, we may have a type of plane that can come down and make a landing at a speed considerably less than sixty miles an hour'…"***
***Modern Mechanics,*** **December 1929**

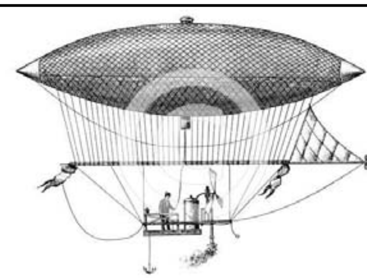
225




226

## Back to Nature

227



***"…Ever since Henri Giffard, in 1852, navigated the air in the world's first dirigible, creeping along near the outskirts of Paris at seven miles-an-hour propelled by a clumsy three-horsepower steam engine weighing 462 pounds, there have been proponents of steam power for aircraft…"***
***Popular Science,*** **July 1933**
**<u>Above</u>: Giffard's dirigible (steerable) steam-powered airship of 1852**

228

***"Every once in a while we have to 'get back to nature' - get back to the simple things our dads used. Often we find that we've been on an engineering merry-go-round and that the old gentlemen who were our for-bears had some right good ideas in design, but were unable to use them to the fullest extent of their theories because the right materials were not available in iron, or steel, or something else. And every so often the subject of what tomorrow's airplane will look like bobs up in some writer's mind. He is usually hard pressed to get something really new to write about, so he lays it on thick and the resulting pipe dream generally makes an air-minded man who has any air 'savvy' pretty sick…"***
***Earl D. Hilburn***, **Aeronautical Engineer (1932)**

229

***"…Recent developments in engineering activities have brought these two phenomena together again: steam and tomorrow's airplane. Strangely, some real progress has been made, and we find that steam, used by our grand-dads as an old reliable medium, has been put into new clothes by the developments in materials to the point where it can be considered within reach on all engineering points to make an ideal power plant for a new airplane which will bristle with logical departures…"***
***Earl D. Hilburn***, **Aeronautical Engineer (1932)**

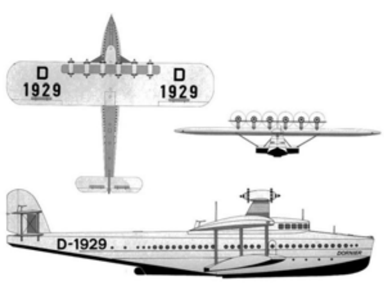
230

***"…Let us take a fundamental consideration: The power plant of the future Leviathan of the air by necessity must be more powerful than is at present practical to build with the present day highly complicated internal combustion engine. The limit is approached in gas engines when such ships as the Dornier Do-X must use twelve 600 h.p. engines separately mounted with all the mess of gauges, magnetos and so forth that must be duplicated time-after-time…"***
***Earl D. Hilburn***, **Aeronautical Engineer (1932)**
**RE: the *Dornier Do-X* was initially powered by twelve 524 hp Siemens-built *Bristol Jupiter* radial engines (in tandem mountings) with six tractor and six pusher propellers mounted in six strut-mounted nacelles above the wing for a "push-pull" configuration**

231

**<u>Caption</u>: "A Dornier Do X flying boat parked on its launch ramp circa 1929 - the year the 56-ton transatlantic luxury craft set a passenger-carrying record (169 souls) that stood for two decades. Only three of the type were ever built."**

232




233

***"…Airplane designers are far ahead of engine designers in aircraft developments and many of the leading minds of the engineering world are striving to develop engines of suitable design for tomorrow's airplane needs…"***
***Earl D. Hilburn***, **Aeronautical Engineer (1932)**

234

*"…Among them is Capt. Richardson, of the Great Lakes Aircraft Corporation, for whom the aeronautical world has profound respect. Also, working along different lines in this search which points toward steam as tomorrow's motive power is Abner Doble, one of the world's leading authorities on steam. Whether or not the ultimate power plant will be of the turbine type such as Richardson is developing, or whether the engine will be of the reciprocating expansion type as is being developed by Doble remains to be determined…"*
***Earl D. Hilburn***, **Aeronautical Engineer (1932)**

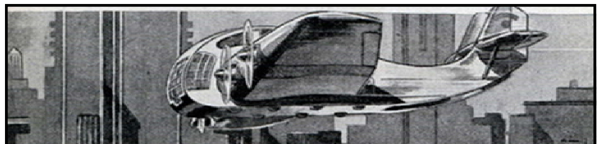
235

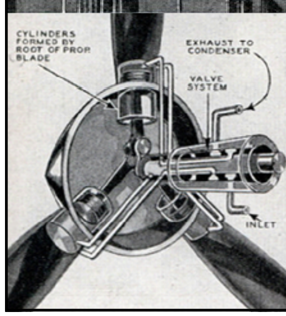
*"…These are the advantages which may be derived from the steam in the operation of controls, combination shock absorbers and retracting devices for landing gear, single throttle for all engines, heating of leading edge and propeller to prevent the formation of ice, heating of cabins, cooking of meals, generation of electricity for lighting and for radio equipment…"*
***Earl D. Hilburn***, **Aeronautical Engineer (1932)**

236

*"…The exhaust steam from engines and cylinders will be condensed and returned to its original state through the process of cooling effected by series of tubes which form the leading edge of the entire wing. This device not only serves as a condenser preventing the loss of water but acts as a heater to prevent the formation of ice on the leading edge of the wing, also warms the air which is conducted along the air ducts in the girders of the wing spars which furnishes heat and ventilation for the cabins…"*
***Earl D. Hilburn***, **Aeronautical Engineer (1932)**

237






*"…The propeller and engine may be combined as a single unit as shown in the illustration…"*
***Earl D. Hilburn*****, Aeronautical Engineer (1932)**
**<u>Above</u>: caption: "Central boiler plant will furnish steam to many simple motors in the wing; will heat the cabin comfortably and prevent ice formation on wing's in tomorrow's plane"**
**<u>Left</u>: caption: "The rotary motor is the only perfect power plant using reciprocating motion without reciprocating weight. Here's Hilburn's suggestion for the simplest 'irreducible' power plant."**

238

*"…The engine utilizing the hub as a crankshaft which is fixed similar to that of the old Gnome rotary, with the engine revolving about the crank shaft opening and closing intake and exhaust ports which form the valve mechanism to drive the pistons operating in the shanks of the propeller blades which would carry off sufficient heat to prevent the formation of ice on the propeller. The generation of electricity will doubtless be accomplished by a direct drive turbine generator set which like the other steam devices will exhaust directly into the condenser on the leading edge of the wing…"*
***Earl D. Hilburn,*** **Aeronautical Engineer (1932)**

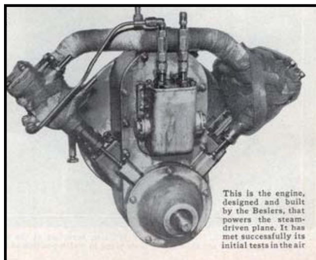
239

## The Brothers Besler

240

***"OVER the Oakland, Calif., Airport, a few days ago, a silent plane slanted across the sky trailing a thin ribbon of white vapor. Spectators heard the pilot shout a greeting from the air. They saw him flash past, skimming the ground at a hundred miles an hour. They watched him bank into a turn, slide to a landing, and, with the propeller spinning backward, roll to a stop in less than a hundred feet. They had seen, for the first time in history, a man fly on wings powered by steam!…"***
***Popular Science,*** **July 1933**

241


This is the engine, designed and built by the Beslers, that powers the steam-driven plane. It has met successfully its initial tests in the air

At right, drawing shows the arrangement of the V-type engine in the nose of the Besler plane. All parts of the power plant are ahead of the cockpit.

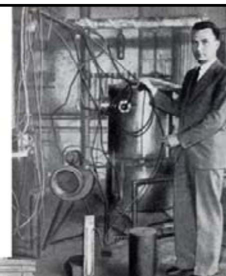
George Besler, left, with his brother William, inventors of the first successful steam engine for planes

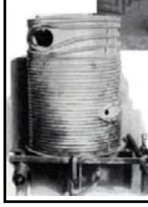
***"Two brothers, George and William Besler, the former a geologist thirty-one years old, and the latter a mechanical engineer, two years younger, have achieved the dream of Maxim, Langley, and other pioneers of flight. Through their work, the steam-driven airplane, long talked about, long planned, has become a reality. This spectacular development in the field of aeronautics is the result of three years of secret experiment. The inventors began their work in 1930, in a machine shop at Emeryville, Calif. A few weeks ago, they brought the product of their researches, a 180-pound engine developing 150 horsepower, to the Oakland Airport and install-ed it at the nose of a conventional Travel Air biplane…"***
***Popular Science,*** **July 1933**

242

***"…The engine is a two-cylinder, compound, double-acting, V-type power plant. Its high-pressure cylinder has a three-inch bore and a three-inch stroke; its low-pressure cylinder has five and a quarter-inch bore and a three-inch stroke. Just behind the engine, the inventors showed me the barrel-shaped metal boiler which, with its super-efficient burner, explains why they have succeeded where others have failed in attempting to drive planes with a steam engine. Using vaporized fuel oil, the patented burner releases as much as 3,000,000 British thermal units per cubic-foot of firebox space. This, they told me, is far in excess of anything hitherto attained…"***
***Popular Science,*** **July 1933**

243





Here is William preparing power plant for a test run in the workshop. At left, the interior of the boiler exposed to show coiled pipe used in generating steam.

***"…An electric blower drives this tremendous heat down among the flat spirals of a single 500-foot pipe coiled within the boiler. Three-eighths of an inch thick, in-side measurement, at the bottom, the pipe gradually increases in size until it has an inside diameter of five-eighths of an inch at the top. The water supply to the coiled pipe is thermostatically controlled to keep the temperature constant regardless of pressure. Under the fuselage nose is the condenser which looks like an ordinary radiator for a water-cooled motor and which is said to recover more than ninety percent of the water from the used steam. By using a steam-feed water-pump, the inventors employ the exhaust vapor to pre-heat the feed water entering the boiler and thus decrease the time required to build up pressure within the coils…"***
***Popular Science,*** **July 1933**

244

***"…At 800 degrees F., the steam pressure built up witin the coils reaches 1,500 pounds. With a 1,200-pound pressure, the engine will deliver 150 horsepower, whirling the propeller at 1,625 revolutions a minute. Tests have shown that ten gallons of water is sufficient for a flight of 400 miles. By increasing the size and efficiency of the condenser, the experimenters told me, they believe they can make this amount of water last indefinitely…"***
***Popular Science,*** **July 1933**
**<u>Caption</u>: "Besler's plane enveloped in its own steam"**

245

**Steam Stealth**

246

*"…Because, above a thousand feet, steam-driven planes would be as silent as soaring birds, they would have particular value in military work. Noiseless war planes have long been sought. But muffling gasoline engines reduces their power to such an extent that the plan is impractical. The new power plant, silent by nature, would permit long-distance raids above the clouds by ghost ships giving off no telltale drone of motors to warn the enemy or to aid in directing anti-aircraft fire…"*
***Popular Science,* July 1933**

247

**Conquering the Stratosphere**

248

*"…Most spectacular of all are the possibilities of steam on the airways of the stratosphere. In the thin atmosphere of this region, ten miles or more above the surface of the earth, experts agree, the high speed transport ships of the future will fly. Here there are no clouds, no storms, and the steady trade winds of the upper blue will increase the speed of long distance passenger, mail, and freight machines. Already, here and abroad, stratosphere ships, with pressure cabins and variable-pitch propellers, have been designed and are under construction. Test hops have been made in such high-flying experimental craft in France and Germany…"*
***Popular Science,* July 1933**

249

*"…The chief stumbling block at present is the gasoline motor. It steadily loses power as it ascends. Climb to 20,000 feet and a motor that delivers 150 horsepower at sea-level will retain only half its power. Spiral on up to 30,000 feet and your engine will have but three-tenths of its sea-level horsepower. And you are then only half way to the stratosphere! Superchargers, driving a blast of air into the carburetor to make up for the reduced pressure in rarefied atmospheres, help these gasoline motors. They are heavy, however, adding to the weight of the plane, and they never completely prevent loss of power at high altitudes…"*
***Popular Science,* July 1933**

250

*"…Now consider the steam engine. It loses no power at all with altitude and gains in efficiency the higher it goes! This is because the pressure on the exhaust is less in thin air than at sea-level. Thus the perfection of the flying steam engine is a vital step toward conquering the stratosphere…"*
***Popular Science,* July 1933**

251

252

## As Old as Aviation Itself

253

**With a background as old as aviation itself, Major Arnold, who conducts this department, is well qualified to look into the future and speculate on probable methods of air transportation**

***Modern Mechanics,*** **January 1931**

**RE: introduction to a "Plane Talk" article edited by Major *H.H.* ("Hap") *Arnold,* former Assistant Chief, *U.S. Army Air Corps* (USAAC) entitled: "What Will Come Next - Air Trailers or Mammoth Planes?"**

254

## Lift and Propulsion

255

***"A FEW years ago it was quite common to hear the expression, 'It's a queer looking contraption but I don't think that it will fly.' Today it is not a question as to whether or not it will fly for it seems as if any kind of device will fly as long as it has wings to hold it in the air and an engine to pull it or push it…"***

***Modern Mechanics,*** **January 1931**

256

## Curb Your Enthusiasm

257

***"…The airplane has been developed to such a point that it has now taken its place as a common carrier. Everyone expects it to be used as such and accordingly now accept, as a matter of course, feats which a few years ago would have been considered as utterly impossible. However there is a limit to all things. What is the ultimate in commercial aerial transportation?..."***

***Modern Mechanics,*** **January 1931**

258

**Prevailing Wisdom**

259

***"…If we go back a few years we find that there was a tendency among designers and engineers to produce large multi-motor planes for commercial operations. They were slow but could carry a big pay load. The thought prevailed that even though the planes made but 70 to 90 miles-an-hour the destination was reached much sooner than it would be were any other form of transportation used…"***
***Modern Mechanics,*** **January 1931**

**Above: produced by the *Dornier Company* of Germany in 1929, the *Dornier Do X* was the largest, heaviest and most powerful flying boat in the world, at the time, with twelve engines. First conceived by *Dr. Claude Dornier* in 1924, planning began in late 1925 and, after over 240K work-hours, it was finally completed in June 1929.**

260

261

**The Aerial Transportation Problem**

262

***"…The American public demands speed. It makes no difference what use is made of the time saved, transportation must have speed or it will not be popular. However, speed itself will not solve the aerial transportation problem…"***
***Modern Mechanics,*** **January 1931**

263

***"…Hawks' itinerary for his flight across the continent would have satisfied patrons whose destinations were Wichita, Indianapolis and New York where he made his stops but how about those who wished to go to such points as Chicago, St. Louis or Kansas City? Obviously on all long lines provisions must be made for branch connections and intermediate stops. However, if such stops are made the time en route is greatly increased and the demand for speed not satisfied…"***
***Modern Mechanics,*** **January 1931**

264

## What Manner of Aircraft?

265

***"…What manner of aircraft then can be used to the variety of demands imposed? The through traffic requires maximum speed with a minimum number of intermediate stops. However, there probably will be as much income from the intermediate traffic, that with points of origin and destinations between the ends of the line. The first thought which comes to mind is a large number of air-liners each with a different destination. Certainly by this means all airports and branch lines could be served. However, the expense would be terrific…"***

***Modern Mechanics,*** **January 1931**

**Caption: "Answer to the problem? – the Boeing Air Transport"**

266


**Founded late in 1926 to bid for the Chicago-San Francisco section of the transcontinental mail route, *Boeing Air Transport* (BAT) won the contract, beginning service in July 1927 with new aircraft produced by its owners; the *Boeing Airplane Company*. In January 1928, Boeing bought one of the early mail carriers; *Pacific Air Transport* (PAT), flying between Seattle and Los Angeles. PAT continued as a separate division, also after *United Aircraft and Transport Corporation* (UATC) was created by Boeing as a holding company in February 1929. Among the UATC companies were *Sikorsky Aviation Corporation* and *Stearman Aircraft Company*, as well as engine producer *Pratt & Whitney*. The "Boeing System" (as the operating airlines of UATC became known) was augmented with further acquisitions; *Stout Air Lines,* in June 1929; *Varney Air Lines,* in mid-1930 (flying mail between Seattle and Salt Lake City) and *National Air Transport* (NAT).**

267

268


**NAT held the important mail contract between New York and Chicago and was merged with the Stout division, enabling the *Boeing System* to offer a complete transcontinental mail and passenger service. During the spring of 1931, the Boeing System became known as "United Air Lines" (from July 1931 onward, it was also the new name of the holding company). After the cancellation of the mail contracts in 1934, *United Air Lines* (UAL) was reorganized as an operating company, merging all the divisions. BAT was based at the *Cheyenne Municipal Airport,* which played a significant role in the early development of aviation in the U.S.**

**Above: caption: "Boeing Model 80A, a three-engine biplane that could carry up to 12 passengers"**

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270

## Air Trailers

271

*"…The first thought which comes to mind is a large number of air-liners each with a different destination. Certainly by this means all airports and branch lines could be served. However, the expense would be terrific. Another solution is to put into effect the idea advanced by Anthony Fokker several years ago - a towing plane with air trailers…"*
***Modern Mechanics,*** **January 1931**

272

*"…It has not been so very long since Hawks traveled across the United States in an air trailer. The elapsed time was rather long but the practicability of the trailer was demonstrated. Fokker advanced the idea that several trailers could be pulled by a single towing plane. As a matter of fact there are people working along that line at this time. Accordingly perhaps we will some day see a towing plane with several air trailers flying along the route from say, St. Louis to Cleveland. When the aerial train arrives over the airport at Indianapolis, a trailer will be uncoupled and brought to earth by its pilot. Similarly other trailers will deliver their cargoes to Dayton, Columbus and any other point en route where a pay load makes it worth while…"*
***Modern Mechanics,*** **January 1931**

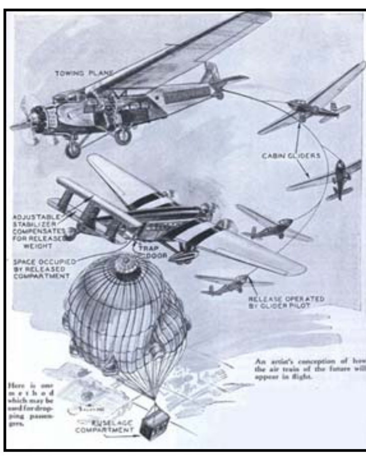
273

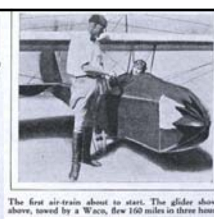
## Plan B

274

*"…Another method of securing the same service would be to have large cargo planes with parachutes attached to light weight platforms. When the destination for cargo or passengers was reached, the steward, after loading up the platform, could pull the lever which would allow the parachute to deliver its load. The cabin of the large plane would have to be so constructed that these parachutes with their platforms could be set up during flight. Perhaps an additional cabin would solve the problem as all arrangements could be made without discomfort to other passengers or making a rearrangement of the cargo necessary…"*
***Modern Mechanics,*** **January 1931**

275



The first air-train about to start. The glider shown above, towed by a Waco, flew 160 miles in three hours.

*"…An opening in the floor the size of platform with a trap door to shut when not in use would fill the bill. When approaching the destination the steward might call out, 'Passengers for Columbus please move forward to the shuttle 'chute.' Then baggage, passengers and any express would be attached to the platform and the 'chute dropped…"*
***Modern Mechanics,*** **Jan. 1931**

276

## Far Fetched(?)

277

***"…It sounds rather far fetched at this stage of aircraft development but passing years change many things. It is quite easy to picture a towing plane with its trailers taking the air but things look different when plans are made for its accomplishment…"***
***Modern Mechanics,* January 1931**

278

***"…The train must of necessity be rather long and thus requires a very large airdrome. The various cables connecting the plane to the first and successive trailers gives an enormous drag as the train endeavors to get up flying speed. This further emphasizes the need for a large airdrome. The angle which the trailers make with the line of travel differs while running along the ground from that taken when traveling through the air. This could be taken care of by a system of bridles attaching the trailers to a main cable. The problem becomes simpler when the train is in the air. The pilots of the trailers then have a steady pull to take care of."***
***Modern Mechanics,* January 1931**

279

## Who Knew?

280

**WHO could have envisioned in 1928, when a dozen young men were making the first glider experiments at the University of Michigan, that the crude ship then used was the forerunner of what would ultimately be one of the world's great means of transportation?**
***Popular Mechanics,* December 1942**
**RE: introduction to an article written by *Colonel Edward S. Evans,* President of the *Evans Products Company,* entitled: "The Age of Air"**

281

***"These members of the first glider club of America, which was formed under my sponsorship, learned the delight of being pulled into the air with a rubber cord and gliding gently to the ground several hundred yards away. Some of these same young men today are still flying gliders, beautiful ships known as sailplanes which have established records of distance, altitude and duration that are almost unbelievable…"***
***Popular Mechanics,* December 1942**
**RE: in 1928, *J.C. Penney Jr.,* son of the founder of the *J.C. Penney* department store chain, provided financial backing for a glider pilot training school run by the *American Motorless Aviation Corporation* (AMAC). In order to gain publicity, AMAC sponsored some soaring flights at Highland Light, Mass., and South Wellfleet, Mass., on Cape Cod. AMAC's chief pilot, *Peter Hesselbach,* made the first flight on July 28, 1928 in the *Darmstadt I* glider. This flight was of 57-minutes duration, bettering Orville Wright's 1911 American glider duration record flight of 9-minutes, 49-seconds (glider flights had been made up to fourteen hours in Germany). Hesselbach flew again on July 31, 1928 from Corn Hill, Mass., and flew for more than four hours, soaring in the winds that flowed up over the dunes. This flight was given front page coverage in the *New York Times*.**

282

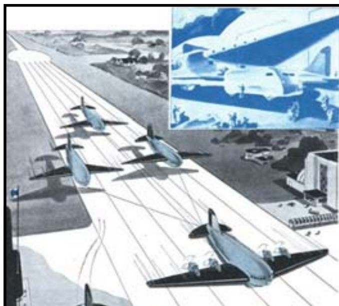
**German Glider Thrills Americans**

IN ONE of the first demonstrations of German gliders in America, Peter Hesselbach, holder of the world's duration record of five hours for motorless flying with a passenger, recently had a thrilling escape from death at the edge of a high cliff near Highland Light, Cape Cod, Mass. By inches, his machine missed plunging over the bluff. Hesselbach was piloting the 300-pound German glider *Darmstadt.* Pulled by an untrained ground crew, the craft failed to gain altitude. When, at the last minute, Hesselbach blew the whistle that signaled them to release the rubber launching rope, the craft settled and slid along the ground until its nose overhung a 140-foot drop to the ocean's edge. In another flight, Hesselbach remained aloft for four hours and five minutes, soaring about 120 miles. The photographs above show the start of the flight. The Cape Cod region, according to the pilot, offers better possibilities for soaring flight than many of the best spots in Germany…(*Popular Science,* Nov. 1928)

283

## Air Depots of the Future

284




***"…Looking toward tomorrow, we can see the same principle employed for motorless cargo ships towed by tractor or tug planes, carrying enormous loads of freight or delivering human cargo in the most quiet and delightful way ever known to man; ships that will carry twenty tons or more freight or up to 100 passengers, with no engine vibration, no noise, with a wing span and a speed which will assure smooth riding. One employing such facilities can rest comfortably at night and arrive at his destination as rested as if he had slumbered in his own bed…"***

***Popular Mechanics,*** **December 1942**

**<u>Caption</u>: "Three huge cargo gliders taking-off from an air depot of the future are in the air before the giant tow plane. At upper right, stowing freight in a glider."**

285


***"…Freight thus transported could be delivered in quantity at 200 miles per hour and at a cost well within the range of economical shipping; in other words, somewhere between two and three cents a ton mile. According to the best information obtainable today this is less than truck freight or box-car freight and only a fraction of the cost of railway express. Cargoes of oranges, grapes and other perishable fruits could be loaded ripe in California, something unheard of today, and delivered in New York in time to go on the breakfast table the next morning…"***

***Popular Mechanics,*** **December 1942**

**<u>Caption</u>: "At left, air freight terminal. All perishable and first class cargo will be shipped economically by air, says Colonel Evans."**

286

## Economies of Scale

287

***"…A few basic figures will give a fairly good conception of the advantages of this modern means of transportation over anything evolved before. The average train of loaded box cars carries 2,000 tons of freight at 25 miles an hour. Seven glider trains could deliver the same freight in one-tenth the time or, to express it differently, seven glider trains could deliver ten times as much freight as a railroad train in the same length of time and in much better physical condition, as the cargo will not be subjected to the shocks of switching and shunting…"***

***Popular Mechanics,*** **December 1942**

288

***"…The Army, transporting goods from Northern India into China by airplane, requires 35 planes to do the work formerly done over the Burma Road with 7,700 trucks, 4,500 of which were in constant service and the balance in reserve or in the shops for repair. The trucks delivered about 30,000 tons per month. These comparatively few transport planes now can deliver the same with a smaller percentage of waste in human labor…"***

***Popular Mechanics,* December 1942**

**RE: the Allies' aim in the *C*hina-*B*urma-*I*ndia (CBI) *Theater* was to supply and buttress Chinese armies in their struggle against a massive Japanese incursion. The Japanese seizure of China's seaports had severed its traditional supply lines. Thus, the Allies were forced to transport equipment, men and supplies to China through Burma by building roads and pipelines, and to India by flying the "Hump" route over the Himalayas.**

**Caption: "Convoys ascending a 21-curve stretch along the Burma Road"**

289

***"…We are not talking now about glider trains but about transport planes alone. If glider trains were used, this same amount of freight could have been delivered with eight glider trains as compared to the 7,700 trucks used on the Burma Road…"***

***Popular Mechanics,* December 1942**

**Caption: "Air crews flying heavily loaded C-47 Skytrain transports faced the dangers of bad weather, high altitude and hostile Japanese aircraft while flying vitally-needed supplies over the 'hump'"**

290


291

***"…Transports being used in China can carry a payload of 9-1/2 tons. If they pulled three gliders, each glider could probably carry 18 tons. The speed would necessarily be decreased, but nothing like the proportional increase in payload. The Army has come to the conclusion that three gliders in an inverted 'V' formation are the most practical number to be towed…"***

***Popular Mechanics,* December 1942**

292

***"…I have found the one thing that invariably commands a situation is the law of economics. Therefore, I can assert that economics will ultimately force the use of airplanes and gliders for the transportation of freight and passengers to a point where a majority of our passengers and at least 60 percent of our high grade freight will take to wings…"***

***Popular Mechanics,* December 1942**

293

**Advantage: Gliders**

294

***"…For carrying freight, the glider has certain advantages over the air transport plane. Not having engines and propellers on the leading edge of its wings, it can be molded and faired so that its nose resistance is one-third that of an airplane. Because it does not carry an engine with all of its inherent strains, it can be built much lighter. But with its wing spread and with heavy wing loading, the glider can carry a gross weight equal to the transport plane, which would be approximately twice the pay load the transport plane would carry. In other words, the weight normally consisting of fuel, engines and the heavier bracing in the transport plane could be replaced by payload in the glider…"***
***Popular Mechanics,* December 1942**

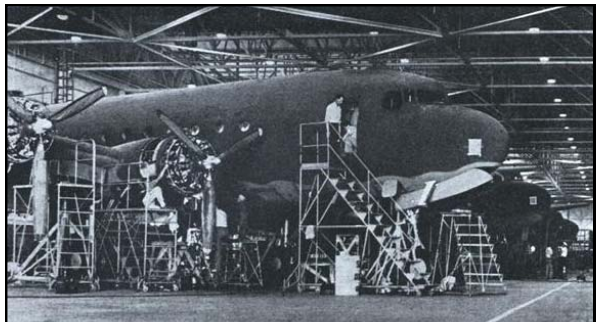
295

***"…General railroad freight at present costs slightly under one cent a ton mile. This cost includes coal, ore, grain, sand, gravel, stone and other bulk commodities. Personally I do not believe air freight will ever be able to compete in this particular field. Its place is for the higher grades of freight…"***
***Popular Mechanics,* December 1942**

296

## New Neighbors

297

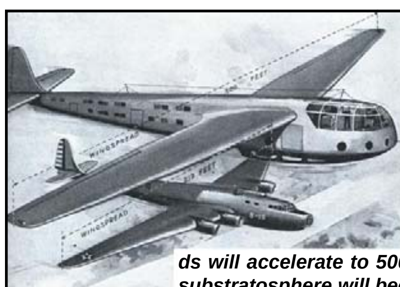


***"…We would be remiss if we confined our thinking to the North American continent. Once in the air, great planes and gliders can span the oceans in a few hours. …"***
***Popular Mechanics,* December 1942**
**<u>Caption</u>: "Giant four-engine C-54 transports with cargo capacity of a railway boxcar are in production at Douglas plant"**

298

***"…Freight that now takes 10 to 14 days to deliver by cargo ships will be safely brought to its destination by air in as many hours. The world will shrink to a size where we can look upon the Fiji Islander as a next-door neighbor. We will then be able to take our vacations in the South Sea Islands with much greater ease than we used to go to the Riviera…"***
***Popular Mechanics,* December 1942**

299



***"…Airplanes and gliders will be built with wing spans of over 300 feet; methods will be developed which will insure greater safety than any present mode of transportation; speeds will accelerate to 500 miles an hour; the substratosphere will become a highway; ships will carry internal air pressure for comfort of the passengers. Future generations will look upon our present modes of transportation as we look upon the high-wheel ox cart…"***
***Popular Mechanics,* December 1942**
**<u>Caption</u>: "The author foresees a motorless freight and passenger ship with a 300-foot wing spread – nearly 100-feet wider than that of the B-19, drawn to same scale, above"**

300

## Part 4

## All-Metal

301

**The Skin of the Plane**

302

**In the Plane Talk department this month Major Arnold discusses several important developments in aviation, several of which are of British origin**
***Modern Mechanics,*** **March 1931**
**RE: introduction to a "Plane Talk" article edited by *Major H.H.* ("Hap") *Arnold,* former Assistant Chief, USAAC entitled: "Metal Skins for AIRPLANES"**

303

**The Tin Goose**

304

**"*EVERY day that passes sees more airplanes in which cloth and wood construction has been discarded and metal substituted. At first the metal was used in wing and fuselage truss construction only but recently metal sheets have found great favor as wing and fuselage covering…"***
***Modern Mechanics,*** **March 1931**
**RE: *Henry Ford* took the airplane, considered by most people, at the time, to be noisy and dangerous and transformed it into a successful commercial product that was radically different than anything that came before it. His all-metal airplane design was called the "Ford Tri-Motor" (a/k/a "Tin Goose") – a goose that would lay a golden egg.**

305


**The *Ford Trimotor* was the seed that would spawn commercial aviation, pioneering coast-to-coast airline service in the U.S. TAT (forerunner of TWA), provided regularly scheduled flights from New York to California. *Pan American Airways* (PAA) used the Trimotor extensively in Central and South America and made their first international flights from Key West, Florida to Havana, Cuba. The Trimotor also served as military transports. The USN received nine of the 4-AT and 5-AT versions from 1927, while the USAAC received thirteen.**
**Above: caption: "A Ford Trimotor placed next to a TWA Boeing 707 during a promotional tour (ca. 1966)"**
**Left: caption: "Ford Trimotor interior"**

306

## The Duralumin Age

307

*"…Engineers talk among themselves of a Duralumin Age. They speak of vast quantities of fuel saved by lighter engines, trains and motors; of buildings dizzily high; of mechanical wizardry in manufacture; of a world unshackled by ponderous iron and steel…"*
***Popular Mechanics,*** **December 1924**

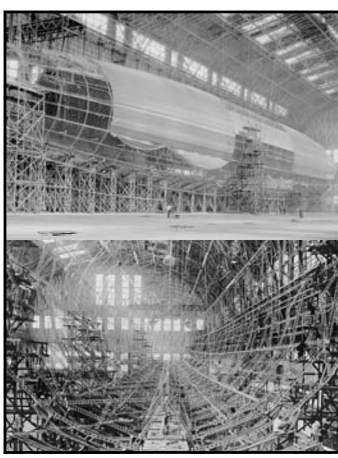
308

## Marvel Metal

309

***"…The story of duralumin, the marvel metal of the twentieth century – the metal invented especially for airships. It is a remarkable partnership, this between the airship and duralumin…"***
***Popular Science,*** **December 1924**
**Caption: "Assembling the duralumin framework of the USS Macon"**

310



***"…The airship requires strength and lightness for its ribs and hull. Wood, while light, isn't strong enough. It won't stand the stress. Steel is strong enough, but too heavy. Duralumin is stronger than wood and much lighter than steel, in fact, about one-third the weight of the latter. So light and so strong is it that you can pick up with two fingers a girder of it that will support six men…"***
***Popular Science,*** **December 1924**

311

***"…Duralumin is an alloy of copper, manganese and magnesium, with about 94 per cent of aluminum. In 'strength-weight' efficiency, that is, strength and lightness, it is 17 per cent greater than a good alloy steel and nearly three times better than mild steel or half hard aluminum. It was first made by Alfred Wilm in Germany in the development of Zeppelin airships, but it is now being made in England and the United States…"***
***Popular Science,*** **December 1924**
**RE: *Duralumin* is the trade name of one of the earliest types of "age-hardenable" aluminum alloys. The main alloying constituents are copper, manganese and magnesium. A commonly used modern equivalent of this alloy type is AA2024, which contains 4.4% copper, 1.5% magnesium, 0.6% manganese and 93.5% aluminum by weight. Typical yield strength is 450 MPa, with variations depending on the composition and temper. Duralumin was developed by the German metallurgist *Alfred Wilm* at *Durener Metallwerke Aktien Gesellschaft*. In 1903, Wilm discovered that after quenching, an aluminum alloy containing 4% copper would slowly harden when left at room temperature for several days. Further improvements led to the introduction of duralumin in 1909.**

312

**Today, the name "Duralumin" is obsolete, but it's still used in to describe the Al-Cu alloy system (or 2000 series, as designated by the *International Alloy Designation System,* originally created in 1970 by the *Aluminum Association*). Its first use was in rigid airship frames, eventually including all those of the "Great Airship" era of the 1920s and 1930s, including: the German passenger Zeppelins LZ-127 (*Graf Zeppelin*), LZ-129 (*Hindenburg*), LZ-130 (*Graf Zeppelin II*) and USN airships *USS Los Angeles* (LZ-126), *USS Akron* (ZRS-4) and *USS Macon* (ZRS-5). Its composition and heat treatment were a wartime secret. *Duralumin* quickly spread throughout the aircraft industry in the early 1930s where it was well suited to the new "monocoque" (a structure in which the chassis is integral with the body) construction techniques that were being introduced, at the time. Duralumin is popular for use in precision tools such as levels because of its light weight and strength.**

313


314

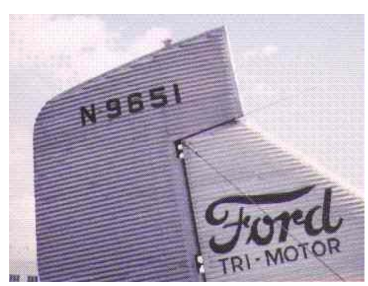
**"*…The German engineers were the first to take advantage of duralumin in airplane design abroad and the Ford company the first to make extensive use of it in this country. The strength varies with the thickness of the sheets used. Additional strength is obtained by utilizing corrugated metal as the corrugations act as small trusses…*"**
***Modern Mechanics,* March 1931**
**RE: the *Ford Trimotor* was of all-metal construction of three-layered "Alclad" aluminum sheeting. The sheeting core metal was "duralumin," which had coatings of pure aluminum on either side, making it highly resistant to corrosion (even at the edges and where it was riveted).**

315

316

**This process created a material that was very durable and long-lasting. The metal sheeting was also corrugated, which provided additional strength, but increased drag, thus decreasing overall performance. Unlike most aircraft at the time, the flight controls (i.e. flaps) were also all-metal rather than fabric covered (fabric covered flight controls reduced weight and were easier to balance).**
**<u>Caption</u>: "The Ford Trimotor's corrugated skin gave additional strength, but also increased drag"**

317




318

## The Talented Mr. Stout

319

The story of the *Ford Trimotor* begins with *William Bushnell Stout* who, during WWI, worked for the *Packard Motor Car Company* as Chief Engineer of their aircraft division. As the war drew to a close, Stout designed an airplane for the USAAC called the "Batwing." It was the first American-built, internally-braced, cantilever-wing monoplane. It also had the first plywood veneer used as aircraft skin in the U.S. However, by the time it flew, the war had ended and the USAAC had lost interest. Despite this setback, the *Batwing* drew the attention of the USN, who commissioned Stout to build an all-metal, twin-engine torpedo bomber. It crashed during a test flight and never went into production.

320

In the wake of the crash, Stout turned to the commercial market for financing of a new design. He sent letters to one-hundred Detroit industrialists asking for $1K from each of them; he received about sixty-five responses. Stout raised $20K, including $1K each from *Edsel* and *Henry Ford*. Now, with enough funds, Stout incorporated the "Stout Metal Airplane Company" on November 6, 1922, "to develop and manufacture aircraft."
Caption: "Stout Metal Airplane Company Factory, Ford Airport, Dearborn, Michigan, 1924"

321


Stout's first design was a four-passenger monoplane made of metal and powered by an *OX-5* engine. He called it the "Air Sedan" (AS-1). The *Air Sedan* first flew on February 17, 1923, however, its performance was poor. On the test flight, it was obvious the plane lacked power. Stout installed a *Hispano Suiza* engine and, with this new engine, the power problem was resolved.
Caption: "Stout's AS-1. The Air Sedan first flew on February 17, 1923, and its performance was poor. Stout wanted to build a larger airplane with a more powerful engine."

322

When *Henry Ford* heard of Stout's experiments he began to consider the possibilities for commercial aviation. In a conversation, Stout told Ford that he wanted to build something more powerful than the *AS-1,* an airplane that could carry ten people (two crew and eight passengers) or the equivalent in cargo, have a high wing and use the 420 hp *Liberty* engine.

323

## 2-AT

324

Stout's follow-up design was the ***2-AT*** **"Air Pullman," which first flew on April 23, 1924. It was a single engine, high wing monoplane built entirely of corrugated** ***duralumin*****. Stout's idea to build an airplane completely out of metal was radical. At the time, American airplanes were being built of fabric stretched over wood or metal frames. Stout named his airplane "Maiden Detroit," to promote public interest in the venture. When it was used for freight it was called the "Air Truck" and was the first Stout plane to have the Ford emblem on its fuselage. In December 1924, the USPS bought** ***Maiden Detroit*** **to carry airmail, giving the** ***Stout Metal Airplane Co.*** **the financial boost it desperately needed.**

325


**By March 1925, Stout's "Maiden Dearborn," was ready for tests. On April 13, 1925,** ***Maiden Dearborn*** **left Detroit for Chicago. It was the first flight of the** ***Ford Air Transport Service,*** **(FATS) established by the** ***Ford Motor Company*** **to carry auto parts, company mail and executives to their Chicago plant. Soon, 2-AT "Maiden Dearborn II" was placed in service on the FATS route.**

**Caption: "Stout 2-AT 'Maiden Dearborn'"**

326

**On July 31, 1925,** ***Henry Ford*** **bought the** ***Stout Metal Airplane Co.*** **and it became the "Stout Metal Airplane Division of the Ford Motor Co." By December 1925, Stout had manufactured eleven single-engine 2-ATs and five were used by the FATS.**

**Caption: "One of Stout's 2-ATs at work carrying mail for Florida Airways. Note the open cockpit and thick wing root."**

327

## The Right Thing to Do

328


**On August 25, 1925,** ***Henry Ford*** **announced his entry into the commercial aviation field. "The Ford Motor Company," he said, "means to prove whether commercial flying can be done safely and profitably." Ford tried to convince the public that flying in a Ford plane was the "right thing to do." In August 1925, he established the** ***Ford Air Reliability Tours,*** **covering thirteen cities and 1,775 miles. The event was open to all aircraft manufacturers and it attracted Europe's best-known aviation figure; Dutchman** ***Anthony Fokker.***

**Above L&R: caption: "1975 Franklin Mint First Ford Air Reliability Tour 50th Anniversary"**

329


**In 1925, while living in the U.S.,** ***Anthony Fokker*** **heard of the inaugural** ***Ford Air Reliability Tour,*** **which was proposed as a competition for transport aircraft. Fokker had the company's head designer;** ***Reinhold Platz,*** **convert a single-engined** ***F.VII A*** **airliner (a 1924** ***Walter Rethel*** **design) to a trimotor configuration powered by three 200 hp** ***Wright Whirlwind*** **radial engines.**

**Caption: "The original F.VII was a single-engine airplane powered by either a 260 hp Rolls Royce Eagle IX, 450 hp Napier Lion or Bristol Jupiter engine. In 1925, the F.VIIa was powered by a 400 hp Packard Liberty engine and was demonstrated in the United States."**

330

The resulting aircraft was designated the "Fokker F.VII A/3M." Following shipment to the U.S., it won the ***Ford Air Reliability Tour*** in late 1925. The Trimotor's structure comprised a fabric-covered steel tubing fuselage and a plywood-skinned wooden wing. The "Fokker F.VII B/3M" had a slightly increased wing area over the A/3M, with power increased to 220 hp per engine, while the F.10 was slightly enlarged, carrying twelve passengers in an enclosed cabin. The aircraft became popularly known as the "Fokker Trimotor." The modified Fokker dominated the tour, coming in first, followed three minutes later by the Ford entry; a single engine ***Air Sedan.*** Both Ford and Fokker profited enormously from the publicity, allowing Fokker to introduce his airplane designs successfully in the U.S.

331

**Caption: "The Fokker F.VII was a successful 1920s trimotor airliner"**


332

## 3-AT

333

Not completely satisfied with the ***2-AT, Henry Ford*** directed Stout to build a larger airplane with three engines. Stout took the basic layout of the 2-AT and mounted a ***Wright Whirlwind*** air-cooled radial engine under each wing, with a third engine in the nose. The nose was rounded with windows to give forward vision for the passengers. The pilot's open cockpit was placed above the cabin and wing, which provided the pilot with poor landing visibility. However, the "3-AT" was unattractive and was derided for its appearance.

334

**Caption: "The 3-AT was labeled a 'monstrosity' by observers"**

The test pilot; ***R.W.*** ("Shorty") ***Schroeder***, almost crashed the ***3-AT*** on landing. His report to ***Henry Ford*** (and that of another test pilot) convinced Ford that the 3-AT was a non-starter. Angered, Ford dissolved his relationship with ***William Stout.*** On the night of January 17, 1926, a suspicious factory fire destroyed the 3-AT and Stout's earlier designs. Stout was sent on a speaking tour to promote aviation and a new group was formed to design a new trimotor airplane.

335

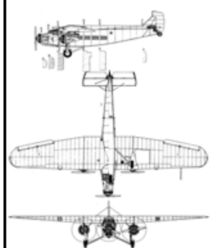
## 4-AT

336



For many years, Stout was credited with having designed the *Ford Tri-Motor,* this despite the fact that he never made that claim personally. The original "4-AT" design was the result of the ideas of several men, none having claimed exclusive credit for it. However, *Tom Towle,* an assistant to Stout, figured most prominently in the design of the *4-AT.*

Caption: "The plate that appears on every Tri-Motor implies that Stout designed the airplane" 337



Towle was directed to layout the design and others were brought in to assist. Towle would take the general layout of the *2-AT* as the basis for the *4-AT* design. The 4-AT was a vast improvement over the *3-AT.* On June 11, 1926, it made its first flight. The test pilot reported that the plane's performance was "perfect."

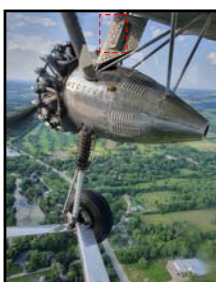
Caption: "Views of Ford Trimotor 4-AT"

338


Although designed primarily for passenger use, the *4-AT* could be adapted for hauling cargo (its seats were removable). The 4-AT used simple systems that were easy-to-maintain, giving it a reputation for ruggedness. When first built, the service life of the plane was only expected to be 2,500 hours. However, Trimotors remained in service long after they were expected to be retired, setting a new standard for the expected service life of aircraft.

Caption: "This Ford, 4-AT-10, C-1077 was the tenth off the assembly line and is the oldest flying Ford trimotor" 339


340



The 4-AT-A carried eight passengers, had a crew of two and was powered by three 200 hp *Wright J-4 Whirlwind* engines. The flight control cables were routed outside of the fuselage (common at the time) and engine oil temperature and pressure gauge/s were mounted outside, on the engine cowling, to be viewed by the crew from the cockpit. The cockpit instrument panel was basic with no redundancy.

Left: caption: "Ford Trimotor passenger's view of one engine" 341
Right: caption: "The cockpit of the Ford Trimotor"

Ford claimed the *4-AT* was "the safest airliner around." However, there were accidents where the wings separated from the fuselage in-flight. If a 4-AT had an engine failure on take-off, the resulting vibrations and the poor airflow over the corrugated skin would often cause the plane to stall, resulting in a crash.

Caption: "The early production line for the Ford Tri-Motor was duplicated from Ford's automobile assembly line" 342


The Ford All-Metal Tri-motored Monoplanes have covered over three million miles in regular service without passenger accident.

They pioneered in mail service, and to such an extent has this service grown in America that letters by air mail are now sent at less than half the cost of special delivery postage.

Not only in Government flying, but as railroad auxiliaries, as carriers between the great industrial cities, they have proved that their reliability is absolute.

* * *

Ford Monoplanes are of duralumin construction – strong as structural steel and only one-third as heavy. These planes can be left out of doors for long periods without harm; only cleaning is required to prevent corrosion.

All-metal, the strength of any part can be gauged accurately, its serviceable life accurately accessed. With all-metal construction the terrible risk of fire is eliminated.

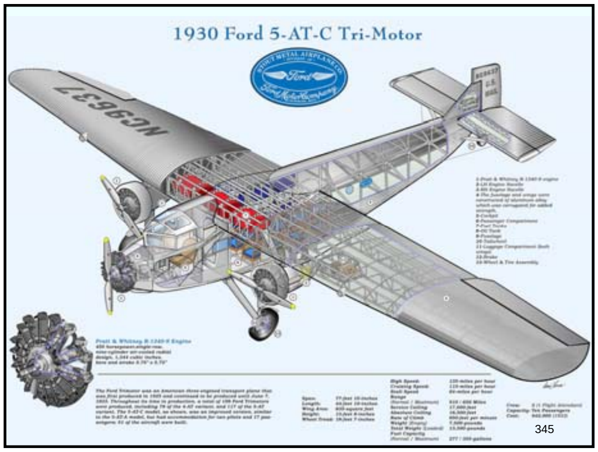
* * *

Ford Monoplanes have three engines. They can climb on two only. Even with one the angle of descent can be extended to cover an area of a thousand square miles.

343

**In 1927, the 4-AT-A was followed with an improved 4-AT-B, which had a larger wingspan, seating for twelve passengers and was powered by three 220 hp *Wright J-5 Cyclone* engines. The last version of the 4-AT series was the 4-AT-F, which was powered by three 300 hp *Wright J-6 Cyclone* engines. Total 4-AT production was 78. Additional aircraft production included three 6-AT-As powered by 300 hp Wright J-6 Cyclone engines and one 8-AT freighter making the total production 199 Trimotors. The 9-AT, 11-AT and 13-AT were conversions of either the 4-AT or 5-AT. The 10-AT and 12-A were never-built projects and the 40-seat 14-A never flew.**

344




345

**The popularity of the 4-AT stemmed from its appearance; it had no wires or struts and its metal skin had corrugations running span-wise. Aluminum was stronger than wood thus, Ford tried to convince the public their planes were safe and comfortable in their advertisements for the airliner: "Your comfort is given the same consideration as has been given structural strength. The fuselage is enclosed and plenty of windows allow good visibility and ventilation. Exhaust manifolds throw the sound away from the fuselage and padding of the compartment further muffles it. Conversation is carried on with ease. Large upholstered chairs assure riding ease for twelve passengers."**

346


**While Ford's advertising spoke of comfort and safety, the cabin was not heated and the sound level inside a *Ford Trimotor* was a deafening 117 decibels. Co-pilots handed out packs of chewing gum, cotton and ampoules of ammonia. The gum was to equalize the pressure on the passenger's ears while the cotton dampened some of the noise and the ammonia was to relieve air sickness, which was commonplace. When passengers arrived at their destination, they got off the plane both physically and psychologically exhausted from the experience.**

**<u>Caption</u>: "The new Ford all-metal, tri-motored club plane…This great new plane permits you to forget the mechanics of flight. It gives you the freedom, the exhilaration, the full joy of sailing at will across the skies in club comfort…"**

347

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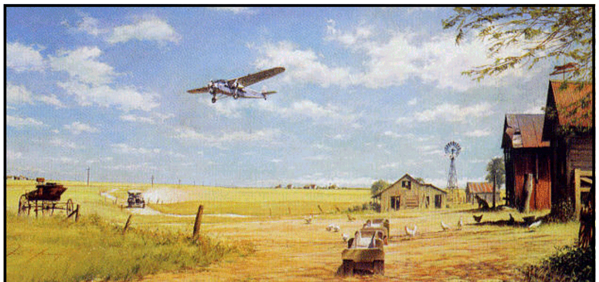


**The deepening of the *Great Depression* by the early 1930s and the appearance of new and faster types of airplanes forced the *Ford Trimotor* out-to-pasture, prompting both *William Boeing* and *Donald Douglas* to build on the idea of the "All-Metal" monoplane.**

**<u>Caption</u>: "Shrinking Land," by John Young. The Ford Trimotor made travel across America possible in days instead of weeks."**

349

## Sharing the Load

350

**"*…As modern airplane design contemplates the skin carrying a considerable portion of the load, the strength of the sheet metal must be very accurately known. Furthermore as it is impossible to secure sheets of the size and shape of the airplane parts, the strength of all joints in the skin and the points of attachment of the skin to the framework is important…"***

***Modern Mechanics,* March 1931**

**RE: constructed of aluminum alloy, which was corrugated for added stiffness, the corrugations resulted in drag, thus reducing aerodynamic performance**

351

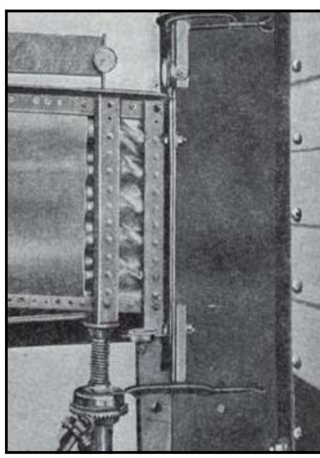
352

**"*…In certain modern planes as the Ford, Junker, Thomas Morse and Breguet every effort has been made to eliminate as much truss work in the wings and fuselage as possible. Thus the stresses and strains may be carried almost entirely by the skin. From the above the necessity for having strength tests made of metal sheets, their riveted or bolted joints and the points of attachments of sheets to plane members is apparent…"***

***Modern Mechanics,* March 1931**

**RE: the Ford Trimotor's fuselage and wings followed a design pioneered by *Hugo Junkers* during WWI that was used postwar in a series of airliners, some of which were exported to the U.S. In fact, so similar were the designs that Junkers sued, and won, when Ford tried to export a Trimotor to Europe. In 1930, Ford countersued and lost, with the court finding that Ford had infringed upon Junkers' patents.**

353



**"*…The accompanying photograph shows a piece of corrugated sheet duralumin mounted in a form for strength test. The pressure from the jack is gradually increased until the metal loses its original shape and becomes distorted. The reading on the scales at that point of the test gives the sheer strength."***

***Modern Mechanics,* March 1931**

**<u>Above & Left</u>: caption: "The photo at left shows a Ford all-metal airplane, the covering of which is sheet duralumin. The photo above shows a sheet of this metal mounted in a frame for the strength test. Pressure is applied by the automobile jack under the frame and is read directly in pounds on the scale. In the tests shown the sheets are just beginning to give way under the strain, the distortions showing plainly."**

354

**<u>Part 5</u>**

## A Decade of Progess

355

**War and Peace**

356

**Ten years ago the first aerial mail line had been in operation for a very short time. The war trained pilots were trying to make up their minds whether to take up aviation as a profession or to get jobs on the ground. The Army and Navy had hundreds of surplus airplanes which they were selling for almost nothing.**

***Modern Mechanics,*** **August 1931**

**RE: introduction to a "Plane Talk" article edited by *Major H.H.* ("Hap") *Arnold,* former Assistant Chief, USAAC entitled: "Ten years of Commercial Aviation"**

357

**Coming Into its Own**

358


**"*THERE were then a few far sighted people who were convinced that air transportation must certainly come into its own some day and were struggling with short air lines. There were hundreds of gypsy pilots picking up a few dollars here and there as they flew around the country. Then there was the trans-continental air mail system operated by the U.S. Post Office Department…"***

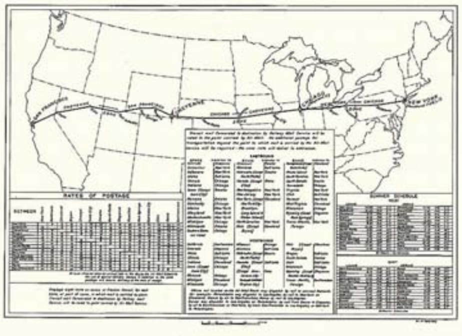
***Modern Mechanics,*** **August 1931**

**<u>Caption</u>: "The first U.S. Air Mail takes off from Washington, D.C., on May 15, 1918"**

359


**<u>Above</u>: the first scheduled *U.S. Air Mail Service* connected Washington, D.C., and New York. Designed by *Augustus Post,* the Secretary of the *Aero Club of America,* the 218-mile route was the first step in establishing a transcontinental route by air. Letters and parcels intended for Air Mail Service were marked as "Via Air Mail" (or equivalent), appropriately franked (i.e. postage) and assigned to any then existing class or sub-class of the Air Mail Service.**

360

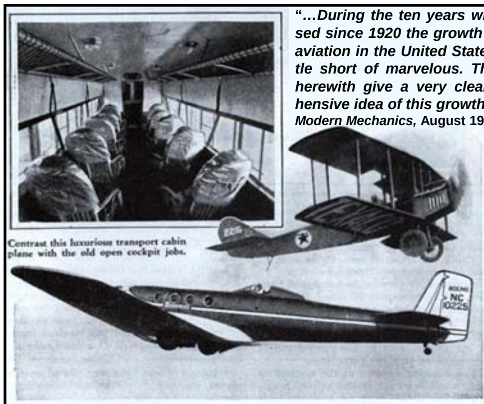


**Caption: "U.S. Post Office Department map of the First Transcontinental Air Mail Route involving both day and night flying over the entire route opened July 1, 1924"**

361

**1920 vs. 1930**

362



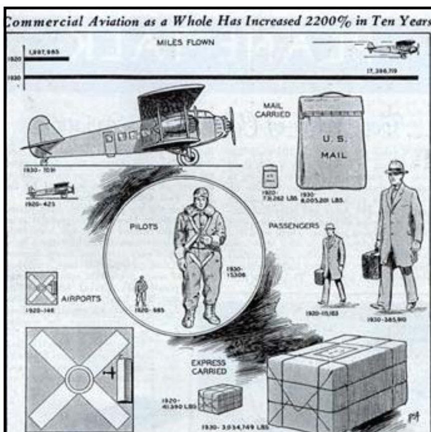

A ten year advance in mail plane design is shown here. Below is a transport plane which carries eight passengers and a heavy load of mail at 150 m.p.h. Above is the type of mail plane of 10 years ago.

**"*…During the ten years which have passed since 1920 the growth of commercial aviation in the United States has been little short of marvelous. The illustrations herewith give a very clear and comprehensive idea of this growth…"***
***Modern Mechanics*, August 1931**

363

**"*…We have read and heard so many pessimistic opinions of our present day aerial transportation that it is hard to realize the miles flown in 1930 on regular air lines was about nine times the number flown in 1920. That there was 73 times more express carried last year than ten years ago. Similarly there are 19 times as many planes and 22 times as many pilots engaged in established commercial operations…"***
***Modern Mechanics*, August 1931**

364




The drawing at left graphically illustrates the growth which commercial aviation has attained in ten years. The number of regularly scheduled miles flown has increased 9x, There are some 19x as many planes in service as there were in 1920, and 22x as many pilots to fly them. Although there are only 3x as many passengers carried, the amount of express has increased 73x.

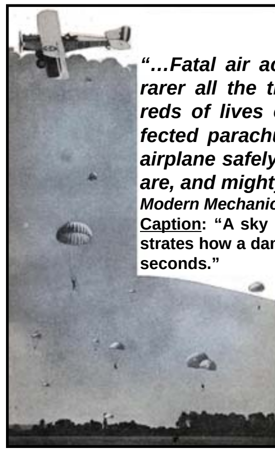
365

**"*…While the figures would indicate that our air transport lines have taken on a natural healthy growth, the volume of business will be materially increased when passengers can ride with the same feeling of safety that they have on railroad trains. This may be brought about by a different design of planes or by the general use of individual or airplane parachutes…"***
***Modern Mechanics*, August 1931**

366

## Mighty Effective

367



***"…Fatal air accidents, however, are becoming rarer all the time. The parachute saves hundreds of lives every year. They have even perfected parachutes which can lower a disabled airplane safely to the ground. Huge chutes they are, and mighty effective…"***
***Modern Mechanics,*** **February 1929**
**<u>Caption</u>: "A sky full of parachutes! This picture demonstrates how a damaged plane can be vacated within a few seconds."**

368


***"…Passengers aboard tomorrow's transport planes need have no worry in the very unlikely event that their machines crash in the air, as depicted on the cover of Modern Mechanics this month. All they'll have to do will be to pull a lever and, zip! The chutes grab hold and the planes drift easily to earth."***
***Modern Mechanics,***
**February 1929**

369

## Dumped Earthward

370

**Plane Passengers Bailed Out Automatically**

ONE of the most pressing needs of aviation has been a mechanical method whereby all passengers could be simultaneously and automatically bailed out at the psychological moment, that is, when the pilot learns that all hope for saving the plane is lost.

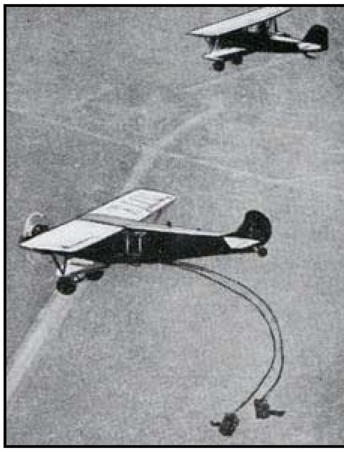
Such a method has now put in its appearance in the aviation world. With the equipment shown in the above photo, it is possible for the pilot to send his passengers on a flight groundward by parachute whether they want to bail out or not…(*Modern Mechanix,* October 1932)
<u>Caption</u>: "When plane is imperiled, cranes on side of fuselage swing passenger seats out to side, then drop them, with parachute attached, earthward. Mechanism is controlled by the pilot."

371

…The seats of this new safety device are suspended from small cranes hanging on the side of the fuselage. When disaster overtakes the ship the pilot operates a lever which swings the seats outward as demonstrated in the photo, then unloosens them, dropping the passenger to earth.

The top of seat is hooked to a parachute, which in flight is carried under the fuselage. When the seat is dropped, the parachute is jerked from its moorings, opening on its way down, so that the passenger is lowered safely on old Mother Earth…(*Modern Mechanix,* October 1932)

372

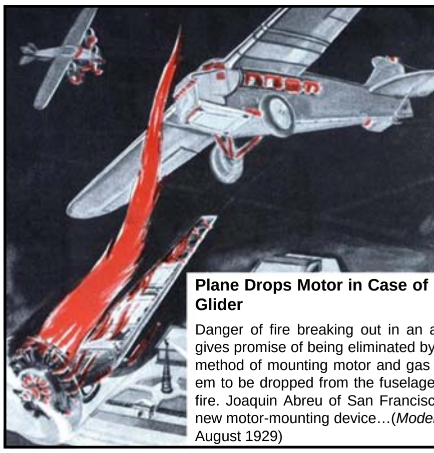


The device proved a decided success when it was put through a test recently over Los Angeles. The two professional parachute jumpers bailed out at 2000 feet. (*Modern Mechanix,* October 1932)
Caption: "In test of device conducted near Los Angeles, two parachute jumpers serving as passengers were dumped earthward, as seen in this photo. When seats are released for descent, they disengage parachute from its position under the fuselage, so that passengers are lowered gently to earth without slightest danger. Passengers have no voice in procedure; they are dumped out at moment pilot determines ship can't be saved, and the 'bailing out' is necessary."

373

**In Case of Fire**

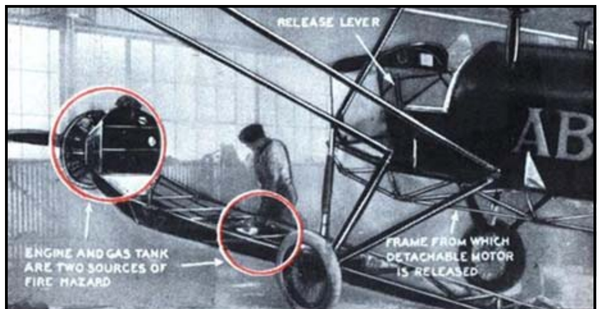
374



**Plane Drops Motor in Case of Fire, Then Lands as Glider**

Danger of fire breaking out in an airplane engine in flight gives promise of being eliminated by the perfection of a new method of mounting motor and gas tanks which permits them to be dropped from the fuselage of the plane in case of fire. Joaquin Abreu of San Francisco is the inventor of the new motor-mounting device…(*Modern Mechanics,* August 1929)

375




…The photo above shows how the mechanism is attached to a frame underneath the plane, from which it can be dropped at an instant's notice by simply moving the release lever. After the motor has been dropped, the plane lands easily as a glider. (*Modern Mechanics,* August 1929)

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**Flying Windmill**

377


***"…The autogiro appears at the moment to offer possibilities for greater safety. Sport-type ships of this type are now available which can land on the proverbial dime and take-off on a field no larger than a tennis court…"***
***Modern Mechanics*, August 1931**
**Caption: "THIS Pitcairn Autogiro is a sister ship to those whose countless miles of flight from coast-to-coast have shown a new source of security to those who fly or want to learn to fly. Here you can see the rotor, whose blades are turned constantly by natural forces alone, to supply continuous support independent of the engine of maneuvers of the pilot. It is this support and the security it provides which make the Pitcairn Autogiro the craft so obviously suited for the needs of the amateur or private owner flyer…"**

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*Advantages* – Steep angle of climb, short radius of turn . . . Can not go into a tail spin . . . Lands vertically without any ground roll . . . Descends in a glide with short ground roll . . . Descends slower than a man in a parachute . . . Takes-off at slow speeds, lands with no forward speed . . . Flies fast, slow, or hovers momentarily . . . Easy to learn to fly, its characteristics make it the aircraft for the private owner-flyer.

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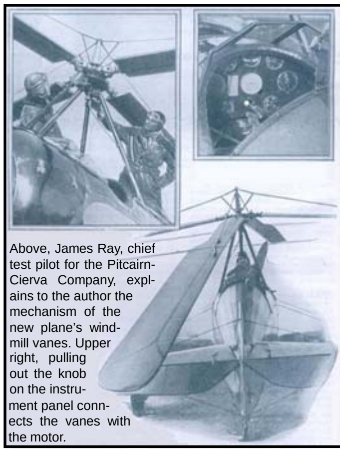

Above, James Ray, chief test pilot for the Pitcairn-Cierva Company, explains to the author the mechanism of the new plane's windmill vanes. Upper right, pulling out the knob on the instrument panel connects the vanes with the motor.

***"…Many people think the autogiro is a form of helicopter; that its whirling windmill pulls it vertically upward. This is not true. Each vane is a separate airplane wing. It lifts, just as does the usual aircraft wing, by moving rapidly through the air. In the ordinary airplane, the amount of lift given by the supporting surface is entirely dependent upon the forward speed of the machine. Because the vanes of the autogiro turn at high speed, they continue to exert their lift even when the craft has come to a standstill…The autogiro gets off in less than thirty yards and takes to the air at twenty-five miles an hour…"***
***Popular Science,* March 1931**

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***"…Already, a five-passenger cabin autogiro is under construction in England for landing and taking-off on roof tops and small plots in large cities…"***
***Popular Science,* March 1931**
**RE: *Robert B.C. Noorduyn* had joined *Pitcairn Aviation* as Executive Engineer in February 1932, at the commencement of the *PA-19* project, the largest Autogiro ever produced (it was equaled only by the *C-34* prototype constructed in France by *SNCASE* in March 1939, which never advanced beyond the testing phase). The stated goals of the "Cabin Autogiro" were strength, reliability, ease-of-maintenance, comfort, appearance and luxury. The prototype PA-19 was first flown by test pilot *Jim Ray* in September 1932. When introduced to the public on October 19, 1932, the *Cabin Autogiro* was received with acclaim: "…rivaled the luxurious comfort of fine automobiles, suitable for women in skirts and older passengers…" Despite the fact that the PA-19 rivaled passenger airplanes in terms of comfort, only five were ever built thus, it was a commercial failure.**

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**<u>Caption</u>: "The Pitcairn PA-19 Cabin Autogiro was the largest American Autogiro built. Five were constructed but it failed to find a market due to the depression."**

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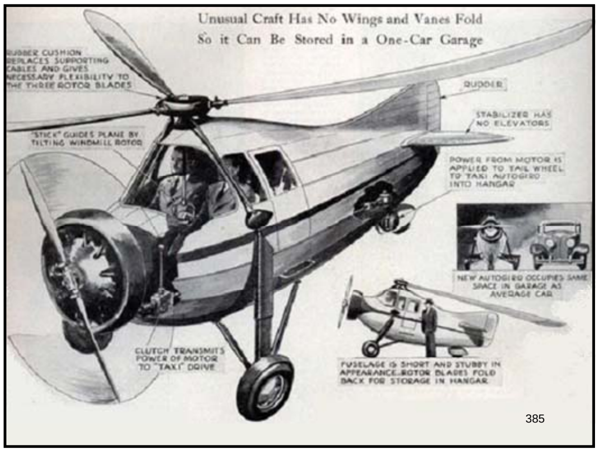
Artist's drawing shows the "flying auto" doing duty as both plane and auto. When it is to negotiate the highways the gyro blades are disengaged and power applied to the wheels. Right, motor is mounted in the front as in an auto, the power being transmitted from there to either the gyro blades or the front wheels. Forward propulsion of the plane is obtained through action of the little vertical fins on the gyro blades.

***"…For private owners, little machines with ten-foot vanes are entirely practicable, designed with vanes that fold together like the blades of a jackknife so the machine can be stored in an ordinary garage…"***
***Popular Science,* March 1931**
**<u>Above</u>: the "roadable" autogiro had been a *Pitcairn Aviation* project for the *Bureau of Air Commerce.* The roadable autogiro did receive media attention appearing in several publications, but failed to excite the public who saw it as a novelty.**

384

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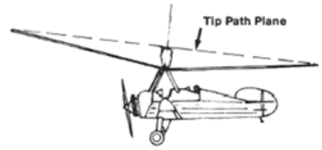


***"…An autogiro's ceiling is around 20,000 feet; its high speed, over two miles a minute. Cierva, its inventor, is planning a racing autogiro which is expected to pass the 200-mile-an-hour mark. The 'windmill craft' has withstood vertical dives at 140 miles-an-hour carrying 600 pounds of sand. It will do anything an airplane will do and, while these stunts have not been attempted yet, there is no aerodynamic reason, Ray told me, why they cannot loop the loop and fly upside down…"***

***Popular Science,* March 1931**

**RE: in forward flight, the blades of an Autogiro are flapped up in the front and flapped down in the rear. The blades climb up from their low position at the tail to the high position at the nose and descend back to the tail position. An imaginary line drawn from the tip of the most-forward blade to the tip of the rear-most blade would describe the blade tip position at any point in its rotation. This is called the "tip path plane" (above). In addition, air passes up through the rotor disc (unlike the downwash from a helicopter rotor). Although the rotor could not stall, even when the autogiro is flying at very low airspeed or even zero airspeed, the airplane-type control surfaces that were used on early autogiros could stall.**

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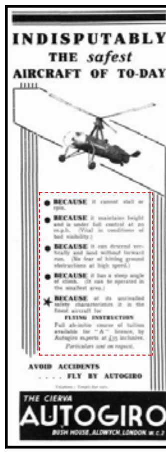
***"…The faster the autogiro settles, the faster the rotor spins, just as a windmill speeds up when the breeze freshens. No matter at what altitude the machine is stalled, it merely settles. In the 'flying windmill,' the deadly tail spin is unknown. The reason is that the wings continue to rotate at hundreds of miles-an-hour and so maintain flying speed even though all forward movement of the craft has stopped. It was a tail spin that led Juan de la Cierva, the Spanish designer, to invent the autogiro…"***

***Popular Science,* March 1931**

**<u>Caption</u>: "Juan de la Cierva y Codorníu, First Count of De La Cierva (1895-1936)"**

387




## INDISPUTABLY

**THE *safest* AIRCRAFT OF TO-DAY**

- **BECAUSE** it cannot stall or spin
- **BECAUSE** it maintains height and is under full control at 20 m.p.h. (vital in conditions of bad visibility)
- **BECAUSE** it can descend vertically and land without forward run. (No fear of hitting ground obstructions at high speed)
- **BECAUSE** it has a steep angle of climb. (It can be operated in the smallest area)
- **BECAUSE** of its unrivalled safety characteristics it is the finest aircraft for

**FLYING INSTRUCTION**

Full ab-initio course of tuition available for "A" License by Autogiro experts at £35 inclusive.

*Particu!ars sent on request.*

388

***"…Although few people know it, Cierva was a famous airplane designer before he turned to his windmill craft. He built the first successful biplane in Spain and constructed the first tri-motored tractor in the world. In 1910, when he was fourteen years old, he got into the air in a homemade glider by hiring a dozen boys at a penny apiece to pull him at the end of a long rope. Two years later, with a total capital of sixty dollars, he started his first motored machine. The propeller was carved from the wine-soaked wood of an old bar taken from a deserted inn. It was several pounds heavier on one end than the other, so the plane flew like a bucking bronco - but it flew, later, in 1918, he designed a huge, eighty-foot, tri-motored passenger plane that was flown successfully. But the over-confident pilot stalled it in landing and spun into the ground. That spin led Cierva to believe that something was wrong with the entire system of airplane flight. …"***

***Popular Science,* March 1931**

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Above, the windmill vanes, designed with the greatest care, are put together with the utmost accuracy in the factory. In circle, the author examines the manner in which the vanes are attached to the plane.

Above, Ray, right, explains to the author exactly what the vanes are designed to do. Left, the author and Ray inspect the landing gear.

***"…He sought other means of getting off the ground; tried wing-flappers and helicopters. Finally, he worked out the whole theory of the autogiro on paper before he built even a model. His first machine was built in 1920. It and several others that followed failed to fly. It was not until he gave the vanes complete freedom and depended upon centrifugal force that he succeeded. The first flight over a closed circuit in an autogiro was accomplished at Madrid, Spain, in 1923…"***

***Popular Science,* March 1931**

**RE: after two years of thorough testing, the *Pitcairn Autogiro* went into production in the Spring of 1931**

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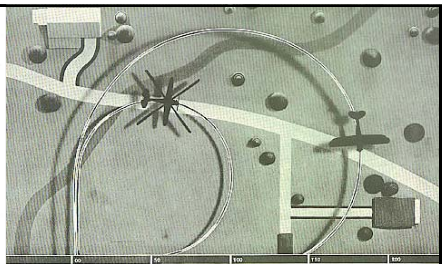

***"…The autogiro is the only heavier-than-air craft that can slow down suddenly. Once Cierva took off toward a row of high trees, saw he could not clear the barrier, jerked back the stick at the last instant, and sat down seventy-five feet from the obstacles. An airplane would have crashed…"***
***Popular Science,* March 1931**
**<u>Caption</u>: "Chart showing how the Autogiro can avoid obstacles by turning sharply close to the ground"**

391

***"…In the thousands of hours that autogiros have been flown, nobody who has piloted one has been seriously injured. Once, a vane broke off high in the air and the pilot was only shaken up and bruised in landing. That accident occurred when Cierva was experimenting with rigid vanes. Since they have been made flexible there has been no repetition of the trouble…"***
***Popular Science,* March 1931**

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## Lady Lindy's Grand Tour

393

**By 1930, famed aviatrix *Amelia Earhart* (a/k/a "Lady Lindy") became interested in the Autogiro. She had, after a single 15-20 minute flying lesson by Pitcairn factory test pilot *John Paul* "Skipper" *Lukens,* soloed at the *Pitcairn Aviation* field at Willow Grove, Pa., on Dec. 19, 1930, thus becoming the first female Autogiro pilot. Advertising for the Autogiro was just beginning and Pitcairn's offices received deposits and advanced orders from individuals and corporations seeking the convenience, safety and publicity that seemed to accompany almost every Autogiro flight.**
**<u>Caption</u>: "Amelia Earhart with Pitcairn Autogiro Co. PCA-2 No. 4, NX760W, at Pitcairn Field, Warrington, Pennsylvania, April 8, 1931"**

394

**Seeing a publicity bonanza, the *Beech-Nut Packing Company* offered Earhart the use of its previously ordered *Pitcairn PCA-2* if she would fly it coast-to-coast with the company logo painted on its side and accompanying promotional efforts related to its chewing gum brand. Brokered by her husband *George Palmer Putnam* (who was known for his acumen at garnering publicity), Earhart agreed to pilot the Beech-Nut Autogiro coast-to-coast, however, since Beech-Nut was scheduled to receive the 13th production model, Earhart, superstitious about such things, requested that she receive a lower number and, in fact, received the twelfth production model instead.**
**<u>Left</u>: caption: "Amelia Earhart at the Reading Airport, her first stop on the cross-country flight in the Beech-Nut Autogiro"**
**<u>Right</u>: caption: "Amelia Earhart flying over Pennsylvania in Beech-Nut Autogiro during Transcontinental Tour"**

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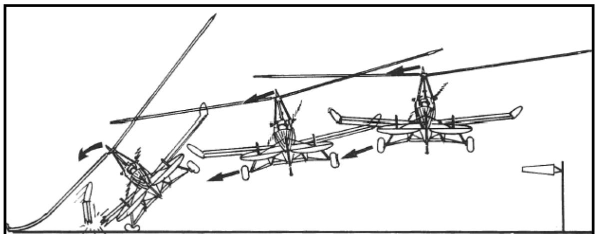
**Beech-Nut's Autogiro had performed flawlessly on the tour, validating Earhart's confident appraisal of the aircraft. However, during her return trip she encountered some difficulties that called her ability as a pilot into question. On June 12, 1931, she was preparing to land in Abilene, Texas, in front of a crowd when the winds suddenly calmed. She aimed the craft away from the onlookers, narrowly missing them as she crash-landed. Earhart climbed out of the cockpit unhurt, but the Autogiro had been badly damaged. Arrangements were made for another Autogiro to be flown from *Pitcairn Field* in Willow Grove, Pa., to Oklahoma so the tour could continue. According to news reports, she flew from Abilene to Oklahoma City in a plane piloted by another flier.**
**<u>Left</u>: caption: "Abilene, TX - June 11. Beech-Nut Autogiro nose-down after Amelia Earhart's crash on take-off."**
**<u>Right</u>: caption: "Abilene, TX - June 11. Beech-Nut Autogiro surrounded by onlookers after Amelia Earhart's crash on take-off."**

396



When brought in for a landing, and the nose pulled up to reduce the contact speed, all control was lost. If the autogiro was too high when the flare was performed and the nose was not directly into the wind, the Autogiro might begin to drift away from the wind. If this did happen and the autogiro contacted the ground in this altitude, the down-wind wheel would strike the ground sideways and the lift from the rotor, high above the wheel would cause the craft to roll over (above). This was seen as a serious problem and the early pilots, who were professionals for the most part, learned to avoid this condition. As more Autogiros were manufactured and amateur pilots (who did not have had the same piloting experience) bought them, the result was an increase of these crosswind accidents occurring.

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***"The air just went out from in under me. Spectators say a whirlwind hit me. I made for the only open space available…With any other type of plane the accident would have been more serious."***
***Amelia Earhart***
**RE: the *Pitcairn PCA-2* had dropped thirty-feet, hit two cars and damaged its rotor and propeller. She and her accompanying mechanic were unhurt, but her attempt at setting a record (using the southern mail-route) on the eastbound cross-country return trip (to avenge rival John Miller's pre-empting her for the first (westbound) transcontinental Autogiro record by just nine days) was over. She returned to the East Coast by train. The *Aeronautic Branch of the Department of Commerce* (renamed the *Bureau of Air Commerce* in 1934) did not accept her version of the incident and issued her a formal reprimand for "carelessness and poor judgment" based on the report made by the local inspector, *R.W. Delaney.* Actually, the government had intended to ground Earhart for ninety days had her friend, *Senator Hiram Bingham,* not interceded. He secured a lesser penalty; a formal reprimand from *Clarence Young,* then Assistant Secretary of Commerce for Aviation.**

398

399

## Low and Slow

400

***"…The most fun in flying is to fly low. And that is as dangerous as dynamite in an airplane. You have to fly up at 2,000 or 5,000 feet to have a safe gliding range in case the engine stops. Such flying is monotonous. It is like passing over a huge map. People are the size of pin heads. You want to see what is going on but dare not take the chance. All this is changed with the autogiro. You can fly low and slow with safety. In case of engine trouble, you can drop down into any open space; you don't have to pick out a wide and level field…"***
***Popular Science,* March 1931**

401

402


***"…Anyone who can learn to drive an automobile can learn to fly a windmill ship. Safety in an airplane depends more on the skill of the pilot. In an autogiro the human factor is reduced immensely. Ninety percent is taken care of by the machine itself. They told me a student could master a windmill plane in a quarter the time it takes to learn to fly an airplane.…"***

***Popular Science,* March 1931**

**<u>Left</u>: period ads highlighted the Autogiro's safety and ease of flight training, which promised a revolution in aviation**

403


**Important Notice**

to Those About To Take Up

**Flying Instruction**

THE AUTOGIRO is the safest and most practical aircraft for flying tuition. It cannot stall or spin. It ensures complete control throughout its very wide speed range. It has a rapid take-off and steep climbing angle, and it can be landed without forward run…Complete Ab Initio "A" License Course. All dual Instruction and Solo Flying for Air Ministry requirements. £35-00 We have successfully trained Pupils ranging in age from 17 to 69

**Special Charter**

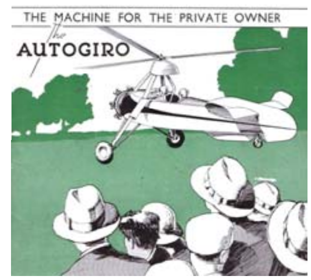
Latest types of Autogiros available for cross country flights at competitive rates

404

***"…The danger of the take-off is eliminated; the difficulty of landing is done away with; the menace of stalling and getting into a deadly tail spin is gone. It is the first plane designed for the average person…"***

***Popular Science,* March 1931**

405




406

**Autogiro Principle Adapted to Helicopter**

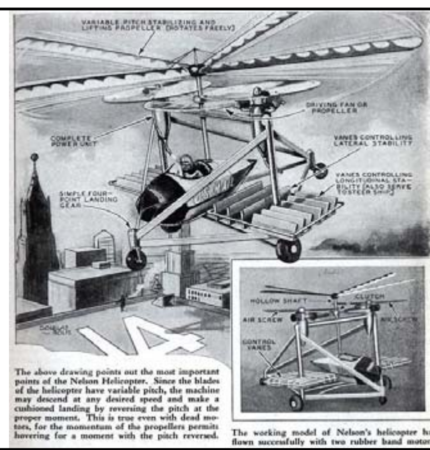
HARRY T. NELSON, a war-time aviator now living in Dallas, Texas, has recently developed a helicopter which has proved very successful in the model stage and which he believes to be a solution of the problem of vertical flight.

One outstanding feature of the machine is the means of rotating the large horizontal propeller at the top. This is done by the slipstream of the powered propellers situated directly below it and turning in opposite directions. This big propeller, which rotates freely; in much the same manner as the rotor blades of an autogiro, not only assists in lift and getting a "toe-hold" on the air, but acts as a vertical stabilizer and as a parachute in landing.

The lower propeller takes hold similar to the clutch on a bicycle, and coasts when the motors are dead. The speed of the large propeller may be built up gradually just before taking off vertically, thereby giving elasticity to the contact between the motors and the large propeller. As soon as the speed is built up a vertical drop is impossible.

As soon as the desired altitude is reached, horizontal travel is attained by tilting the machine slightly in the desired direction. (*Modern Mechanics,* October 1931)

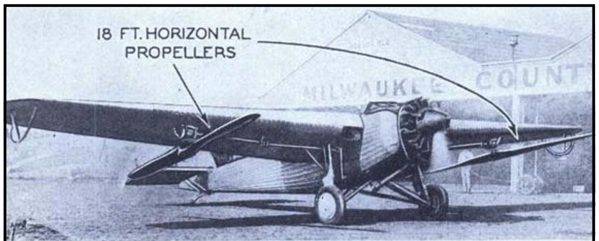
407




The above drawing points out the most important points of the Nelson Helicopter. Since the blades of the helicopter have variable pitch, the machine may descend at any desired speed and make a cushioned landing by reversing the pitch at the proper moment. This is true even with dead motors, for the momentum of the propellers permits hovering for a moment with the pitch reversed.

The working model of Nelson's helicopter has flown successfully with two rubber band motors.

408



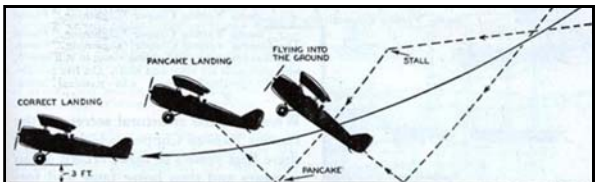

**New All-Metal Helicopter Has Eighteen-Foot Wing Props**

THE "Maiden Milwaukee," all-metal monoplane produced by the Hamilton Metalplane company of Milwaukee has been converted into an experimental helicopter by Jesse C. Johnson of Delray, Florida. Johnson provided 18-foot wing propellers for each wing, in addition to the front prop. The wing props are driven by shafts from a motor in the fuselage and are expected to cause the plane to rise and land vertically.
(*Modern Mechanics,* November 1929)

409

## The Feet of the Plane

410




**"*…Any one who spends much time around an aviation field sees many kinds of landings. When a pilot makes a pancake landing he levels off and lands ten feet or more above the ground. As a result the plane drops to the ground with a flop that uses up all of the flexibility of the shock absorbing device. In some cases there are no resulting breakages but in others the entire landing gear seems to slowly fold up under the plane. However it is remarkable the rough usage a landing gear will stand…"***
***Modern Mechanics,* August 1931**
**<u>Caption</u>: "The correct and wrong ways to land are shown here. The right way is to glide in and level-off three feet above the ground. When the plane loses flying speed it will then settle gently to earth on three points. The dotted lines show what happens if one levels-off too soon, or worse still not soon enough."**

411

**"*…Modern planes are tested with a view of insuring a factor of safety sufficient to withstand a moderate pancake. The present day pilot normally flies in worse weather and flies in bad weather more often than the pilot of ten years ago. Thus the planes are given much worse treatment in landings for the visibility or lack of visibility has a direct bearing upon whether a good or bad landing is going to be made…"***
***Modern Mechanics,* August 1931**

412

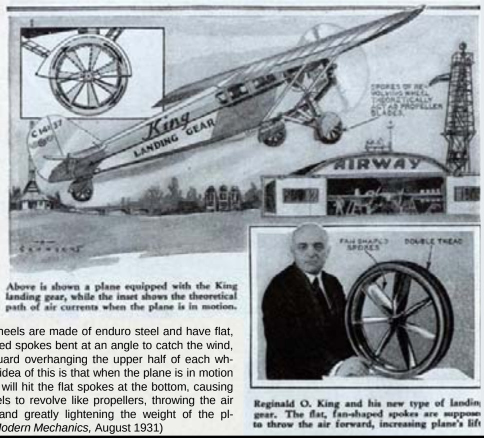
**"*…The accompanying photo shows an airplane being given a landing gear test. The bare fuselage with landing gear is loaded until it carries a weight equal to the maximum for which the plane was built. It is then raised to an inclined platform. The fuselage is then cut loose and allowed to fall freely."***
***Modern Mechanics,* August 1931**
**<u>Caption</u>: "Testing a landing gear for strength. The weighted plane is dropped 15 feet from an inclined platform. This is quite a severe test, and when the landing gear stands this shock, pancaking is not to be feared."**

413

**New Type Airplane Landing Gear Said to Give Added Lift**

REGINALD O. KING has recently applied for patents on a new type of landing gear which he believes will compensate for the wind resistance to the plane and thus add considerably to its speed…(*Modern Mechanics,* August 1931)

414




Above is shown a plane equipped with the King landing gear, while the inset shows the theoretical path of air currents when the plane is in motion.

Reginald O. King and his new type of landin gear. The flat, fan-shaped spokes are suppose to throw the air forward, increasing plane's lift

…The wheels are made of enduro steel and have flat, fan-shaped spokes bent at an angle to catch the wind, with a guard overhanging the upper half of each wheel. The idea of this is that when the plane is in motion the wind will hit the flat spokes at the bottom, causing the wheels to revolve like propellers, throwing the air forward and greatly lightening the weight of the plane….(*Modern Mechanics,* August 1931)

415

…These wheels are much lighter than those now in use. They also have a double tread so that the plane has six points of contact with the ground when landing and taking off. The wheels measure 30” x 8” regular size and have three-inch rubber cushion tires.

The invention has been approved by one of the largest airplane manufacturers. (*Modern Mechanics,* August 1931)

416

## <u>Part 6</u>

## Man of Vision

417

### Daring Greatly

418

**Alfred W. Lawson, pioneer figure in aviation, who built the first commercial cabin passenger plane and the first tri-motored ship with heated cabin and sleeping berths, reveals to Modern Mechanics readers his plans for a 125-passenger air liner weighing 50 tons which he is now building in his New Jersey factory.**

**Editor’s note:** Known as one of aviation’s keen-visioned pioneers, Alfred W. Lawson is one of those few men who, back in the earliest days of flying, dared to look into the future and predict that the day was coming when giant ships of the air would carry passengers comfortably, safely, and swiftly to destinations throughout the world. Not content with mere prediction, he has been quietly working out the design of a gigantic passenger airplane which will be the largest in America when completed. In this interview, one of the very few he has ever accorded, he reveals interesting facts concerning his past and present work in aviation, and explains in detail features of his huge 125-passenger air liner.

***Modern Mechanics,* July 1930**

**RE: introduction to an article authored by aviation pioneer *Alfred W. Lawson* entitled: “Building AMERICA’S Largest Plane’**

419

### Looking Back

420


***"BACK in aviation's uncertain pioneering days in 1908, when I was editor of 'Fly,' then the national aeronautical magazine, I was regarded as a prophet of doom. The general public, which is always skeptical at the appearance of engineering innovations, sneered and scoffed at my forecasts for flying. Everywhere I was regarded as a crank. It is a wonder I wasn't condemned to the stake for witchcraft, now that I reflect on turbulent days that have gone…"***

***Alfred W. Lawson,*** **July 1930**

**RE: the first issue of *FLY* was published just five years after the first powered flight by *Orville Wright,* in December 1903**

**<u>Left</u>: cover of *FLY - The National Aeronautic Magazine,* Vol. I – Nov. 1908 thru Aug. 1909**

421

***"…During the twenty-two years that I have now completed in the field of aviation, sticking tenaciously and doggedly to my theories and principles through periods of time when the future of aviation seemed doubtful, I have seen that industry rise from a struggling business to the most thriving enterprise on the great American commercial scene…"***

***Alfred W. Lawson,*** **July 1930**

422

## Vindication

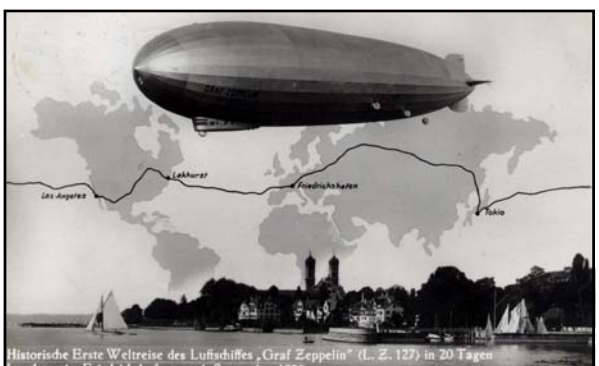
423

***"…Today, no less enthusiastic in my belief in aviation than I was twenty-two years ago, I am the advocate of the air-liner. My disciples are legion, at this time, however. The Graf Zeppelin's round-the-world flight, the incarnation, so to speak, of one of my ideas, has demonstrated that my ideas are not so fantastic as they once were thought to be…"***

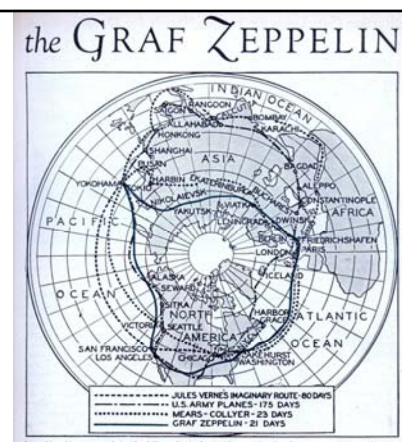
***Alfred W. Lawson,*** **July 1930**

**RE: the *Graf Zeppelin* (Count Zeppelin), completed in 1928, departed the *Lakehurst Naval Air Station* on August 8, 1929 (piloted by *Dr. Hugo Eckener*) for its return flight to Friedrichshafen, Germany – Leg No. 1 of its historic round-the-world flight. It carried a crew of forty with twenty-two passengers and a cargo of mail. Among the passengers were: *Charles E. Rosendahl* (USN Commander of the USN airship *Los Angeles*), *Lieut. Jack Richardson, Lady Grace Drummond Hay* (*Hearst Press* reporter) and *Sir Hubert Wilkins* (Arctic explorer).**

424




**<u>Above</u>: On August 15, 1929, *<u>G</u>raf <u>Z</u>eppelin* (GZ) left Germany for *Kasumigaura Naval Air Station*, near Tokyo, Japan, arriving there on August 18, 1924 (Leg No. 2). On August 23, 1924, the GZ began its trans-Pacific flight, arriving at Los Angeles, Calif., on August 26, 1924 (Leg No. 3). The next day, the GZ left Los Angeles for Lakehurst, NJ, arriving on August 29, 1929 (Leg No. 4). The GZ then returned to Friedrichshafen, arriving on September 4, 1929 (Leg No. 5).** 425




Record-breaking route of the Graf Zeppelin is shown above with other famous round-the-world trips.

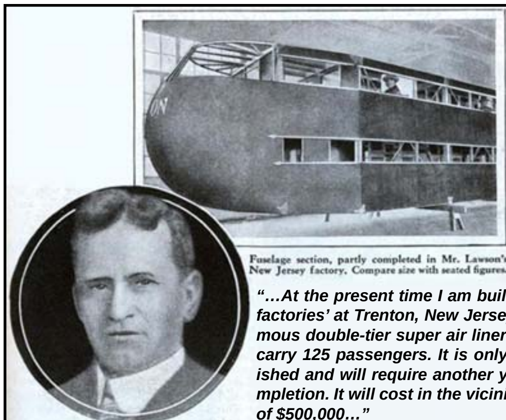
426

## Thinking Big

427

*"…Rarely have I come from behind the scenes to be interviewed for publication. My mission and my work in aviation has at all times been that of the quiet producer. On this occasion I have been induced to enter the limelight for a brief moment in the interests of the industry which has occupied my attention night and day for twenty-two years. I am pleased to tell about my super air liner and the future which is in store for this branch of aeronautics…"*
***Alfred W. Lawson,*** **July 1930**

428



Fuselage section, partly completed in Mr. Lawson's New Jersey factory. Compare size with seated figures.

Alfred W. Lawson, designer of the plane.

*"…At the present time I am building in my factories' at Trenton, New Jersey, an enormous double-tier super air liner which will carry 125 passengers. It is only partly finished and will require another year for completion. It will cost in the vicinity of $500,000…"*
***Alfred W. Lawson,*** **July 1930**

429

## First Generation

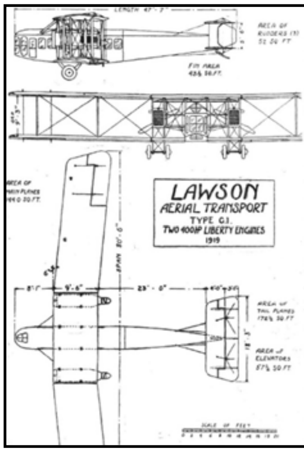
430

*"…It was back in 1909 that the first air liner was born in my brain. I saw the idea in the crude Bleriot fuselage. However, it was not until 1919 that the industry had developed sufficiently to allow me to build an air liner. During those intermediate ten years my mind was thinking about big, practical air carriages. At the same time I was quietly accumulating the knowledge and experience necessary to build them…"*
***Alfred W. Lawson,*** **July 1930**
**RE: the *Lawson Airline Transportation Company* designed and built a series of large bi-plane airliners for use on its planned airline routes. The initial Lawson "Aerial Transport" (Lawson C.1) was built early in 1919 to demonstrate that a large commercial passenger plane could be built.**

431

*"WE have received the following particulars of the latest American commercial aeroplanes, the Lawson 'Aerial Transports,' designed by Alfred W. Lawson, of the Lawson Airline Transportation Co., Milwaukee, Wis…"*
***FLIGHT,*** **September 11, 1919**

432

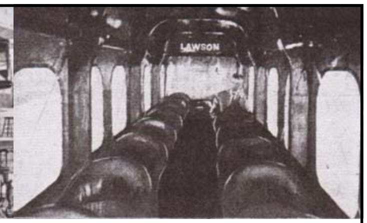



*"…The accompanying drawings are of the Type C.1, to which our description mainly refers, whilst the photographs show the Type C.2, which has just been completed and put through its trials…"*
***FLIGHT,* September 11, 1919**

**RE: the *Lawson Type C.1* was a single pilot, 10 passenger biplane with twin *Liberty* 400 hp pusher motors. It was followed by the *Lawson C.2* (a/k/a "L.2"). The C.2 was a tractor biplane, also with 400 hp motors, capable of carrying 26 passengers and was flown by two pilots (with differential controls). Lawson took it on a 2K-mile multi-city tour to advocate commercial air travel.**

**<u>Caption</u>: "The Lawson 'Aerial Transport,' Type C.I: Plan, front and side elevations to scale"**

433




***"…The C.2, which, with a large fleet of the same type, is intended for a daily service between New York and San Francisco, differs from the C.I only in some of the dimensions and the arrangement of the air-screws. These, it will be seen, are pushers in the C.1 and tractors in the C.2. The following description of C.1, therefore, will also serve for C.2…"***
***FLIGHT,* September 11, 1919**

**<u>Left</u>: caption: "Two views of the fuselage with center sections and engines, of the Lawson 'Aerial Transport'"**

**<u>Right</u>: caption: "The interior of the cabin of the Lawson 'Aerial Transport'"**

434

***"…The whole machine has been designed from a strictly commercial point of view, and al! the details of its construction and performance characteristics take into consideration the safety and comfort of the passengers. It possesses a high degree of inherent stability, a very flat gliding angle, and a relatively high factor of safety. The maneuverability, both in the air and on the ground, is good, all the control surfaces being of generous proportions and well balanced…"***
***FLIGHT,* September 11, 1919**

435

***"…The fuselage is built to accommodate 26 passengers, the seats being placed at windows on each side of the body, as shown in the illustrations, and an aisle between the seats allows passage from the front and rear of the cabin. On the port side of the cabin, forward of the wings, is a door of ample proportions to ensure easy entrance and exit, one of the pilots' seats being made to swing back out of the way. All the seats are of wicker construction, upholstered with green leather and provided with safety belts. They are secured to the floor, but are readily detachable, and sleeping quarters may be installed for a fewer number of passengers when cruising for considerable distances…"***
***FLIGHT,* September 11, 1919**

436

***"…The interior of the cabin is finished in polished mahogany and the floors are covered with carpet. The depth of the body is sufficient to allow one to stand up without stooping when walking through. The cabin is built up on box formers without transverse bracing, and is covered with veneer. The rear portion of the fuselage is of girder construction with veneer panel struts and wire bracing, and is covered with fabric. The longerons are of solid section ash in the cabin portion, and spruce at the rear…"***
***FLIGHT,* September 11, 1919**

437

***"…The main planes, which have the U.S.A. 5 wing-section, are in seven sections, comprising one top and two bottom center sections carrying the power plant, and the outer sections. The latter have a sweep back of 6-degrees and a dihedral angle of 1-degree. The wings have a comparatively high factor of safety of 14, and are strongly braced internally and externally by double cables. The interplane struts are of deep streamline section wood. Balanced ailerons of wood construction are fitted to both top and bottom planes…"***
***FLIGHT,* September 11, 1919**

438

*"…A large biplane tail is fitted having a cambered upper surface and a comparatively flat under surface. The fuselage terminates in a tubular steel stern post to which is attached the rear spar of the lower tail plane, and also the tail skid. The tail plane is adjustable. The rudders, of which there are three, and elevators are of the balanced type of wood and steel construction, mainly the latter in the case of the rudders…"*
***FLIGHT,* September 11, 1919**
**Caption: "Three-quarter frontal view of the Lawson 'Aerial Transport,' Type C.2"**

439

*"…Dual control is provided at the forward end of the cabin, the wheels being 18 ins. diameter, and mounted on columns carried by a transverse rocking shaft extending right across the body; the usual foot-bars operate the rudders. All control cables are duplicated. For night flying, electric lights are provided for the instrument-board, cabin interior and wings…"*
***FLIGHT,* September 11, 1919**

440

*"…The landing-gear is composed of two pairs of 36 ins. by 8 ins. wheels, carried on large streamlined tubular steel struts. One pair of wheels is located under each engine in such a way as to take up evenly the landing shocks with a minimum of strain to the fuselage and wings…"*
***FLIGHT,* September 11, 1919**

441

*"…Two Liberty engines, of 400 h.p. each, are installed, mounted on stout ash bearers, braced by steel tubes. They are completely enclosed by neat metal 'bonnets,' in the nose of which are mounted the radiators. Effective silencers are fitted, which add greatly to the comfort of the passengers…"*
***FLIGHT,* September 11, 1919**

442

*"…The general specifications are as follow:*

| | |
|---|---|
| Span, top and bottom | 80 ft. (95 ft. C.2) |
| Chord, top and bottom | 9 ft. 6 ins. |
| Gap | 9 ft. 3 ins. |
| Overall length | 47 ft. 7 ins. |
| Overall height | 14 ft. |
| Area of main planes (incl. ailerons) | 1,440 sq. ft. |
| Area of ailerons (4) | 168 sq. ft. |
| Incidence of main planes | 3-degrees |
| Weight of machine fully loaded | 12,000 lbs. |
| Speed | 100 m.p.h. |
| Climb in 10 mins. | 4,000 ft. |
| Ceiling | 15,000 ft. |
| Gliding angle | 1 in 8 |
| Fuel duration | 5 hours |
| Range | 500 miles" |

***FLIGHT,* September 11, 1919**

443

*"…In 1919 I first demonstrated the practical usage of the air liner in a successful flight from Milwaukee through New York City to Washington and return, personally acting as captain and navigator, and with nothing but a map, a compass and my sense of direction for guidance. On August 27, 1919, without any advance notice, I covered the first lap of the trip from a point ten miles north of Milwaukee to Chicago, a distance of more than 100 miles, in less than an hour…"*
***Alfred W. Lawson,* July 1930**

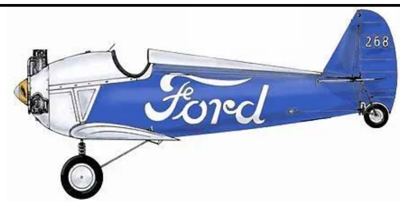
444


*"…Betting ran high in Milwaukee that day and few imagined that the weighty machine would ever soar from the earth. They called me a drunkard of dreams. But today I sit back in my offices at 1819 Broadway, New York City, and during odd moments there flash across my mind the spectacles of my types of commercial airplanes flitting across the American and European continents - all dreams which have come true…"*
***Modern Mechanics,*** **July 1930**
**Caption: "Lawson C.2 airliner in flight"**

445

**The Latest Lawson Air Liner**

446




***"…When the Lawson 125 seater air liner proves to be the success which I expect, I shall enlarge my factories and build planes of this type in mass production. We will be able to turn them out as fast as flivvers once we get started…"***
***Modern Mechanics,*** **July 1930**
**RE: in 1925, *Henry Ford* introduced the all-metal *Ford Tri-Motor,* which he then used to run a scheduled passenger service from Detroit to Chicago. A year later, on his 63rd birthday, Henry Ford unveiled an even more ambitious project: the Ford "Flivver" (above), an aircraft for the masses that was supposed to do for airplanes what *the Model T* had done for automobiles. However, within two years his dream of affordable aviation was over, mainly due to the onset of the *Great Depression,* competition in the auto industry and the crash, on Feb. 25, 1928, of the *Flivver,* which killed its 25yo test pilot; *Harry J. Brooks.***

447


**Caption: "Harry Brooks and the flying Flivver at Ford Airport in December 1927"**

448

***"…In the latest Lawson air liner now under construction, the front section of the cabin, rounded out to reduce wind resistance, will be devoted to the pilots and mechanics. Two pilots will sit up front at the dual controls. Beneath them space has been provided for the mechanics. They will remain there until some emergency makes it necessary for them to crawl out on the wings to the motors. On either side of the cabin and halfway back trap doors have been built in the sides through which the mechanics will pass to reach the engines. It will not be necessary for the ship to descend to make repairs…"***
***Alfred W. Lawson,*** **July 1930**

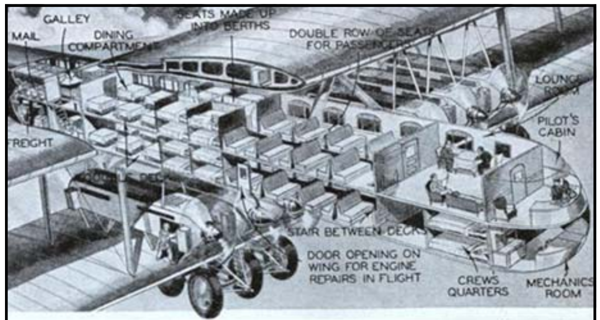
449

***"…Directly behind the extreme front compartment and next to the cabin are the officers' quarters, where the conductor can count his tickets and discuss with the pilots whether or not they will arrive on time. The next section is the main passenger cabin itself. There is an aisle through the center and double seats on both sides. Above is another tier of seats which are reached by steps located at intervals. Inside, the cabin resembles the ordinary Pullman car made up for the night, except that seats take the place of berths…"***
***Alfred W. Lawson,*** **July 1930**

450

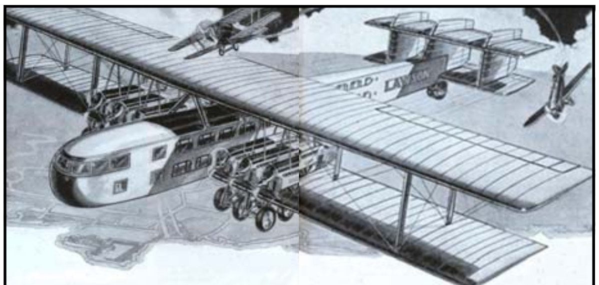
***"…The passengers will make the trips in chairs, although the liner can be converted into a sleeper in two hours. A porter in the customary white coat will serve light lunches and put up tables between seats for card games, or for passengers who elect to spend the time writing letters. The compartment behind the cabin will be used for freight and mail and the sorting of mail during the trip. Two lavatories will be installed in this part of the ship…"***
***Alfred W. Lawson,*** **July 1930**

451




**Caption: "Double-Tier Decks Are Unusual Feature of This Giant Air Liner's Design. Interior arrangements of the Lawson air liner include seats and sleeping accommodations for passengers in case of long-distance flights, as well as a freight storage section and a mail room where letters are sorted in flight. The double-deck arrangement is a special feature of the liner."**

452



***"…The ship will be equipped with twelve motors. Only eight of them will be necessary to keep the plane, weighing fifty tons, in the air. Each of these motors will develop 400 horse-power. The four reserve motors will insure the safety of the ship…"***
***Alfred W. Lawson,*** **July 1930**
**Caption: "Drawing of the liner now under construction, as the 125-passenger craft will appear in flight. Twelve motors will be used in the super airliner, eight of which will keep the giant in the air."**

453

***"…Six men as a crew will be all that will be needed to man the new Lawson super air liner, so the operating expenses will be low. By the way, the fuselage is 100-feet-long and the wing spread is 200-feet-wide. As I designed this giant airplane, I had in mind not only safety and economy but also speed. I have calculated that my ship will make 100 miles-an-hour easily and steadily…"***
***Alfred W. Lawson,*** **July 1930**

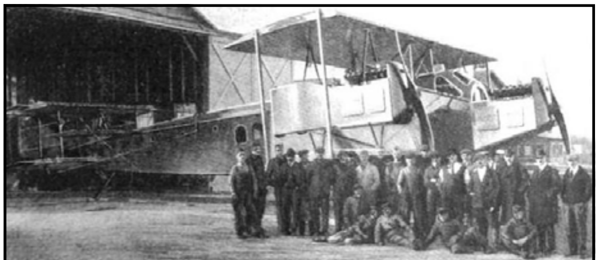
454

## Whereof I speak

455

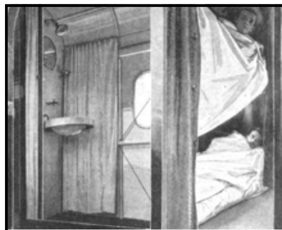
***"…When I speak of air transportation, and it is my remotest notion ever to over-leap the bounds of modesty, I unhesitantingly say that I know where-of I speak. In 1913 I was christened the first air commuter when I flew daily from my New Jersey home to my New York office. In 1918 I built the first commercial cabin passenger plane, in which people could actually stand up and walk around…"***
***Alfred W. Lawson,*** **July 1930**
**RE: *Alfred William Lawson* was a professional baseball player, manager and league promoter from 1887 through 1916. In 1904, he wrote a novel, *Born Again,* in which he developed the philosophy which later became known as "Lawsonomy." He went on to play a pioneering role in the U.S. aviation industry, having published two early aviation trade journals. Frequently cited as the inventor of the airliner, Lawson was awarded several of the first air-mail contracts, but he could not fulfill them. He founded the *Lawson Aircraft Co.,* of Green Bay, Wis., to build military training aircraft and later, the *Lawson Airplane Transportation Co.,* of South Milwaukee, Wis., to build airliners. After Lawson completed his 2K-mile multi-city C.2 flight, he determined to build a larger, trimotor airliner.**

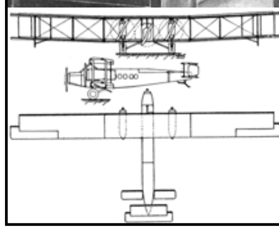
456



*"…In 1920 I built the first three-engine air liner with sleeping berths, heated cabin and mail chutes…"*
***Alfred W. Lawson,*** **July 1930**
**RE: the *Lawson L.4* (a/k/a "Midnight Air Liner") was the last in a series of Lawson biplane airliners designed and built by the company. The largest of the series, with three 400-hp *Liberty* engines (one on each wing and another in the nose), the L.4 was designed for long-distance flights (night service between Chicago and New York). Completed in 1920, it never flew, having crashed on its initial take-off. Despite the fact that a 100-passenger, double-deck version of the L.4 was never realized (due to the company going bust in 1922), *Alfred Lawson* never stopped dreaming of bigger and better airliners.**
**Caption: "The Lawson L-4 'Midnight Air Liner,' ca. 1921"**

457





**Above: caption: "Lawson L.4 'Midnight Air Liner'"**
**Upper Left: caption: "Interior photograph of the Lawson L.4 showing washroom facilities and sleeping berths"**
**Lower Left: caption: "Lawson L.4 3-view drawing"**

458

## Relay Route to Europe

459

***"…And if I may be permitted another admission, those who have followed the glowing pages of aviation's history will recall that on August 10, 1918, I appeared before War Department officials and proposed a trans-oceanic float system, installing landing stations in relays along the route from America to Europe. Today such a float system is actually in the course of construction."***
***Alfred W. Lawson*, July 1930**

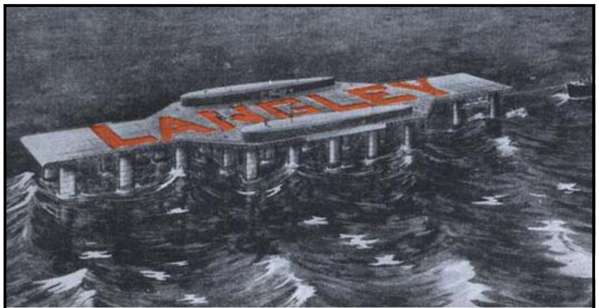
460

***"THE signing of Construction Contracts definitely assures the building of islands in Mid-Atlantic to service transatlantic seaplanes and to furnish hotel and restaurant facilities for their passengers…"***
***The American Architect*, December 1930**
**RE: excerpt from an article entitled: "Transatlantic Flying a Commercial Reality through Man-made Islands"**

461

## Ocean Airdromes

462




*"THE seadrome, designed by Edward R. Armstrong, may solve the problem of providing safety over long water hops. The first seadrome, to be launched between New York and Bermuda, will cost $1,500,000. A chain of dromes placed every 400 miles across the ocean would provide a means of safe air transport."*
***Popular Mechanics,*** **January 1931**
**<u>Above</u>: rendering of the proposed "Seadrome"**

463

***"…Stability of the airport, even in the roughest seas, is assured by the fact that the supporting floats extend for 50 feet beneath the ocean's surface, a depth at which the motion of the largest waves is not felt…Through a system of winches and drums for paying out and dragging in the cables, the airdrome will move with the wind so that pilots can always land into the breeze…"***
***Modern Mechanics,*** **August 1929**

464

***"…A second type of seadrome, varying from Mr. Armstrong's design in that it is constructed in units on shore and assembled at sea in any desired combinations, has recently been patented by Gustave M. Sachs, of Minneapolis, Minn…Each unit will be 48 feet square. The platform will be supported by a series of cylindrical tanks, with the largest tank at the bottom filled with ballast to maintain stability. In assembling the landing field, the units are secured to one another by means of couplings and steel, cables…"***
***Modern Mechanics,*** **August 1929**

465

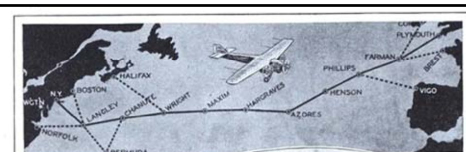


All the work of constructing the seadrome shown above, invented by Gustave M. Sachs of Minneapolis, Minn., can be carried out on shore. It is built of units 48 feet square which are carried out to sea on ships and then coupled together to form a landing field of any desired size. Ballast tanks and buoyancy chambers provide support for the platform even in the severest storms.

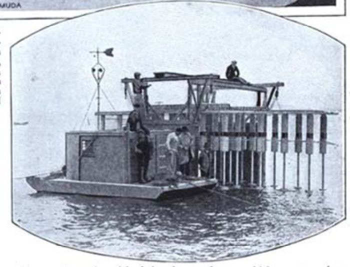
466

***"AN experimental model has proved a success, plans are now being made for the anchoring between New York and Bermuda of the first seadrome for ocean flying airplanes and it is the hope of the supporters that as a result such seadromes will eventually dot the oceans providing safe landings for aircraft. The one-ton steel model of the seadrome was placed in the Choptank River at Cambridge, Md. The model was one-thirty-second the size of the intended dromes. It is essentially a large platform supported by hollow steel columns, each ending in a circular disk. Air in the cylinders supports the platform well above the water and beyond wave action. Speedboats flashed around the model without rocking it and it is expected that the large dromes will not be affected at all by wave action…"***
***Modern Mechanics,*** **February 1930**

467




The map shows the proposed locations of Langley seadromes, 375 miles apart, across the Atlantic, a series of mid-ocean landing fields which is actually being planned as the result of successful model experiments.

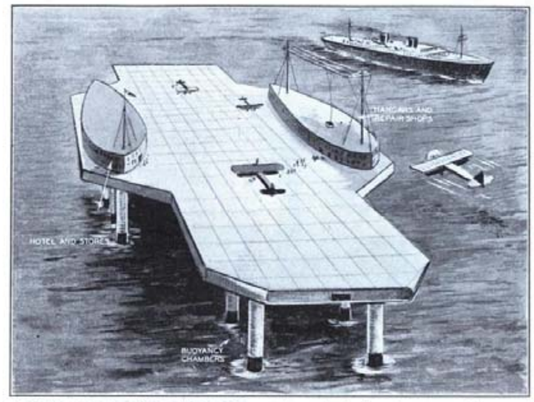


The experimental model of the giant seadromes, which may soon form the mid-ocean landing fields for a trans-Atlantic passenger airline.

468

***"…The inventor of the seadrome which he calls the 'Langley' after the late Samuel P. Langley, designer of one of the first airplanes, was confident of the success of his model. He was formerly a navy engineer and now is consulting engineer for an eastern concern. After devoting sixteen years to his schemes and experiments for safe sea bases for aircraft he succeeded in interesting the du Pont and General Motors financiers in his plans. They have provided Armstrong with three quarters of a million dollars to finance his first seadrome which is now under construction…"***
***Modern Mechanics,*** **February 1930**

469

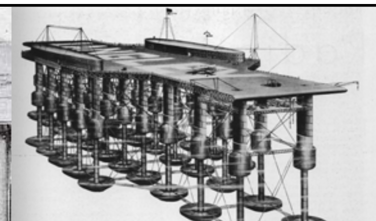


An artist's conception of a full-sized seadrome to house hotels, shops, hangars, storehouses and other services. The first full-sized seadrome will be anchored between New York and Bermuda.

470

***"A model of the proposed seadrome was constructed and tested together with a model of the steamship Majestic, built to the same scale. Under test conditions it was found that the seadrome was unaffected by any combination of waves up to and including those equivalent to 180 feet in height. The model of the Majestic on the contrary was practically swamped in waves exceeding 80 feet in height."***
***Edward R. Armstrong***

471

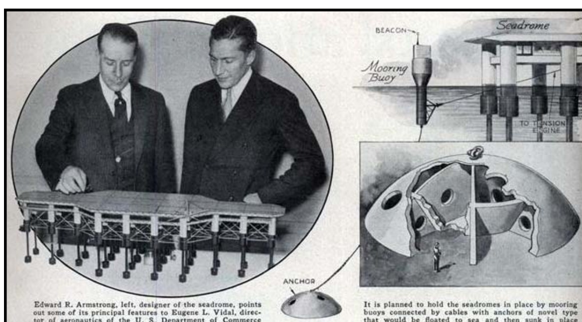



**<u>Above</u>: caption: "Here is what the full-sized Armstrong seadrome will look like when completed. At first but one-fourth of it will be built, the more economically to test the flotation principles of the submerged ballast tanks. Later the complete six-acre field may be built, with hotels at the side as shown or on a lower deck, according to what tests prove."**
**<u>Left</u>: caption: "The seadrome will be anchored to a huge buoy, secured by a 1,500 ton anchor. Inset shows Mr. Armstrong, the inventor, with a working model."**

472

***"…The engineer, Armstrong, plans to anchor his first full-size seadrome halfway between New York and Bermuda. He studied hydro-graphic charts of the region he had in mind and calculated that there must be a high place in the ocean floor and with the aid of a navy survey ship he found the location desired some 400 miles from Manhattan and 375 miles from Bermuda in a virtually straight line. The table on the ocean floor is six miles long and four miles wide. It is only two miles below sea level. The surrounding depth is three to four miles. The difference in depth will make a considerable saving in securing the 3-1/2 inch steel cable which will be laid to hold the seadrome in place. The huge anchors of the round bobbin type will dig into the sea floor and prevent drifting of the seadrome. Mr. Armstrong hopes to have the Langley completed and in place by next fall before Bermuda's tourist season begins…"***
***Modern Mechanics,*** **February 1930**

473

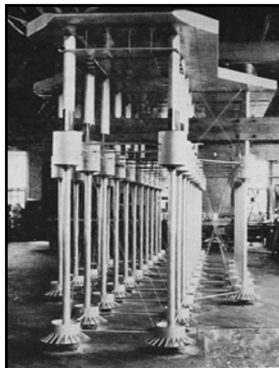



**<u>Left</u>: caption: "Floating landing fields may be used on the trans-Atlantic route. Photo shows Edward R. Armstrong with a model of his seadrome."**

474

*"…The engineer expects that as the Langley makes financial returns he will construct eight similar seadromes between the thirty-fifth and fortieth parallels and some 375 miles apart between New York and Plymouth, England. The 375-mile distance has been determined upon because it is an easy jump for any airplane and would be sufficient to safeguard trans-oceanic air tourists. Mr. Armstrong, who is seeing his dream come true estimates that with these seadromes and the servicing made possible by them there will be safe Atlantic air crossings in as fast a time as 20 hours. If his plans materialize as he confidently expects and his experiments would indicate, it is possible that before many years have passed dangers of air travel over the seven seas will have been enormously reduced…"*
***Modern Mechanics*, February 1930**

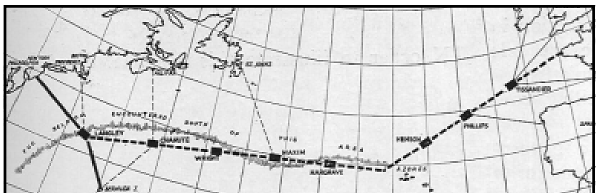
475



*MODEL of Seadrome built at a 1/32" scale and tested in Chesapeake Bay. The completed structure will be 1,000' long, 340' wide, have a deck 70' above sea level, and require 17,500 tons of steel and iron. Displacement, 40,000 tons*

**Engineer *Edward Robert Armstrong* (1876-1955) - a consulting engineer for the *du Pont Corporation*, conceived and advocated the "Seadrome" concept. A *Seadrome* was to be a stopping point for transatlantic flights between *Europe* and *North America*. It was basically a stationary aircraft carrier with amenities for transatlantic passengers. It was to have hotels, restaurants as well as facilities to refuel and repair airplanes. At the time it was conceived, the largest passenger airplane held nine passengers, with a crew of three. The initial plans called for the Seadrome to be 1,100-feet-long, 340-feet-wide at the middle and 180-feet-wide at the ends. The deck would be 70-feet above sea-level.**

476



*"…The resulting bending moments are thus reduced to a few percent of those incurred by a large steamer…"*
***The American Architect*, December 1930**
**RE: the *Seadrome* hull was to be open between buoyancy chambers thus allowing waves to pass through. Seadromes were planned to be anchored semi-permanently at no fewer than eight locations along the route between Europe and North America (above). A truss system of anchorage would hold the big deck by means of cables to a 1,500-ton weight on the bottom of the ocean. The truss-like arrangement consisted of twenty-eight buoyancy tanks floating far beneath the ocean's surface. In turn, these were to be linked to the deck by means of cast-iron columns streamlined into an oval shape above the mean-level of the waves and circular below. Underneath the buoyancy tanks, these columns were to continue downward one-hundred feet to the ballast chambers which would be stabilized by iron ore. The complete column, including the ballast sections, was to be over 300-feet in depth. Armstrong took advantage of a well-known principle in the construction of his ocean island; ocean waves are surface disturbances only while water in the depths is still.**

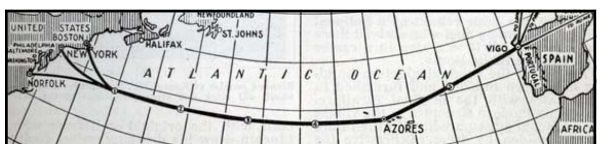
477

*"FUNDS recently appropriated by the government have put the United States Department of Commerce, Aviation Branch, squarely behind the immediate development of a chain of five floating airports which will span the Atlantic for regular airways service. This recently announced appropriation, amounting to $1,500,000 was negotiated by Eugene L. Vidal, Director of Aeronautics of the Department of Commerce, in behalf of Edward R. Armstrong, inventor of the seadrome, and completes a 16 year fight to gain recognition for a project which both Mr. Vidal, a competent and experienced airways operator, and Mr. Armstrong solidly believe in. As well, it will provide work for a great number of unemployed, as 80 per cent of the cost of such development projects goes to labor…"*
***Modern Mechanix*, February 1934**

478

*"…This $1,500,000 is for immediate experiments with a quarter-section ocean landing-field and ends a sixteen-year struggle for recognition of the seadrome system. The final plan calls for a $30,000,000 outlay by the government, contingent on the success of the preliminary experiments now under way. According to information gathered by this member of the staff of Modern Mechanix and Inventions, the ultimate plan calls for similar seadrome stations in the Pacific and other oceans, giving the United States an international supremacy of the air lanes. Great Britain and France both gave the Armstrong plan serious consideration but failed to adopt it…"*
***Modern Mechanix*, February 1934**

479

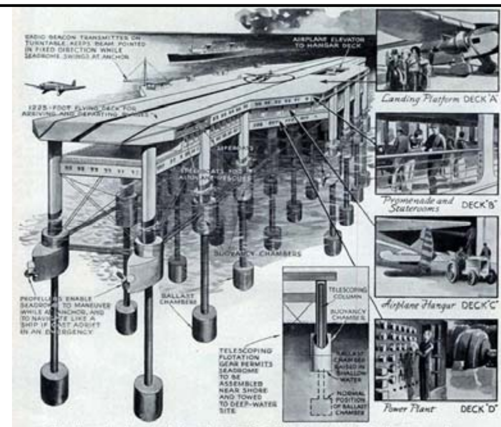



*"…The proposed system calls for five Armstrong seadromes at 500 mile intervals from the Atlantic seaboard here to the western coast of Europe. Each drome will cost $6,000,000. Back in 1927 when Armstrong completed his first models of the floating deck, he intended to have hangars and hotels on the six-acre surface. But the design which has been accepted by the government calls for a vacant deck, with hangar and hotel accommodations confined to two or three decks below the surface. The seadromes will be 1,225 feet long and 300 feet wide. An elevator will take planes from the surface to the underdeck hangars. This specially-designed elevator will adequately handle planes with wing spans up to 120 feet This flying deck will be supported in place by a number of ballast tanks sunk sufficiently below the water so that the flotation arrangement will be unaffected. That was the inventor's predominant problem, constructing his float so that it would not shift and toss with the huge waves…"*
***Modern Mechanix*, February 1934**
**Caption: "Eventually, if tests prove successful, the government seadrome chain would dot the Atlantic as shown for 10-hour service between Europe and America. These five seadromes would be situated in fair weather latitudes 500 miles apart."**

480

***"…Another innovation not found in his earlier plans is an emergency propulsion system that enables the seadrome to navigate like a ship if it is necessary to cast the seadrome adrift to ride out a storm of phenomenal severity, or if it should break loose from its moorings. This is provided by four propellers, each operated by a 500-horsepower electric motor that is supplied with current from the seadrome's gasoline-electric power plant…"***
***Popular Science,*** **February 1934**

481



This illustration shows the design and construction of the latest model of the Armstrong seadrome which the Government recently was reported ready to try out. Note the arrangement of the four decks

482

***"…The engineers of the Seadrome Ocean Dock Corporation associated with Mr. Armstrong estimate that 125,000 tons of iron and steel will be required to erect five airports and anchorages. The seadromes will have radio stations and radio beams to guide the air-liners in inclement weather. Attached to each seadrome there will also be sea-going cutters of the Coast Guard type for emergency as well as auxiliary duty. The floating decks will have weather stations. At the present time the quarter section of a seadrome is being constructed behind the Delaware Breakwater. When it is finished early next summer it will be towed out to sea for the tests. If it comes up to the expectations of its sponsors, the three other sections will be built and the entire seadrome assembled. In turn work will then be started on the rest of the ocean airports. Mr. Armstrong estimates that a 24-hour service can be maintained on the Atlantic Ocean, but he further modifies that calculation in plotting the trip between New York and London. He intends to make that journey a 30-hour trip in eight jumps of 160 miles per hour."***
***Modern Mechanix,*** **February 1934**
**RE: as the decade of the 1930s progressed, both land plane and flying boat range increased dramatically negating the need for these "Ocean Airdromes." Though a contract was let for a *Seadrome* on the *Bermuda* route in 1930, it - like those across the *Atlantic*, was never realized.**

483

**Ahead of His Time**

484

***"When I look into the vastness of space and see the marvelous workings of its contents . . . I sometimes think I was born ten or twenty thousand years ahead of time"***
***Alfred William Lawson*** **(1869–1954)**

485

## Part 7

## Airliners of Tomorrow

486

## Superliner of the Skies

487


*"The commercial airliner of the future will probably resemble closely the airplane pictured here, especially if intended for supermarine travel. Radical as the design may seem, it will be observed that in its essentials – in cantilever wings, hull profile, retractable chassis – the airplane is simply an embodyment of engineering practices already sanctioned in America and abroad."*
***Capt. Eddie Rickenbacker***
**(*Popular Science,* July 1922)**

This Superliner of the Skies, for passenger and freight transportation, which Captain Rickenbacker predicts will be realized 'with the passing of but a very few years,' will be a giant monoplane, perhaps 300 feet from wing tip to wing tip. The motors will be approximately 1,000 horsepower each, several motors to a unit, and each unit driving a great propeller with three blades from 15 to 20 feet long. The motor units will be set in the wings, which will be very thick – from five to ten feet on the leading edge – and will be internally braced cantilever construction. The fuselage will be in the form of a boat, but landing wheels that draw into the body during flight will also be provided. This will enable it to alight on land and water.

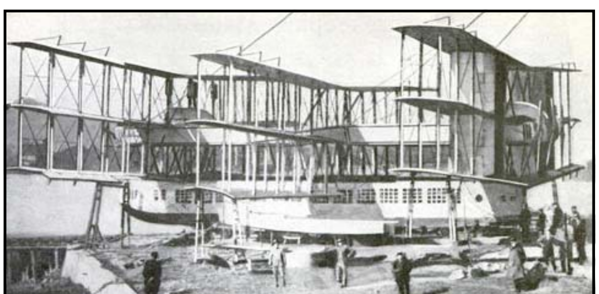
488

## Across the Atlantic on Many Wings

489

***"CAPRONI, the famous Italian designer and builder of airplanes, a man who dreams of aerial navigation on a grand scale, has built the biggest airplane that anyone has yet ventured to construct. Those who saw the huge bombers he built during the war, multi-planed machines with spans of about 100 feet, gasped at his daring. But now he exhibits to us a flying-ship with which, he believes, the Atlantic ocean may be crossed in not more than a day, and in the completely enclosed hull of which a hundred passengers find comfortable accommodation…"***
***Popular Science,* June 1921**

490

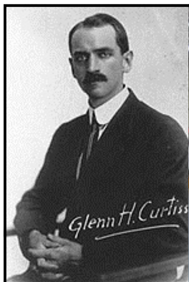


**Caption: "Caproni, world-famous as designer and builder of huge flying machines, has surpassed himself with this new giant. Nine planes support a sixty-six foot hull in which one hundred passengers take their seats. Eight engines, developing 3,200 horsepower, will drive the craft across the ocean at a speed of at least sixty miles-an-hour."**

491

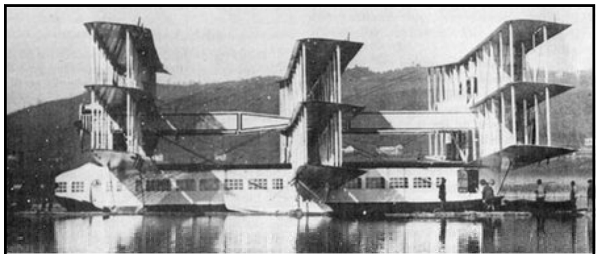
***"…The building of so huge a craft means more than the magnification of an ordinary biplane or triplane. This machine weighs twenty-four and one half tons, we are told. If it were to alight on land at so low a speed as forty miles an hour, the impact would be terrific. Indeed, this problem of landing has been one of the most difficult to solve by the designer of big land planes. Curtiss, who built the 'America' which was to have flown across the Atlantic just before the war broke out, and which had a span of about 130 feet, appreciated the difficulties correctly. Accordingly, he made 'America' a seaplane. It is easier to alight on water than on land…"***
***Popular Science,* June 1921**

492




AMERICA: The Curtiss-Wanamaker Flying Boat, 1914. The largest flying boat of its day and the first twin-engine flying boat, the Model II was built for the first aerial crossing of the Atlantic Ocean. After a prize of $50,000 was offered by the London Daily Mail of London, England in 1913 for the first transatlantic crossing of a heavier-than-air aircraft, Rodman Wannamaker, a wealthy department store owner, put up $25,000 to start construction at the Curtiss Aeroplane Company . . . Constructed and christened the AMERICA in Hammondsport, N.Y. in the summer of 1914, the flying boat was scheduled for the historic flight on August 5th of that year. Painted bright red for visibility, the plane was disassembled and shipped to St. John's, Newfoundland, Canada, for the start of the journey. However, with the outbreak of WWI taking place at that time, the attempt was Cancelled . . . (excerpt from museum plaque inscription)

493



***"…Caproni, looking back on his own experiences with heavy land machines has evidently decided that Curtiss' policy is right; for his huge craft starts from the water and alights upon it. This mammoth Caproni flying boat, largest airplane ever built, is undergoing tests in Milan, Italy. Nine wings, arranged in triplanes in tandem, are to lift the huge houseboat-like body. Benches along the cabin provide seats for 100 passengers – more than the capacity of the dirigible 'Graf Zeppelin.' Motors are at front and rear."***

***Popular Science,* July 1929**

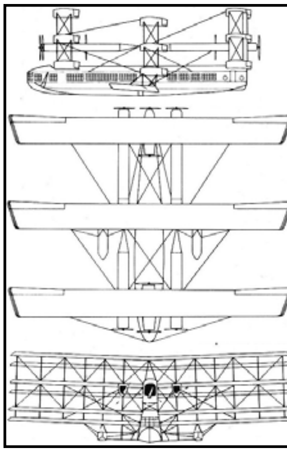
**<u>Above</u>: *Caproni CA60 Transaereo.* It was a nine wing flying boat intended to be a prototype for a 100-passenger trans-Atlantic airliner. It featured eight engines and three sets of triple wings.**

494

***"…To lift a weight of twenty-four and a half tons, a huge wing surface must be provided, in this case 7,150 square feet. A single pair of superposed wings, such as we find in the ordinary biplane, could hardly carry so huge a load. The span would be enormous, so much so that it would be far more difficult to make the wings strong and stiff enough than to build a bridge. Hence, Caproni built three superposed wings, thereby cutting down the span…"***

***Popular Science,* June 1921**

495



***"…But evidently two sets of triplanes were not enough, according to his figures. He has supplied three sets, with a veritable forest of struts to tie them together and a maze of wires between. All this means wind resistance, and therefore low speed, despite eight engines developing at total of 32,000 horsepower. No definite figures of performance has reached us from Italy, but it is doubtful whether more than sixty miles an hour can be made…"***

***Popular Science,* June 1921**

**<u>Left</u>: front, side & plan view/s of the *Caproni CA60***

496

***"…In one of the first short trial flights on Lake Maggiore in Italy, the hull was damaged as it struck the water, showing that even impact with a fluid that can easily be displaced is not without its dangers…"***

***Popular Science,* June 1921**

**RE: with the CA60, *Count Gianni Caproni* hoped to fly over 100-passengers across the Atlantic. Amidst all the struts and wings, the absence of any tail surfaces could easily be overlooked. Reportedly making a short hop without incident, the official first flight was less successful. Rising to about 18-meters above *Lake Maggiore*, the CA60 suddenly nosed down and dived into the water (above). Some said that testing had shown the need for a lot of lead ballast and that this had shifted in flight. The test pilot crawled out of the wreck unscathed. Later, a suspicious fire destroyed the wreck and ended the Count's transatlantic dreams.**

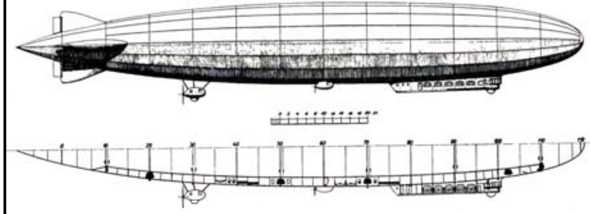
497

## Advantage: Zeppelin

498

***"…Those who have studied the commercial possibilities of aerial navigation will naturally compare Caproni's nine-planed flying-ship with a rigid dirigible of the Zeppelin type. Caproni can probably build a transatlantic flying-ship at a smaller cost than the Zeppelin Company can turn out one of its 600-foot dirigibles. But it is a question whether, in the end, the dirigible will prove commercially more practicable. The speed of the Zeppelin would certainly be as great as, if not greater than, that of the giant Caproni. It could carry fully as many passengers. It is not utterly dependent on engine power for support…all things considered, the advantage lies all with the dirigible for long-distance commercial flying."***
***Popular Science,*** **June 1921**

499



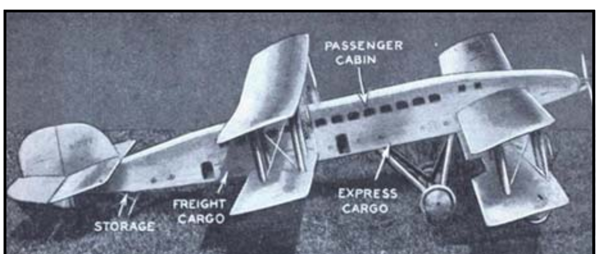
**Above: *LZ-120* (a/k/a "Bodensee") was the first civilian airship built after WWI. She was designed to provide fast air service between Friedrichshafen and Berlin. Construction was completed within six months and she made her first flight on August 20, 1919. LZ-120's advanced aerodynamic teardrop shape, which differed greatly from the thin, pencil-like shape of most previous Zeppelin airships, was a great leap forward in airship design, due primarily to the engineering theories of designer *Paul Jaray*. With its revolutionary design and four 245 hp *Maybach MB-IVa* engines, LZ-120 could reach a speed of 82 mph and was a commercial success.**

500

501

## Nonstop Service

502




**Navy Flyer Invents Tandem Airplane for Heavy Loads**

A TANDEM airplane called the KarrAvan has been invented by Harold H. Karr, a naval aviation pilot at North Island, San Diego, California. The ship which is 130 feet long and has a wing spread of 96 feet is able to lift 85,000 pounds. The unique flying machine will be powered by five 420 h.p. engines and will have a top speed of 135 miles an hour. The ship will carry 80 passengers and their baggage more than 4,000 miles without a halt. (*Modern Mechanics,* December 1929)
Caption: "This tandem airplane is 130 feet long and has 96-foot wingspread to lift more than 85,000 pounds"

503

## Air-to-Ground Communication

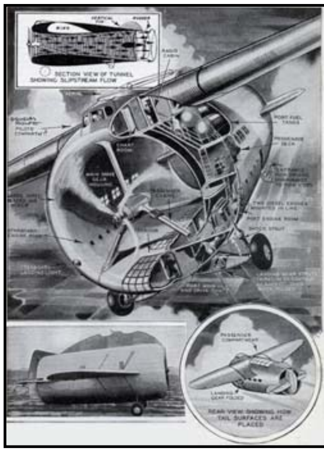
504

***"…PASSENGERS riding the transport planes of the German air company, Deutsche Luft Hansa, may now send commercial telegrams not in code and not exceeding fifteen words to stations on the ground, according to advices received from Trade Commissioner A. Douglas Cooke at Berlin. Telegram blanks have been placed on all planes, and one merely writes his message and hands it to the steward. It is sent to the ground station, with which the pilot is in communication, by radio, and forwarded from there the same as any telegram…"***
***Modern Mechanics,* August 1931**

505

## What Next, Flying Barrels?

506



**Flying BARREL to Carry 100 Passengers**

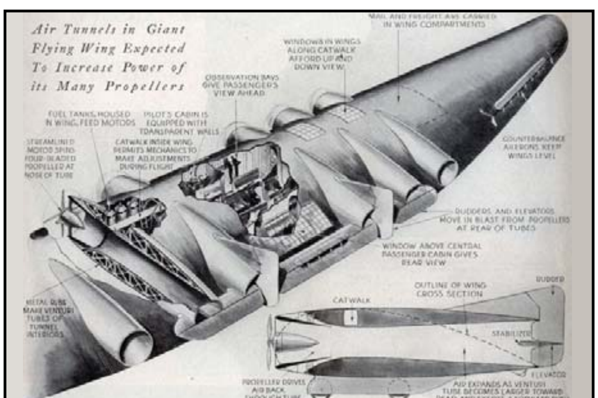
Development of a huge "flying barrel" transport plane capable of carrying a hundred passengers inside its thick tubular hull is foreshadowed by recent successful test flights of the hollow fuselage plane shown in the photograph at lower left, designed by Engineer Stipa of the Italian Caproni works. The picture shows: double cockpits placed on top of the cylindrical body, but in the refined version of the plane for large scale passenger traffic, the piloting compartment is faired into wing and propeller is driven through gears much like the dirigible Akron. (*Modern Mechanix,* March 1933)

507

**Huge Barrel Plane for Ocean Flights**

PIERCED by a battery of tunnels a flying wing airplane is proposed by an engineer at the famous Caproni airplane works in Italy. Streamlined motors and four-bladed propellers will drive air blasts through the tunnels, each of which forms a Venturi tube, expanding toward the rear. Thus, according to the inventor, the air will give a forward push something in the manner of rocket propulsion. Aided by the Italian government, the designer recently completed a single-engined experimental craft incorporating his ideas. This odd flying barrel was put through successful tests near Rome…(*Popular Science,* April 1933)

508




…Details of the huge machine he proposes to build for transatlantic travel are shown in the pictures above…(*Popular Science,* April 1933) 509

…A half-dozen tunnels or more will run through the immense flying wing. Rudders and elevators will be mounted so they will move in the blasts issuing from the tubes. The craft will be piloted from a cabin with transparent walls at the center of the leading edge of the wing. On either side will be observation bays from which passengers can look ahead. Other windows will afford a rear view from the central passenger's cabin. Another feature of the machine will be a catwalk running lengthwise through the wing. It will enable mechanics to make adjustments while the plane is in flight. (*Popular Science,* April 1933)

510

## Coming and Going

511


As may be seen from the sketches, the method of launching the taxi plane is very similar to that used by the U.S. Navy in handling pursuit planes on dirigibles. A trapeze crane lifts the small ship into the hull of the transport, where passengers may be transferred to roomy quarters on the airliner.

HIGH speed taxi planes that can come and go from a giant "mother" air transport at will are proposed as a means of providing fast, non-stop transcontinental air service. The smaller ship, released over a city, would land at the airport to discharge and take on passengers and freight, then soar upwards again to catch up with the slower airliner. (*Modern Mechanix,* March 1935)

Above: the USN originally envisioned airships as scouting vessels which carried airplanes for defense. However, over time it was realized that the vulnerable airship itself was best employed out-of-range of a potential enemy. The airship's function would be to carry scouting planes within range of the enemy, but not itself come within range. As naval airship doctrine developed, rather than the airplane extending the scouting range of the airship, as first envisioned, it was the airship which extended the scouting range of the airplane.

512

***"…This country was among the first to investigate the possibility of airplanes being carried by airships…Four years ago at the Naval Air Station in Rockaway, New York, a non-rigid airship of the C-class was equipped with a cable and winch for carrying an airplane suspended from it…On the top of the wing, a ring was secured to the structure of the plane. On the end of the cable let down from the airship, a hook engaged the ring and the plane was suspended from the ship at a distance of about 50 feet below it. When the hook was released by a tripping device, the plane fell a vertical distance of about 200 feet, then recovered its equilibrium and flew to a safe landing…"***

**Admiral *William A. Moffett,* Chief of the *Bureau of Naval Aeronautics***

**RE: comments made in 1923**

513


***"…Means of returning the planes to the parent ship could take the form of a landing deck, on top of the ship or suspended beneath it. Stowage space for the fighters could be provided in the body of the ship along the keel line. The launching of them is merely a matter of pushing the planes off into space, where they can recover themselves with the ease of a bird thrown into the air…"***

**Admiral *William A. Moffett,* 1923**

514

## Mother Ship

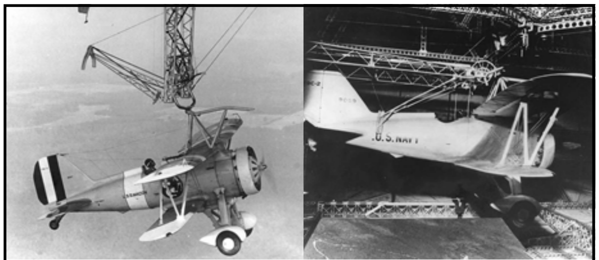
515

***"…Perhaps the most spectacular phase of the airship's growth is its recently acquired ability to carry airplanes. The new British ships, it is reported, are designed primarily as mother ships for airplanes, and are equipped so that the planes can be used as auxiliary power plants. The American Zeppelins will have compartments within the hull that will hold five to seven planes, depending on size…"***

***Popular Mechanics,* February 1930**

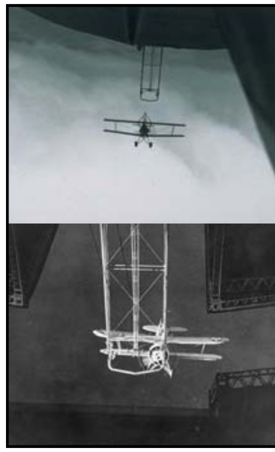
**RE: in 1926, *Congress* approved a five-year plan proposed by the USN's *Bureau of Aeronautics* authorizing the construction of two airships. The giant airships made large, slow targets which were extremely vulnerable to destruction by enemy aircraft.**

516



**The ability to launch and/or recover fixed-wing aircraft was the essential element of the USN dirigible's ability to serve as naval scouts. Airplanes greatly increased the range and area over which the airship could search for the enemy, but also addressed the airship's own inherent weakness; vulnerability to attack.**

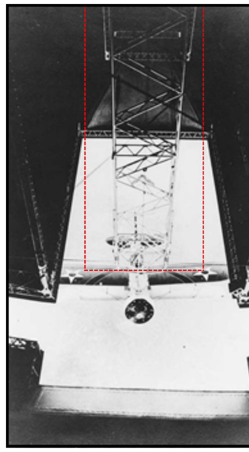
**<u>Above L&R</u>: *F9C-2* biplane hooked on trapeze (left) and stowed in hangar deck (right)** 517

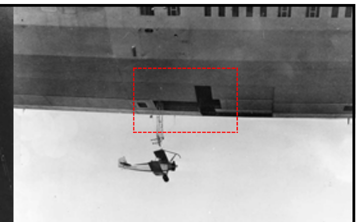


**<u>Above</u>: caption: "Vought UO-1 observation airplane attached to the trapeze of USS Los Angeles (ZR-3) during mating experiments in the airship hangar at Naval Air Station Lakehurst, New Jersey, 15 December 1928"** 518

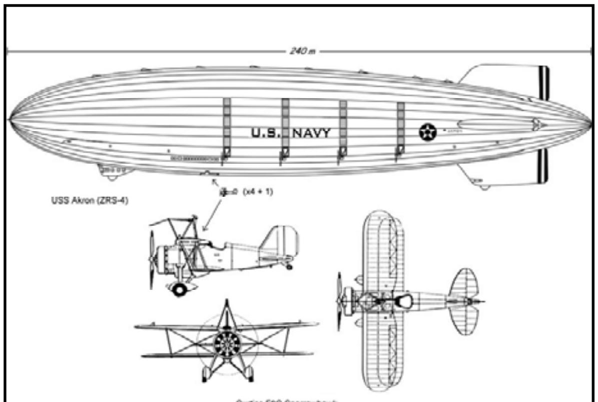
**The *U.S.S. Macon* (ZRS-5) and its sister ship; *U.S.S. Akron* (ZRS-4), were the largest helium-filled rigid airships ever made. They were launched in 1933 and 1931 respectively. Both were designed for long-range scouting in support of fleet operations. Often referred to as "flying aircraft carriers," each airship carried *F9C-2 Curtiss Sparrowhawk* biplanes, which could be launched and recovered in flight, greatly extending the range over which the two airships could scout the open ocean for enemy vessels. Both the Macon and Akron were lost in separate severe storms.** 519

**<u>Caption</u>: "USS Macon cut-away view"**





**<u>Above & Left</u>: both *USS Akron* and *USS Macon* were designed as airborne aircraft carriers which could launch and/or recover heavier-than-air biplanes for use in reconnaissance and/or self-defense. The airships were equipped with hangars; approximately 75-feet-long by 60-feet-wide by 16-feet-high which could stow and service up to five aircraft. Aircraft were launched and retrieved by means of a "trapeze" (left), and could enter and/or exit the hangar though a large T-shaped opening at the bottom of the hull (above).** 520

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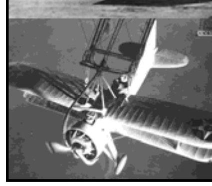
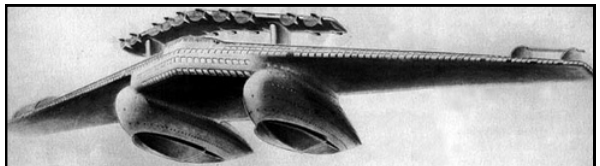


**<u>Above</u>: caption: "Consolidated N2Y-1 training plane photographed while serving as 'hook-on' familiarization trainer for USS Akron (ZRS-4), 1932. An O3U-1 is in the background."**

**<u>Left</u>: caption: "Curtiss XF9C-1 Sparrowhawk is lifted into the hangar of USS Akron (ZRS-4), after hooking onto the airship's trapeze landing gear, circa May 1932"** 522

## The Big Wing Concept

523

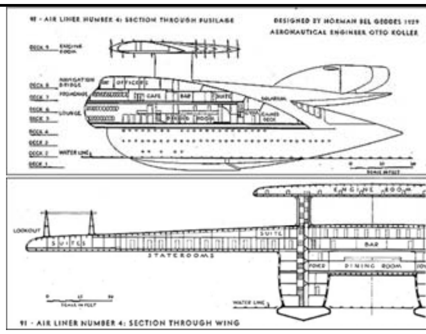


*"Air liners of a size that is not easily visualized today will eventually supplant ocean liners in intercontinental transportation of express traffic - passengers and mail, but not freight…She has a total wing spread of 528-feet. On the water she is supported by two pontoons 104-feet apart, 235-feet long and 60-feet high...Total power required, 38,000 horse power - 20 motors, each 1,900 horse power; maximum speed, 150 miles per hour; cruising speed, 100 miles per hour; normal flying ceiling, 5,000 feet; absolute ceiling, 10,000 feet; time of climb to ceiling, 1 hour; speed at ceiling 87.5 miles per hour; cruising range without refueling, 7,500 miles, gross weight, 1,275,300 pounds...The flying time between Chicago and Plymouth, England is forty-two hours. She is refueled in flight while passing over Newfoundland…"*

***Norman Bel Geddes,* Industrial Designer**

**RE: Bel Geddes designed "Air Liner No. 4" (above) with the assistance of aeronautical engineer *Otto Koller* in 1929. Accommodations were for 451 passengers and a crew of 155. The giant streamlined seaplane would carry six extra motors for in-flight replacement, if necessary.**

524

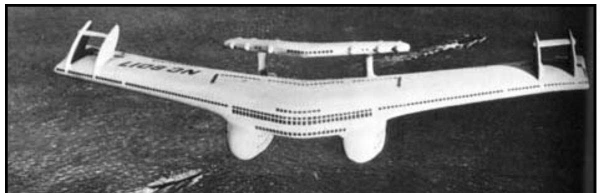



***"…substantially as the hull of a yacht, in order to withstand tremendous pounding when the plane rests on a rough sea…"***

***Norman Bel Geddes***

**<u>Above</u>: "Air Liner No. 4" section/s. The craft would be supported on the water by two enormous pontoons, both 60-feet high and with all the strength of an ocean-going yacht**

525



***"…If it were possible to stand her upon one wing tip against the Washington Monument, she would lack only 23-feet of reaching the top. Or imagine that the Public Library was removed from its site in Bryant Park at Forty-second Street and Fifth Avenue, New York. The plane could then settle comfortably in the park with a clearance of about 35-feet all around."***

***Norman Bel Geddes,* Industrial Designer**

**<u>Above</u>: rendering of "Air Liner Number 4." Her 451 passengers would range over nine decks containing 180 apartments, three kitchens, three private dining rooms, an orchestra platform, a gym, six shuffleboard courts, a dance floor, a library, separate solaria for men and women, a writing room and a promenade deck. The 155-person crew would include two telephone operators, 24 waiters, two masseuses, a manicurist and a gymnast.**

526

## Tomorrow's Airplane

527

**Tomorrow's airplane - a giant flying wing without fuselage or cabin, carrying payloads of 150 passengers and tons of baggage**

***Popular Mechanics,* February 1938**

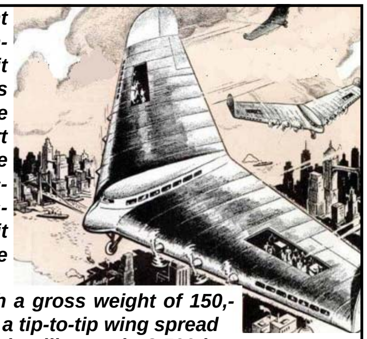
**RE: introduction to an article authored by *Hall L. Hibbard,* Chief Engineer, *Lockheed Aircraft Corporation,* "The FLYING WING of the FUTURE"**

528

## The Range of Future Possibility

529

*"JUDGING from present developments and trends in aircraft design, it is our belief that such is a rough sketch of the commercial transport that will be flying the sky trails within a decade or so. Of stainless-steel construction, it will be almost twice the size of any plane now under construction with a gross weight of 150,000 pounds and having a tip-to-tip wing spread of 300 feet. For power, it will use six 2,500-horsepower motors, so arranged that the mechanics may work on them during flight…"*



***Popular Mechanics,*** **February 1938**

**Caption: "Drawing of the 'flying wing' envisioned by the author"**

530


*"…Travelers will ride inside the giant wing, which will be equipped with individual staterooms, recreational facilities and a promenade deck. Curved windows will be placed in the leading edge of the wing, in the celling and parts of the floor. To complete the picture, the tricycle landing gear will be used to land the big transports…"*
***Popular Mechanics,***
**February 1938**

531

*"…The speed with which these flying wings will travel is difficult to predict. Because we have learned that size has little bearing on speed, 500 miles an hour is not improbable, if certain problems regarding altitude flying can be answered satisfactorily. Speed costs money. The faster a plane travels the more fuel used and the greater the depreciation on equipment, all of which means higher operating costs…"*
***Popular Mechanics,*** **February 1938**

532

*"…The prediction of such radical changes will not meet with the favor of those who feel the ultimate in aeronautical development has been reached. But aircraft designers are not hidebound by precedent or production methods. They have a way of looking beyond the artificial limitations of their tools and in so doing make possible the 'impossible.' For evidence that the flying wing is not beyond the range of future possibility, we need only to compare one of the earlier planes with a modern transport…"*
***Popular Mechanics,*** **February 1938**

533

## Eliminating the Insignificant

534

*"…In efforts to improve aircraft, engineers and technicians have sought to eliminate useless, dragging elements. Struts, braces, and guy wires have disappeared. On the big ships, the next important step is removal of the fuselage. And with it will go the tail, lateral and vertical control being attained through wing-tip fins and wing ailerons…"*
***Popular Mechanics,* February 1938**

535

## Tea-Time Conversation

536

*"…If the size of this future plane seems a bit wild-eyed, consider present developments within the industry. It is no secret that transports are growing larger and larger. There is one plane under construction so big it cannot be assembled within the walls of one of our most modem factories. The building of great supercharged planes operating at 30,000 feet at cruising speeds of 250 miles per hour with flying ranges of between 3,000 and 4,000 miles is tea-time conversation among builders…"*
***Popular Mechanics,* February 1938**

537

## Aviation's Spotlight

538

*"…The next ten years should see stainless steel come into its own as an aircraft metal. Already aviation's spotlight is being focused upon its structural possibilities with the completion of the first all stainless-steel plane built for commercial purposes…"*
***Popular Mechanics,* February 1938**

539

*"…The airplane of the future, as envisioned by Mr. Fishel, will have all-metal wings consisting largely of strong, thin stainless sheet steel, stretched over a framework of the same material. Metallurgists already are at work on the problem of making suitable sheet material. Such planes will be stronger than those in use today, will be fireproof, and will require no special protection against corrosion…"*
***Popular Mechanics,* July 1936**
**Above L&R: the *Budd BB-1 Pioneer* (left) was an experimental flying boat of the 1930s utilizing the *Savoia-Marchetti S.56* design. Its framework was constructed entirely of stainless steel, using a patented method of welding the new alloy. Although the BB-1 was the first American airplane to be made of stainless steel, it was not the only one. The *Fleetwings Sea Bird* (right) was another stainless steel flying boat of the era.**

540

## The Alloy of Endless Possibilities

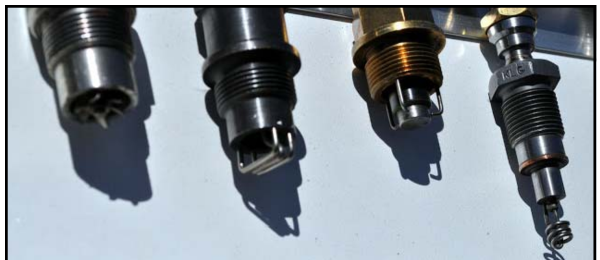
541

***"RUST which, it is estimated, causes a loss of about one billion dollars a year in this age of steel, today is in full retreat before an advance that began about a generation ago. Strangely enough, the big guns of war played a key part in the early stages of the battle…"***
***Popular Mechanics,*** **July 1936**

542

***"…The history of man's attempt to conquer rust goes back almost to the time when the first iron tool was fashioned. The most important chapters, however, have been written since the beginning of the present century. Today, as the result of the struggles, we have stainless steel, wonder alloy that promises to work amazing changes in almost every activity involving steel, particularly the automotive and aviation industries…"***
***Popular Mechanics,*** **July 1936**
**Top: caption: "High-speed trains, fabricated of stainless steel, combine beauty and speed with safety and economy"**
**Middle: caption: "This two-seater monoplane is a sturdy stainless steel craft built for training pilots"**
**Bottom: caption: "Here, complete with tailpipe assembly, is a stainless steel exhaust system for a fighter plane"**

543



***"…The story of present-day rust-resisting steel alloys really began in 1912 and a number of men have had a part in the research. Elwood Haynes of Kokomo, Ind., in an attempt to make spark-plug points that would not corrode and pit, melted iron with nickel, cobalt and chromium. He came very close indeed to a great discovery. Five years later, at the great Krupp works in Germany, Benno Strauss poked about among alloys of iron, nickel and chromium, trying to find a material from which he could make better tubes for pyrometers used in measuring very high temperatures…"***
***Popular Mechanics,*** **July 1936**
**Above: a sampling of early spark plug electrodes (a/k/a "points")**

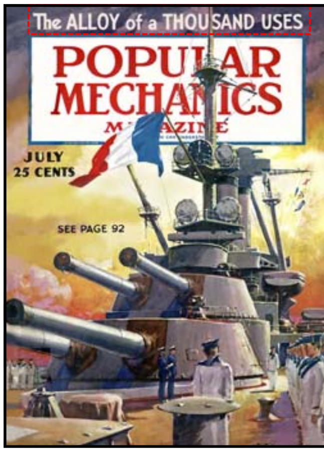
544

***"…Here and there, during the next decade, experimenters tried combinations of the three important metals now found in stainless steels in attempts to make such things as scale-resisting castings and alloys that would withstand the cutting action of the oxyacetylene flame. Mixing iron with chromium was not new, for chromium steel made in crucibles had been in use since 1869 for manufacturing locks, crusher parts and burglarproof safes…"***
***Popular Mechanics,*** **July 1936**
**RE: as late as 1800, only hard steels (of which swords and tools were made) were known. Up to the 18th century, the finest steel used in England came from India (at an estimated cost of $50K/ton). Such steel is still made in India. About one-pound of ore is placed in a small clay crucible with finely chopped wood. The crucible is then covered with leaves and damp clay, dried in the sun and heated in a small furnace. The melted steel is to be found in the bottom of the clay pot.**

545

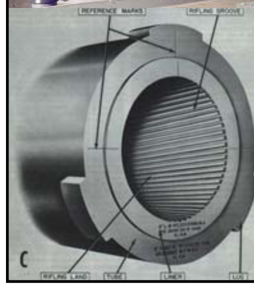
**In Europe, steel was produced slowly and tediously by packing pieces of carbonless iron (a/k/a "wrought Iron") with powdered charcoal in stone boxes and keeping the boxes red hot in furnaces for upward of six weeks. When the bars were cold, they were broken and sorted according to the hardness of the pieces (the hardness varying with the amount of carbon that had penetrated). This irregular steel was reheated, forged and hammered into swords, knives, etc., or made more uniform by melting it in a *Crucible*. Such steel was/is known as "Crucible Steel" (because it's melted in clay or graphite pots, called "Crucibles").**
**Left: "Pulling a pot in a Crucible Steel Plant"**

546




*"…But it remained for Harry Brearley, head of a steel company research laboratory at Sheffield, England, to stumble onto the most important property of iron-chromium combinations, their resistance to corrosion. Brearley was trying to find a better metal for lining the bores of big guns. The life of such guns, ordnance officials complained, was too short, largely because of the action of heat and corrosion on the bore. The heat developed in firing a single shot was, in large-caliber guns, high enough to melt a thin film of the metal then being used. In addition, the corrosive action of chemical products of explosions attacked the bore…"*
***Popular Mechanics,*** **July 1936**

547




*"…Brearley knew that a steel that does not contain much carbon cannot be melted as easily as one having a high percentage. By reducing the carbon in the gun-lining steel, he ought to raise the melting point. But something had to be done to retain the hardness. He knew chromium-iron alloys were hard, and stood up well against heat. So he mixed iron and chromium in various proportions, put them through all kinds of tests but could not produce a gun lining that would meet all the requirements…"*
***Popular Mechanics,*** **July 1936**
**<u>Top</u>: caption: "The business end of the WWII-era U.S.S. Iowa's 16-inch main guns"**
**<u>Bottom</u>: caption: "Cross-section of a large caliber naval gun barrel. In newer types of large guns, the rifling is cut in a liner - a tubular insert that can be replaced when worn."**

548

549

*"…Part of his testing of these experimental steels consisted of sawing little blocks from them, polishing one surface of each block, and applying etching solutions to bring out the crystalline structure so it could be studied with a microscope. But some of the samples refused to be etched. They retained their mirror-like finish in spite of the chemicals…"*
***Popular Mechanics,*** **July 1936**

550

*"…Then Brearley turned from gun barrels to knife blades. He experimented with alloys that would produce, he hoped, hard, tough blades that would hold an edge. He tried some of the combinations he had made in his gun-lining studies, and discovered some of the knife blades did not rust. They were made from the same alloys that had resisted the etching acids. So, in 1916, Brearley received patents on his iron-chromium alloys, and stainless cutlery became the first practical application of stainless steel alloys…"*
***Popular Mechanics,*** **July 1936**

551


552

*"…The scene next shifts to Germany, where nickel was added to improve the qualities of the original alloys. Before the World War, manufacturers in America and Europe were making stainless steels under German patents. Today, following a complicated manipulation of patent rights, the stainless steel industry in America is controlled by the Chemical Foundation, owner of patents worth millions…"*
***Popular Mechanics,*** **July 1936**

553

*"…Stainless steels do not rust, corrode, or tarnish under ordinary conditions of use. They are stainless because they contain chromium. At least 11 per cent chromium is necessary to make steel stainless; usually, the higher the chromium content the more resistant the steel becomes, until, for the extreme conditions exemplified by high-temperature service in chemical plants, the steel may require as much as 30 per cent chromium. Even if steel contains only 4 to 6 per cent chromium it will be moderately resistant to atmospheric conditions since it acquires an adherent rust, which serves as a form of protection…"*
**RE: excerpt from *Stainless Steels and Their Uses* (ca. 1945)**

554

*"…While chromium must always be present in stainless steels, other alloying metals are frequently included to make the characteristics of the final steel most adaptable for its intended use. Second to chromium in importance in stainless steel is nickel, and, in fact, the most generally used stainless steels at the present time are those that contain from 17 to 20 per cent chromium and 7 to 10 percent nickel. All stainless steels contain manganese and silicon and, for specific purposes, some contain such elements as tungsten, molybdenum, columbium, and nitrogen, each of which enhances some particular characteristic. Tungsten confers hardness, molybdenum gives resistance to certain chemicals, columbium improves corrosion resistance in welded structures, and nitrogen increases strength without loss of ductility…"*
**RE: excerpt from *Stainless Steels and Their Uses* (ca. 1945)**

555

*"…In general there are three metallurgical classifications of stainless steels. The first classification (ferritic) is not hardenable by heat-treatment. It can, however, be drawn and formed into many simple shapes. It is particularly suited for chemical plant equipment handling nitric acid and has also been employed for automotive trim. The second class (martensitic) is readily hardened and strengthened by heat-treatment. Careful treatment and polishing are advisable to develop its corrosion-resisting properties most completely. It is most generally used for high-grade cutlery and for machinery parts that require the combination of high strength with corrosion resistance. The third group of stainless steels (austenitic) includes the highly versatile steels, which are tough and ductile, and which may be cold-rolled or drawn to develop high strength and at the same time retain good forming and welding properties. The chromium-nickel alloy steels, of which the well-known '18-8' is typical, belong to this third group…"*
**RE: excerpt from *Stainless Steels and Their Uses* (ca. 1945)**

556

## Cost-to-Benefit

557

*"…Apart from its non-corrosive quality, stainless steel has much to recommend it. Although heavier than dural, its high tensile characteristics would be the means of saving considerable structural weight in a plane the size of a flying wing. Another advantage would be that a new method of fabricating this metal makes possible a further reduction in drag by the elimination of rivets…"*
***Popular Mechanics,*** **February 1938**

558

***"…Stainless steel is more costly than other metals of this character but this is not an important obstacle. When the alloy was first introduced into the commercial field, it was selling for seventy-five cents-a-pound. It was substituted for a metal costing but four cents-a-pound. This cost was offset in other ways, however, particularly in the railroad streamliners, and increased production of the metal has made it considerably cheaper…"***
***Popular Mechanics,*** **February 1938**

559

***"…These are but a few of the thousands of applications, all the more astonishing because stainless alloy steel has been commercially available for little more than a generation, while its cost, compared with other metals, is high - sometimes $1.50 a pound in special forms. Even in scrap form, this mirror-finish stainless steel is worth twenty cents a pound…"***
***Popular Mechanics,*** **July 1936**

560

## Tamed Lightning

561

***"…When stainless steel was first considered for airplane structures, engineers found it couldn't be handled in the manner of spruce, dural or high-tensile steel. This alloy attains its maximum resistance to corrosion by a special heat treatment. When cooled, it has ten times the electrical resistance of ordinary steel, is very ductile, and capable of being drastically cold worked. It was found, however, that any subsequent heating of the metal weakened its resistance to corrosion and impaired its general utility…"***
***Popular Mechanics,*** **February 1938**

562

***"…Because of this, ordinary welding methods were out of the question, so Col. E.J.W. Ragsdale, chief engineer at Budd Manufacturing company, developed what is known as 'shot – welding.' This consists of fusing together two separate sheets of metal by passing through them an electric current and generating heat through the resistance offered by the metal to the current. In principle, this is virtually the same as the light-bulb filament except here the current is not strong enough to fuse the filament. Because of the metal's high electrical resistance, the heating time is made so short that the alloy's stainless properties are not affected…"***
***Popular Mechanics,*** **February 1938**

563

***"…Time is not an essential factor of heat. Lightning has some excellent short-time melting jobs to its credit and some 'shot welds' have been consistently made in 0.0001 second. Thus, a weld consistent with the high-tensile characteristic of the metal was developed. Engineer Ragsdale did not stop there, however. He made his fabricating methods virtually foolproof by designing a mechanism which accurately gauges and records the strength of every weld made or failed. On a tape is written the heat units entering into each weld and also giving notice of any variation…"***
***Popular Mechanics,*** **February 1938**

564

Caption: "Shot-weld apparatus, and tape on which are recorded the heat units in each weld"

565

**Modern Aircraft Requirements**

566

*"…The aircraft industry in this country has been built around the use of aluminum and its alloys, while in Europe, carbon steel is favored. These are both subject to corrosion. While mindful of the advantages of stainless steel, there is need for a comprehensive study of this metal in terms of modern aircraft requirements."*
*Popular Mechanics,* February 1938
Caption: "Gigantic hydraulic metal-forming press at the Lockheed factory. This 175-ton machine stamps out parts formerly made by hand"

567

**Only the Beginning**

568

*"…But in spite, of its brilliant record, metallurgists say that only a beginning has been made. Partly because of a lowering of cost, partly as a result of better design of the article being manufactured, and because of the development of improved alloys, stainless steel is likely to cause changes in many fields, particularly the automobile industry and aviation…"*
*Popular Mechanics,* July 1936

569

*"…J.H. Fishel, Republic Steel Corporation expert in stainless steel, predicts that stainless alloy automobiles, requiring no paint or other finishing, will be commonplace tomorrow. Today such a car would cost too much. But with the production of high-strength stainless steel alloys, cheaper methods of production, and the streamlining of cars so their parts will be easy to make, non-rusting automobiles will be made available to everyone…"*
*Popular Mechanics,* July 1936
Above: in 1935, the *Allegheny Ludlum Steel Corporation* - a pioneer producer of stainless steel, proposed the idea of creating a stainless steel car to the *Ford Motor Company*. The idea took shape in the form of a 1936 *Ford Deluxe Sedan* (left). One of six, all body panels were made of stainless steel. Ford also collaborated with Allegheny Ludlum to fabricate a stainless version of a 1960 *Thunderbird* (right) and, in 1967, a *Lincoln Continental* convertible (middle).

570


571

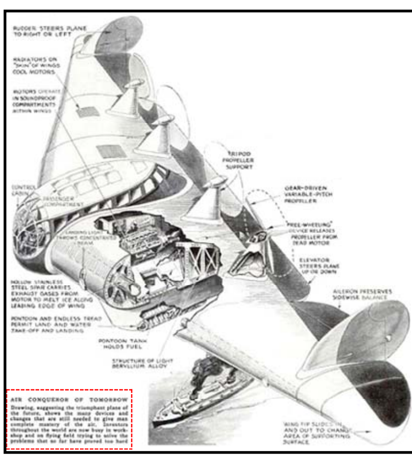
## The Shape of Things to Come

572


**<u>Center caption</u>: "From photographs of designs copyright by Norman Bel Geddes & Co., and published in 'Horizons'"**
**<u>Bottom caption</u>: "The designs shown above indicate the undoubted future trend of the high-speed transportation means of the future; they show how the graceful curves of beauty combine with those of efficiency. The lines of the bus and car have already been approached in actual use."** 573

**In 1932, *Captain Frank T. Courtney* recommended making amphibious landing gear a standard feature. Since not all areas had a usable runaway and landing on rough ground took a heavy toll, it only made sense to make them capable of taking-off and/or landing in water. Although seaplanes had already existed for two decades, engineers had difficulty making a folding device that was strong enough to lift the wheels yet light enough to keep the plane airborne. Courtney recommended scrapping previous designs and staring anew, perhaps by substituting wheels with endless treads. The perfect seaplane would also have a device that would speed up take-offs by minimizing water resistance against the hull. Previous designers suggested that "hydrovanes," which resemble venetian blinds, could provide a bit of lift by tilting upward during take-off, but Courtney warned that fish or seaweed could clog the panels.**

574



AIR CONQUEROR OF TOMORROW. Drawing suggesting the triumphant plane of the future, shows the many devices and changes that are still needed to give man complete mastery of the air. Inventors throughout the world are now busy in workshops and flying field trying to solve the problems that so far have proved too hard."

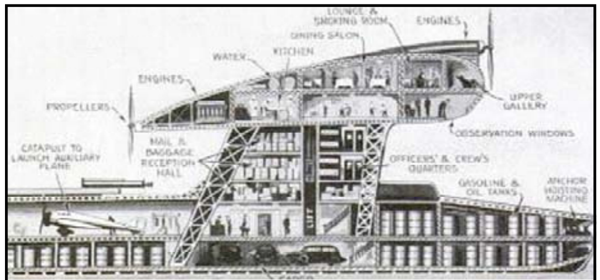
575

## Ocean Air Liner

576

***"BOTH Germany and England are visioning future trans-atlantic aircraft as big as the ocean liners of today, and aero-nautical engineers of these two countries are designing and planning for such hydroplanes. British engineers are dream-ing of an ocean air liner which would carry 1,500 passengers and hundreds of tons of cargo at a speed of 220 miles per hour, making the trip from Southampton to New York in less than fifteen hours…"***
***Popular Mechanics,*** **April 1934**

577




***"…Drawing depicting such a craft show engines and propellers fore and aft and an auxiliary plane which would be launched from the air liner by means of a catapult. A German air company also is said to be backing a venture to build a transatlantic aircraft which would carry 200 passengers and several tons of freight at 187 miles an hour."***
***Popular Mechanics,*** **April 1934**
**Above: caption: "Cross-section of contemplated aircraft as big as an ocean liner; note catapult for launching auxiliary plane and propellers and engines fore and aft"**
**Left: caption: "Artist's conception of giant transatlantic plane of future visioned by British aeronautical engineers"**

578

## Dynamic-Control

579

***"THE tendency at the present time in airplane building is tow-ard constantly increasing size. It is probably realized by all who have concerned themselves with aircraft that the larger machines are not very far in the future…"***
***Hugo Gernsback***
***Everyday Science and Mechanics,*** **November 1934**
**RE: Gernsback authored an article for the magazine entitled: "Dynamic-Control Ocean Airliner"**

580


***"…From the earliest Wright air-plane, which weighed approximate-ly 1/2 ton, to the present record hol-der, the Do-X, which weighed fifty tons, took a period of some 26 years. The 10,000-ton airplane, proj-ected on a like time-scale, would, therefore, make its appearance not later than the year 1952. However, with the nature of the present-day technique, it is quite possible, at this moment, that the 10,000-ton plane will be here much sooner. It is already becoming apparent that ideas of the ordinary ocean liners are more and more embodied in airplane construction; and in all probability this tendency will be followed in years to come. In other words, what we will have is a flying ocean liner that is not only air-worthy, but is seaworthy as well…"***
***Hugo Gernsback,*** **November 1934**
**Left: cover of ES&M depicting the pro-posed "Dynamic Control Ocean Air-liner"**

581

***"….It is also a foregone conclusion that when a 10,000-ton aircraft is built, it will not be a land-type plane but for obvious reasons will have to land in water. This makes the landing and taking-off much easier and more practical; because it would be most difficult to take-off with, or land, a 10,000-ton weight on terra firma…"***
***Hugo Gernsback,*** **November 1934**

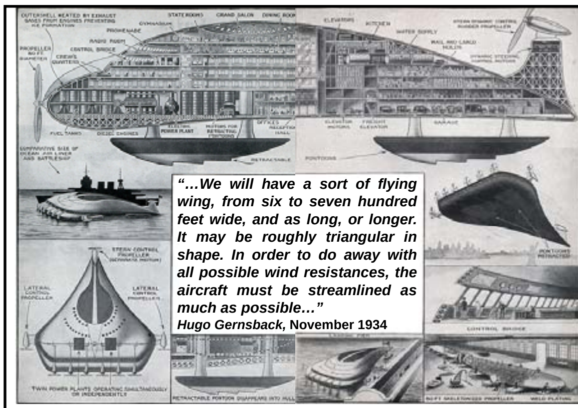
582

***"…The question may be raised, why such a large craft? The same principle that holds good for large ocean liners holds good for large airplanes. In the first place, in order to make it as economical as possible, the craft must carry a sufficient amount of freight and passengers, and it must also be sufficiently speedy; and, if past history is a teacher, it will be found that higher and higher transatlantic speeds are needed…"***
***Hugo Gernsback,*** **November 1934**

583


***"…The new French express steamer, Normandie, will make the Atlantic crossing from Cherbourg to New York in less than four days. The aircraft of the future, in order to compete at all, must make it in less than a day. This calls for high speed, and safety as well, which can only be accomplished by great speed…"***
***Hugo Gernsback,*** **November 1934**

584



***"…We will have a sort of flying wing, from six to seven hundred feet wide, and as long, or longer. It may be roughly triangular in shape. In order to do away with all possible wind resistances, the aircraft must be streamlined as much as possible…"***
***Hugo Gernsback,*** **November 1934**

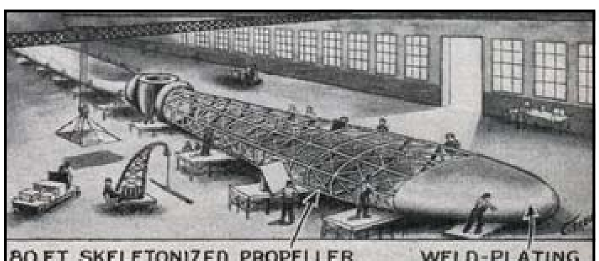
585

***"…Now a word as to the propellers themselves. In order to lift and drive a machine of this type, huge propellers must be used. At the present time, the largest propeller that has been developed is about 12 feet across. The airliner calls for truly gigantic propellers, which are between 75 and 80 feet in diameter. Now then, if you were to turn such a huge propeller, at even 1,000 revolutions per minute, the tip speed of the propeller would be so great that it would fly to pieces; because there is no material that man knows of that could withstand the tremendous pressure set up at such speeds…"***
***Hugo Gernsback,*** **November 1934**

586

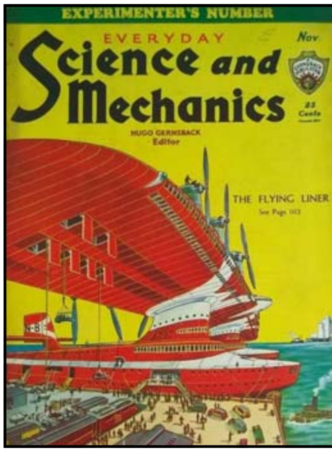
***"…But it is not necessary, nor desirable, to drive such a huge propeller at so high a speed. Indeed, if you drive it at from 200 to 250 revolutions per minute, you get a tip speed of 2,000 miles per hour, which compares well with the speed of our present-day propellers, and the efficiency of this large propeller should be the same, if not higher, than that of the 15 foot type…"***
***Hugo Gernsback,*** **November 1934**

587




***"…In order to reduce the weight, I propose that the propeller of the future airliner be built on the cantilever-bridge principle, as shown in the illustration. It is made in the form of a skeleton, and the material, the toughest known today, could be chromemolybdenum steel, or even some newer alloy, not yet commercially available, such as those of beryllium. By making the propeller hollow, an enormous amount of weight is saved. This becomes important at the huge speed with which these propellers revolve, even when geared down to 200 to 250 revolutions per minute. When the propeller skeleton is finished, it is covered with a 'tungsten-molybdenum' steel sheet, which is welded to the framework in such a manner as to make the entire propeller integral; and it becomes, in fact, almost a solid steel propeller of tremendous strength…"***
***Hugo Gernsback,*** **November 1934**

588

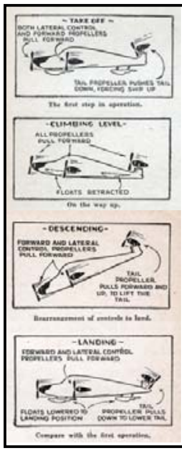



*"…In the November, 1932 issue of Everyday Science and Mechanics, I presented a gigantic flying liner, which had two huge pontoons to support the upper structure. Liners of this kind are under construction this very minute, although not of the very large size which I visualized in 1932, yet we are getting there gradually. There is one disadvantage with this type, however, and that is the two pontoons offer a tremendous air resistance. In the design which I present herewith, I still use the pontoons; but I have made them retractable; so that, as soon as the airplane has taken off, they will be pulled into the body of the airliner, where they will no longer offer air resistance. This is accomplished by pneumatic-hydraulic action when the machine has to land in water…"*
***Hugo Gernsback*, Nov. 1934**

589

*"…The outstanding novelty of my present design, however, is in the dynamic controls of the airliner. In the normal airplane, we have the movable wing surfaces or ailerons for banking and turning the plane, as well as the tail and rudder to guide it in the various directions. In the present design, I have done away with these entirely, and used propellers for these purposes entirely. A number of small 'line' illustrations show the principle…"*
***Hugo Gernsback*, November 1934**

590

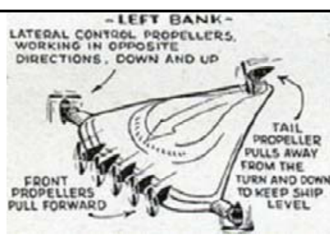



*"…The tail becomes a huge 75-foot propeller, which is arranged in such a way that the propeller can point either forward, sideways, up, or down. The direction of the propeller is, of course, handled by controls from the bridge of the airliner. Similarly, the ailerons, which are now used to tip or bank the machine, are dispensed with; and we now have huge propellers with engines which also can be either raised or pointed down, or sideways, or in any direction the pilot finds necessary…It will also be noted from the small illustrations that the stern propeller, as well as the side propellers, can be used to assist the airliner in rising, as well as descending. The rear propeller, indeed, by reversing its rotation, that is, by turning it around completely, is used very nicely to act as a brake in order to check the flight of the machine entirely…"*
***Hugo Gernsback*, November 1934**

591

*"…By means of this 'dynamic control' it should be possible to fly such a machine in any kind of weather or storm; because the machine will be too heavy to be influenced by anything except a typhoon. Any ordinary wind or storm would not much affect a 10,000-ton weight in the air…"*
***Hugo Gernsback*, November 1934**

592




*"…In the interior of the airliner, we again are using steamship principles. Instead of having separate engines for each of the huge propellers, we have two main power plants located forward in the machine. These power plants, as will be noted, each operate a set of propellers, which are geared down. Each power plant, therefore, is responsible to furnish power for one set of propellers; and should one plant break down, an arrangement is made whereby all propellers can be driven from the other when necessary. The rear propeller, from its large size, requires a power plant of its own, and is, therefore, independent of the forward propellers…"*
***Hugo Gernsback*, November 1934**

593

**Caption: "How the 'dynamic controls' work"**

*"…The future airliner of this type, in order to be commercially feasible, must make at least 200 miles an hour, and possibly a higher speed. It will probably fly at an altitude above 20,000 feet for maximum efficiency…There is no question that an airliner of this type will prove a formidable competitor to steamships in the future…"*
***Hugo Gernsback*, November 1934**

594

## The Stratosphere's the Limit

595

**ALLAN LOCKHEED supplies the nation's premier flyers – Lindbergh, Earhart, Hawks, Post, Wilkins - with Lockheed planes for their record feats. This pioneer of early aviation, now active on design work for air transports of the immediate future, contributed many of the ships that today are burning up commercial airline schedules and cutting air mail time in half. Consequently the words of Allan Lockheed, today one of the outstanding individual technicians of aviation, are of more than usual significance when he deals with the problems of flying airplanes in the stratosphere. This article on the stratoplane of the future tells how huge double-decked planes will speed through the rarefied air from coast-to-coast in six hours.**
***Modern Mechanix,* April 1935**
**RE: introduction to an article authored by aviation pioneer *Allan Lockheed* entitled: "Building Stratosphere Air-Liners"**

596

## Pros and Cons

597

***"WHY fly in the stratosphere? Simply because there's a free 200 mile an hour boost up there that aeronautical engineers want to take advantage of. If one could plan a railway that would run down hill all the way from coast-to-coast, think of the transcontinental speeds he could attain…"***
***Allan Lockheed,* April 1935**

598

***"…Flying in the stratosphere is not as simple as building a downhill railway, but it is a subject which has intrigued airplane designers for a long time. Much data has been accumulated about it. Many rumors have seeped through the daily press about the wonderful trans-oceanic speeds we are going to get. All that is in the offing. Right this minute, however, enough material has been accumulated through pioneer experiments and flights to turn the minds of those of us who are engaged in the business of developing airplanes toward the possibility of building a stratosphere plane today. Under existing conditions, with existing materials, we plan to double our present speed by the simple expedient of welding this 200 mile an hour stratosphere boost to our cause…"***
***Allan Lockheed,* April 1935**

599

***"…Up in the stratosphere - that layer of air between 50,000 and 75,000 feet altitude - there are steady winds that blow from West to East, opposite the direction of the earth's rotation. By these winds alone we can gain a measurable increase in our overland speed. But there is another factor. As we ascend, the density of the air becomes less and less. This eventually diminishes to a point where we have gained the effect of reducing our fuselage and wing drag; which is the same as saying we have reduced our wing surface to the minimum. At the same time, through supercharging or forcing air into the carburetor to increase performance, we have maintained our motor power output. The result is naturally a big jump in speed…"***
***Allan Lockheed,* April 1935**

600

***"…The only justification for stratosphere flight is velocity. If two points are so close together that an airplane could reach one point from another in less time than it would take to climb into the stratosphere, go the distance and descend, there will be no need for stratosphere lines. But the coast-to-coast route is a logical objective! Volume of traffic in paying quantities and the great time to be saved create a demand for such service…"***
***Allan Lockheed,*** **April 1935**

601

***"…Since the eastern trip will take about 6 hours under top conditions, probably the airline men will loaf from Los Angeles to New York, taking 8 hours. Then by speeding the ship up against headwinds, they can maintain the same schedule going west to the coast. Here it will be a matter of psychology in balancing public feeling so that the traffic will be as heavy one way as the other…"***
***Allan Lockheed,*** **April 1935**

602

## The Ultimate Airplane

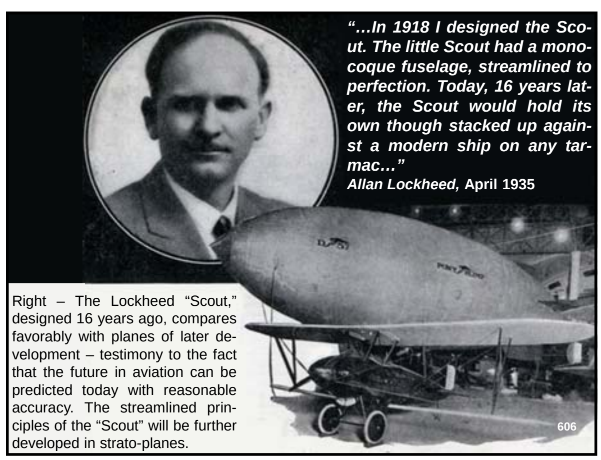
603

***"…But I'm getting a bit ahead of myself. I talk just as though the stratosphere airliner were an accomplished fact. To me it is. I've carried all the probabilities around in my mind's eye until I can recite them backwards. Cleopatra could have had an automobile, you know. At that time all the materials existed which were necessary for the construction of the car. We can have a stratosphere plane if we want it; and we know how to build it and what it will look like…"***
***Allan Lockheed,*** **April 1935**

604

***"…I'll tell you what the plane will look like, and why it will be constructed the way it will. Confidence in this prediction is based on the fact that my early ideas have stood the test of time. Some of the designs I did ten and twelve years ago, radical at the time, can now hold their own with ships of conventional 1934 design. Working closely with aviation problems, things I have seen at an early date have later come to pass with considerable accuracy…"***
***Allan Lockheed,*** **April 1935**

605



***"…In 1918 I designed the Scout. The little Scout had a monocoque fuselage, streamlined to perfection. Today, 16 years later, the Scout would hold its own though stacked up against a modern ship on any tarmac…"***
***Allan Lockheed,*** **April 1935**

Right – The Lockheed "Scout," designed 16 years ago, compares favorably with planes of later development – testimony to the fact that the future in aviation can be predicted today with reasonable accuracy. The streamlined principles of the "Scout" will be further developed in strato-planes.

606


*"…In 1926 I organized the Lockheed Aircraft Corporation. The fuselage construction used in the Scout - the plywood monocoque - was improved upon in detail but not in principle, and we commenced manufacture of the Lockheed Vega. This ship did big things. It was aerodynamically clean, a fact which can be attributed to the idea of building the plywood fuselage in a concrete mold. The resulting streamline fuselage has not been amenable to improvement. The fuselages of the ships that are cutting airmail times in half today are built on forms of a principle laid out 16 years ago!…"*
***Allan Lockheed,* April 1935**
**<u>Caption</u>: "The Lockheed Vega Winnie Mae flown by Wiley Post, set a round-the-world speed record in 1931"**

607

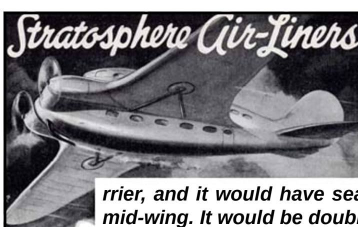
608

***"…Right back into the stratosphere again! We can build a ship for it now. We'll be flying it within a very few years; possibly months. And the speeds, the comforts, the unusual travel factors introduced by actual 400 mile an hour speed will put the stratosphere transcontinental air-liner in a class where it will make today's airmail planes look just as sad as today's ships, today's comforts and progress make the old DH-4 Liberty airmail planes look…"***
***Allan Lockheed,* April 1935**

609

***"…The present twin-motored transports are 60 to 80 feet in span, and 40 to 50 feet long. For stratosphere flight a plane would have to be a real passenger carrier, and it would have seats above and below the mid-wing. It would be double decked, so to speak. It would be more than 100 feet in span, and over 60 feet in length. Those are the major outward differences. Inside the ship is where most of the radical engineering departures will be seen. Why the changes?..."***
***Allan Lockheed,* April 1935**

610




***"…The present twin-motored transports are 60 to 80 feet in span, and 40 to 50 feet long. For stratosphere flight a plane would have to be a real passenger carrier, and it would have seats above and below the mid-wing. It would be double decked, so to speak. It would be more than 100 feet in span, and over 60 feet in length. Those are the major outward differences. Inside the ship is where most of the radical engineering departures will be seen. Why the changes?..."***
***Allan Lockheed,* April 1935**
**<u>Caption</u>: "A double-decked passenger plane following Lockheed's design for Stratosphere air-liners. Note the 'in-line' type motors faired into the wings, the retractable landing gear, and the wings set in the middle of the ship."**

611

***"…Take today's airplane up to 50,000 - 75,000 feet (supposing you could get it there) and what would happen? A number of ridiculous things. For one thing, the engine would slow down and die. If you happened to supercharge it so it could breathe sufficient air to burn a normal amount of gas, it would run away with the propeller and would wind up at a fearful rate, probably breaking a crankshaft and throwing connecting rods all over the countryside. It would be a problem to keep the motor warm. Oils, to be effective, must run at 350-450 degrees, and the cylinders themselves must be that warm to obtain thermal efficiency from the gasoline heat energy which is doing the work…"***
***Allan Lockheed,* April 1935**

612

***"…The tires of an ordinary ship would probably blow out. The people in the cabin would suffer the bends - a nausea and bleeding due to insufficient oxygen and deficient air pressure. And the ship itself would load up with a ton of ice in no time…"***
***Allan Lockheed,* April 1935**

613

***"…What is more, the ordinary airplane of today could travel only in one direction. A 200 mile an hour airplane could make it overland at 400 miles an hour from California to New York. Then when it had performed the phenomenal feat of going from Los Angeles to New York in 6 hours, it could make the return trip quicker by coming back to Los Angeles via London, Constantinople and the Hawaiian Islands! That is because a 200 mile an hour ship flying against a 200 mile an hour wind stays in the same spot…"***
***Allan Lockheed,* April 1935**

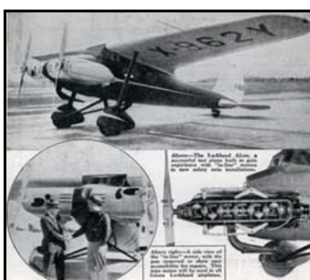
614

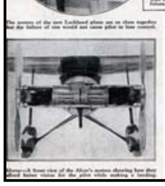
***"…Temperatures are way down, about 50 degrees below zero F. - this means we've got to build a flying ice box to keep the passengers warm. And we must keep the engines warm – normal operating conditions must be artificially supplied. We'll have to design something that will take the ice off wings as fast as it is formed. The sweating of windows, the forming of fog within the cabin, all will have to be accounted for by a separate de-icing, cabin warming, pressure furnishing plant that will run independently of the main motors…"***
***Allan Lockheed,* April 1935**

615

***"…This pressure furnishing feature will probably have to function in the manner of the air conditioner. It will not do to use air bottles, because they are too heavy. The cabin space must be a chamber which has intakes and exhausts for conditioned air. The link between the cabin and the outer air will be a conditioning plant. Because of the low pressures, variable area as well as variable pitch propellers will have to be used. Such devices on the business end of an engine will be comparable to the gear shift on a car…"***
***Allan Lockheed,* April 1935**

616





***"…Purely in the matter of borrowing from terrestrial aviation what appears to be good practice, I would use two motors in my stratosphere plane design. They would be supercharged, air cooled, and of the in-line type. This type is slightly cheaper to manufacture, is more robust, and easier to service. The major qualifying point which is now bringing such motors back into their own is that they streamline into a wing so well…"***
***Allan Lockheed,* April 1935**
**Caption: "In-line type safety motors will feature in new stratosphere planes"**

617

***"…By putting the wing at the middle of the fuselage, making it a mid-wing ship, streamlining the motors into the wing, and allowing a retractable landing gear which can be folded to the wings to lessen air resistance, we will arrive at the design of the ultimate airplane…"***
***Allan Lockheed,* April 1935**

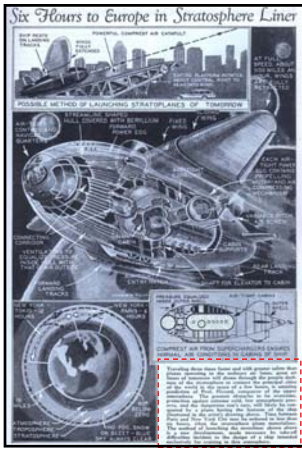
618

***"…Yes, that stratosphere ship will be unique - a flying wing that will whisk people about so rapidly they'll scarcely need to eat from coast to coast. We may have to educate a new breed of passenger, but the knowledge, materials and men to build and fly the stratosphere air-liner are here - right now!"***
***Allan Lockheed,*** **April 1935**

619

**Through the Purple Darkness**

620




Traveling three times faster and with greater safety than planes operating in the ordinary air lanes, great air liners of tomorrow will drone through the purple darkness of the stratosphere to connect the principal cities of the world in the space of a few hours, is amazing prediction of Prof. Piccard, conqueror of the upper atmosphere. The greatest obstacles to be overcome, protection against extreme cold, low atmospheric pressure, and the dangerous sun's rays, will likely be conquered by a plane having the features of the ship illustrated in the artist's drawing above. Time between Paris and New York City may be reduced to less than six hours, when the stratosphere plane materializes. The method of launching the stratoliner shown above is a new development, made necessary by take-off difficulties incident to the design of a ship intended exclusively for cruising in thin atmosphere.
(*Modern Mechanix,* April 1933)

621

**Paper Prophecy(?)**

622

***"FIVE hours out of New York and the flasher lights of the Central London Air Terminal are blinking their welcome to the Trans-Oceanic express as it glides to a swift, effortless landing. Five hours out of New York! This and similar pictures of future transportation have been painted ever since man first flew, but today it can be said that this is no idle fancy or paper prophecy. Even the most casual review of various activities in the United States, Great Britain and France show the vast number of experiments that are now being conducted towards this very end…"***
***Modern Mechanix,*** **May 1936**

623

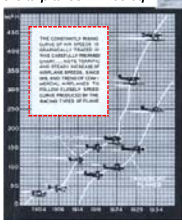
***"…Whether the final success of trans-oceanic flying lies in the development of huge flying boats such as the 'China Clipper,' or in some radically different type of boat is a question no truly progressive engineer would care to answer. This much they will say - that speeds of 500 miles an hour or more must be regarded as commonplace…"***
***Modern Mechanix,*** **May 1936**

624

*"…Fantastic and dangerous as such speeds appear to us now, it must be remembered that 20 miles an hour was regarded as being equally dangerous not so many years ago. The entire history of the motor car and airplane has been one of increasing speed. Again; the history of car and plane alike points to the fact that speeds developed in racing models are rapidly transferred and absorbed by the commercial patterns. So swift has commerce been to adapt the lines of speed planes that today in the United States there is the extraordinary situation of regular air liners being miles faster than the majority of the world's best military pursuit planes. Racing planes are now assaulting the 500 miles per hour mark. It is reasonably certain that the time is not fare off when purely commercial planes will be equaling if not actually surpassing this figure. That speeds like this will be attained with the conventional plane of today with it's numerous power plants strung like beads along the large-spanned wings is dubious. What is more likely and probable is the gradual improvement of wing sections (which is constantly in process) attaining a point whereby it will be possible to dispense with a great deal of the area now essential to safe flight…"*

***Modern Mechanix,* May 1936**

**Above: caption: "With wings reduced to a minimum this trans-oceanic plane is planned to span the Atlantic in five hours. In place of numerous motors blanketing over-sized wings, this craft uses a single power plant installed in the hull to drive a series of small, variable pitch blades constantly revolving about the circular ship"**



**Caption: "The constantly rising curve of air speed is carefully traced in this carefully prepared chart…note terrific and steady increase of airplane speeds since 1919 and trend of commercial airplanes to follow closely speed curve produced by the racing type of plane"**

625


***"…Then; what today forms the predominant portion of a plane may well become a mere rudimentary member with, possibly, extensible surfaces for landing and other maneuvers which involve reduced speed. As a matter of plain fact the whole tendency of wing design today is directed towards this goal as pictured on the cover. To bring New York within five hours of London would mean a facility almost beyond our imagination. Other complications, such as the continual threat in times of war to countries erstwhile virtually isolated, would attain fantastic proportions."***

***Modern Mechanix,***
**May 1936**

626

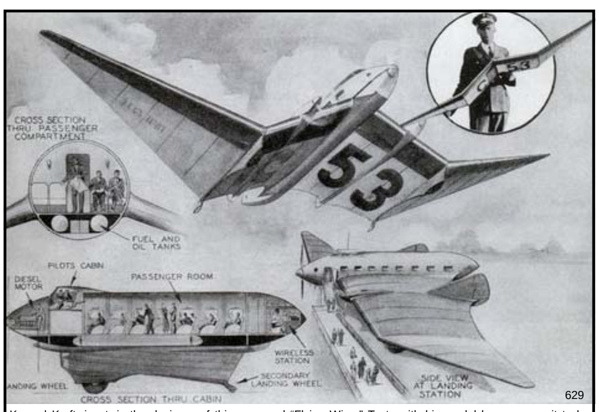
## The Flying "W"

627

**Odd-shaped "Flying Wing" Is Model For Proposed Sky Liner**

KONRAD KRAFT, a young engineer of Thuringia, Germany, has invented a radically new type of airplane in which the wing surface is broken into the form of a W for greater stability in flight. Using a model with a wing span of 2,200 millimeters and a depth of but 280 millimeters Kraft proved that his design was not affected by side winds, and would climb more rapidly than other models. He plans to use his design for a great tri-motored plane having landing wheels in the wing angles and a roomy passenger compartment between the wings. Fuel would be carried in tanks in the hull. (*Modern Mechanix,* July 1936)

628




629

Konrad Kraft, inset, is the designer of this proposed "Flying Wing." Tests with his model have proven it to be unaffected by side winds because of angular construction of wings. It is also reported to require less space for taking-off. Drawings show the arrangements of motors, cabins, landing gear and rudders of proposed sky liner.

## Rumpler's Folly

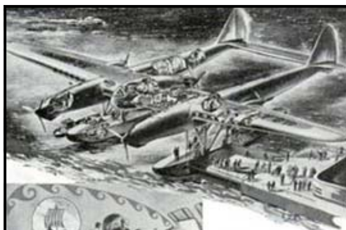
630

***"Give me wings large enough and sufficient motive power and I'll take the earth for an airplane ride."***
***Dr. Edmund Rumpler***
**RE: flying across the Atlantic in a giant airliner was the dream of Austrian engineer *Dr. Edmund Rumpler*. Builder of the well-known "Taube" series of WWI fighters (designed by *Igo Etrich*), Dr. Rumpler also saw the utility of a large wing to house passengers, cargo and engines. However, he did see a limit to increasing the span and size of airplanes designed according to conventional practice. If aircraft progressed in size beyond a certain limit Rumpler theorized, the weight of wings increased out of proportion to the increased size of the airplane. In other words, the larger the airplane, the smaller its payload capacity and range. Dr. Rumpler believed that weight could be kept within reasonable limits if it were distributed evenly over the wing span instead of being concentrated in a single fuselage. His plan was to arrange a number of small airplanes side-by-side and join their wings. The larger aircraft that evolved would have high load capacity and very long range. Rumpler shared only some of the theories advanced by the purists; he advocated eliminating the fuselage, but retained the tail surfaces. Rumpler publicized his concept of a transoceanic airliner in 1926 and, over the next four years, worked on the detailed design while searching for financial backing.**

631

**Above: the all-metal, twin-hulled *Rumpler Flying Boat* was to have a single wing with a span of 289-feet and a height of 8-feet at its thickest point. Sixty-five tons of fuel would be carried in the twin hulls; fuel would be fed by pumps to ten 1000-hp engines which would give the gigantic craft a cruising speed of 185 mph. The accommodations for the thirty-five man crew and 135 passengers were lavish. Cabins were to be situated in the wing interior at the leading edge. Cabins would seat six, each with a breathtaking view forward. A wide passageway extending the entire span of the wing would separate the passenger cabins from the engine compartments at the trailing edge. The passageway, over six feet high, would serve as a promenade deck as well as sound buffer for the passengers. Dr. Rumpler planned to build an entire fleet of these boats to ply the oceans of the world. However, like so many similar schemes, the Rumpler "Double Flying Boat" was only a paper airplane. Rumpler failed to gain the necessary funds for the project at home and/or abroad and was not in favor with the German government after the Nazi's rise to power.**

632



***"Passenger accommodations aboard a super-clipper planned for transatlantic service will offer new luxury in air travel. The huge plane, literally a flying wing, will have a dining saloon and promenade in two-sections, each connected by a cocktail lounge and an observation deck. Observation windows in the leading edge of the wing will afford an excellent forward view. The two sections will have comfortable accommodations for fifty people, so that meals may be served quickly. The clipper is designed to carry a payload of 43,000 pounds and to accommodate 120 passengers…"***
***Popular Mechanics,* July 1938**
**Caption: "…Below are the lounge-observation room in the leading edge of the 'flying wing,' affording direct view ahead for passengers, and control room in central gondola"**

633

***"…A crew of sixteen will operate the great craft, which will have a cruising range of more than 5K miles and a minimum cruising speed of 250 miles per hour. Supercharging will permit flight at high altitude. Passengers will be housed in the 250-foot wing, which is large enough to afford particularly spacious quarters. Attached to this wing will be two large fuselages or outriggers for housing retractable landing pontoons and supporting the tail surfaces. Hydraulic mechanism of the pontoons will perform the dual function of a retractable device and a shock absorber, so that the ship will be able to weather seas that would be disastrous to the conventional flying boat. Eight engines will propel the plane. The control room will be situated in the central gondola, permitting full view for captain and pilots and affording ample working space on the bridge for radio officer and chief engineer…"***
***Popular Mechanics,* July 1938**

634

## Beachhead Flying Boat

635


***"Giant twin-hull flying boats, weighing 250 tons or more may be the amphibious craft for beach landings on hostile shores in future wars. Such huge seaplanes could carry 1,000 men plus equipment, would fly at speeds approaching the top speeds of the fastest land aircraft, and upon approaching a hostile shore would land in the water, taxi up to the beach and open armored bow doors to discharge their troops…"***
***Popular Mechanics,***
**September 1949**

636

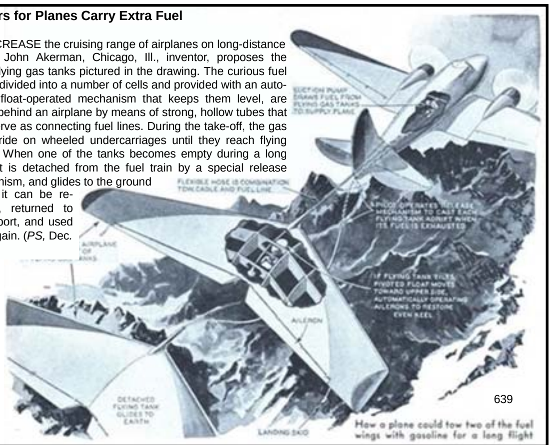
637

## In-Flight Refueling

638

**Trailers for Planes Carry Extra Fuel**

TO INCREASE the cruising range of airplanes on long-distance flights, John Akerman, Chicago, Ill., inventor, proposes the novel flying gas tanks pictured in the drawing. The curious fuel wings, divided into a number of cells and provided with an automatic, float-operated mechanism that keeps them level, are towed behind an airplane by means of strong, hollow tubes that also serve as connecting fuel lines. During the take-off, the gas wings ride on wheeled undercarriages until they reach flying speed. When one of the tanks becomes empty during a long flight, it is detached from the fuel train by a special release mechanism, and glides to the ground where it can be retrieved, returned to the airport, and used over again. (*PS*, Dec. 1938)




639

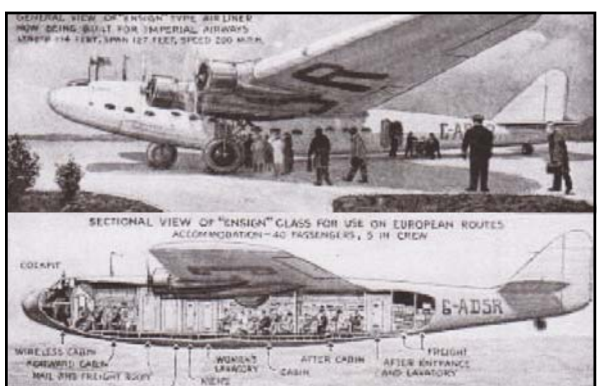
## Part 8

## The Four-Engined Era

640

## Ensign Class

641




**Fleet of Big Air Liners to Fly British Routes**
Top and bottom, giant land plane being constructed for Great Britain's European routes. (*Popular Mechanics,* May 1937)

642

## Around the Corner

643

**Tomorrow's airplane land transport is described by engineers as having a gross weight of about twenty tons, a useful load of about six tons, a flying range of 1,250 miles, and a speed of 225 miles-per-hour on two engines. For water transport, the principal development is increased size. The two major clipper-ship builders of America, Glenn L. Martin and I.I. Sikorsky, have plans ready for the immediate construction of clipper ships twice as large as the "China Clipper."**

***Popular Mechanics,*** **September 1937**

**RE: introduction to an article entitled: "AROUND the CORNER in AVIATION"**

644

## Comparing Favorably

645

***"…SIKORSKY declares that he can begin production on a sixty-ton ship with a range of more than 4,500 miles and a speed of not less than 160 miles-per-hour. This permits a non-stop flight across the Atlantic in about twenty-four hours. She will carry a payload of ten per cent of her gross weight, amounting to 12,000 pounds. This figure compares favorably with the payloads of first-class steamships and railroad trains. Sikorsky's plans provide luxurious accommodations for fifty passengers, including dining saloon, galley, smoking lounge, and luggage space…"***

***Popular Mechanics,*** **September 1937**

646

***"…Details of the projected superliner have been worked out carefully in Sikorsky's factory. In this double-deck transport, the dining saloon amidships will have seats for twenty people and enough room to spare for a dance floor. From the dining saloon a staircase will lead to a 'flying balcony' with a bar and cocktail lounges recessed into the wings, from which one may observe the ground through windows…"***

***Popular Mechanics,*** **September 1937**

647

## Wing Loading

648

***"…One of the prime considerations in building aircraft is the factor called 'wing loading.' You can figure out the wing loading of an airplane if you divide its gross weight by its wing area. For example, if you have an airplane with a gross weight of 100,000 pounds and a wing area of 5,000 square feet, its wing loading is equal to twenty pounds per square foot…"***

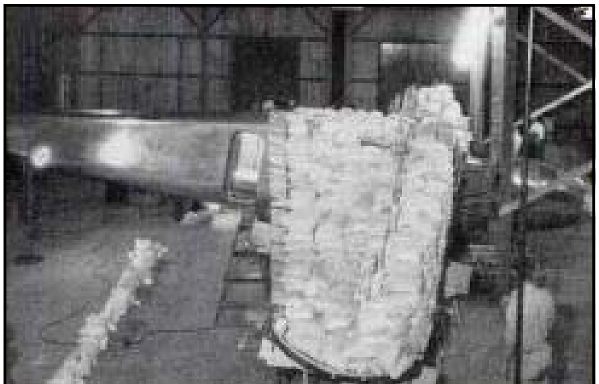
***Popular Mechanics,*** **September 1937**

649

***"…Plainly, the weight of an airplane in the air is supported by the wings. Their efficiency depends largely on their shape and area. Naturally, the smaller the wing, the lower the air resistance. Designers have striven for years to reduce the relative dimensions of wings, and thereby increase efficiency…"***

***Popular Mechanics,*** **September 1937**

650



**Caption: "Static load test of a new Lockheed. Plane is inverted and sandbags weighing far in excess of any weight the plane will carry are placed on the wings."**

651

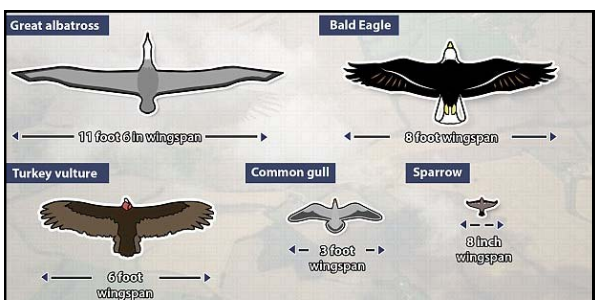
***"…Aside from aerodynamic improvements, higher wing loading increases stability in flight. In other words, wing loading gives an airplane greater protection in rough air and stormy weather. This implies that air-sickness may be banished on the flights of ocean transports…"***

***Popular Mechanics,*** **September 1937**

652

## Look to Nature

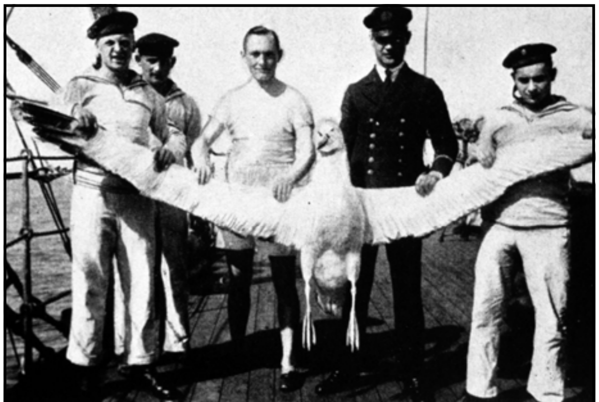
653




***"…'An interesting illustration of this super-stability idea may be observed in nature,' says Mr. Sikorsky. 'The large ocean flying birds have a much heavier wing loading as compared to birds of similar size and weight that live on land. Because of their wing loading, ocean birds have an extraordinary ability to remain in the air for longer periods, even in stormy weather'…"***

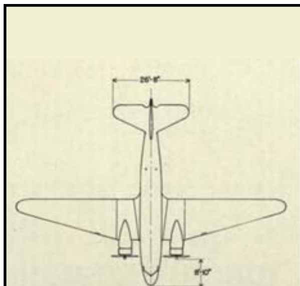
***Popular Mechanics,*** **September 1937**

654

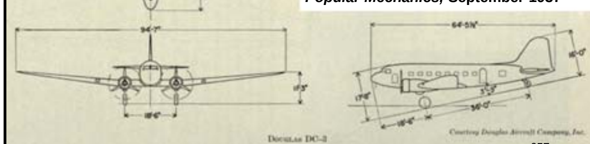


Caption: "This albatross was caught by the crew of the German survey vessel *Meteor* in the 1920s; its wingspan measured more than 9-feet" 655

656



***"…To show what progress has been made in wing loading we recall that only a few years ago the wing loading of transport planes was ten pounds per square foot or less. Those transports behaved like broncos in rough air, and many a passenger came down to earth with a vow of, 'Never again!' The present Douglas DC-3 transports have a wing load of twenty-four and three-tenths pounds, which gives them remarkable stability in flight…"***
***Popular Mechanics,*** **September 1937**

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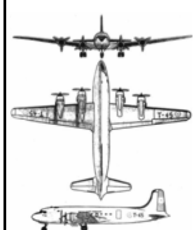


***"…The Douglas DC-2 had a wing loading of nineteen and four-tenths pounds. The new Douglas DC-4, whose development is sponsored by the five leading American domestic air lines, most probably will have a wing loading greater than twenty-five pounds when it goes into service before the end of 1937…"***
***Popular Mechanics,*** **September 1937**
**Caption: "Douglas DC-4 views"**

658

***"…Sikorsky, who has done much research in wing loading, foresees that it will soon be raised up to forty pounds per square foot. Tomorrow's fifty-five and 100-ton transports may be expected to be quite stable in stormy weather…"***
***Popular Mechanics,*** **September 1937**

659

**Less is More**

660

***"…For more than ten years aircraft engineers have been studying the possibilities for larger commercial transports. The multi-engined 'DO-X' was a colossus, but did not live up to expectations. For the time being, designers have definitely receded from the idea of having as many as twelve engines…"***
***Popular Mechanics,*** **September 1937**

661

***"…A reduction in the number of engines is now made possible by the recent increase in horsepower. Within the next five years we may see aircraft engines weighing less than one pound-per-horsepower. Fuel consumption will be reduced to thirty-five hundredths pound per brake horsepower-per-hour, as compared with fifty hundredths or forty-five hundredths pound at present. Liquid-cooled engines will also be much improved…"***
***Popular Mechanics,*** **September 1937**

662

## More is Less

663

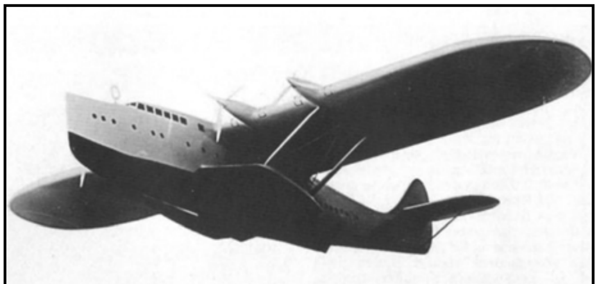
***"…Besides the 'DO-X,' which has been retired from active service, another outstanding giant experimental plane was the 'Maxim Gorki,' built in Russia. It met with disaster when it collided with a small airplane…"***
***Popular Mechanics,*** **September 1937**
**RE: the *Tupolev ANT-20* "Maksim Gorki" was as an eight-engine aircraft constructed between July 1933 and April 1934 and was one of two aircraft of its kind built by the Soviet Union. With a wingspan similar to that of a modern *Boeing 747*, it was not exceeded in size until the *Douglas XB-19* heavy bomber prototype first flew in 1941.**
**Above: on May 18, 1935, the *Maksim Gorki* took-off for a demonstration flight over Moscow with three aircraft flying close to make evident the difference in size. The accompanying *Polikarpov I-5* fighter had performed two loop manoeuvers around the Maksim Gorki, but on the third loop, they collided. Forty-five people were killed in the crash, including the fighter pilot as well as both crew members and the 33 passengers on the Maksim Gorky and an additional nine people on the ground.**

664

665


***"…The largest heavier-than-air craft now operating is the 'Lieutenant Vaisseau' of Paris whose gross weight loaded is 81,400 pounds. It weighs thirty-seven tons unloaded. This transport crossed the South Atlantic ocean once and flew north to Miami, where she capsized but was salvaged…"***
***Popular Mechanics,*** **September 1937**
**Caption: "Giant French flying boat 'Lieutenant Vaisseau of Paris,' which weighs thirty-six and one-half tons, has six motors and passenger capacity of seventy-two"**

666



***"…What is believed to be the greatest heavier-than-air craft now building is the 'DO-20' under construction by the Dornier company, designers of the 'DO-X.' The 'D0-20' is an eight-engined monoplane and will have fifty-eight tons gross weight…"***

***Popular Mechanics,*** **September 1937**

**<u>Caption</u>: "Dornier Do-20"**

667

***"…It is reported that Pan American Airways has contracted for six forty-one-ton clippers with the Boeing company. These will be about fifteen tons heavier than the 'China Clipper,' the largest flying boat constructed in America to date…"***

***Popular Mechanics,*** **September 1937**

**RE: the *Boeing 314 Clipper* was a long-range flying boat produced between 1938 and 1941**

**<u>Caption</u>: "A Boeing 314 flying low over the water"**

668


***"…The famous 'Brazilian Clipper,' which set numerous flight records, weighs nineteen tons. The Douglas 'DC-2' weighs about nine tons loaded…"***

***Popular Mechanics,*** **September 1937**

**<u>Above</u>: the S-42 (1934) was Sikorsky's response to PAA's call for a transatlantic passenger airliner. Despite the aircraft's impressive 1,100-mile range, it was unable to successfully make long-haul flights over the ocean and was used instead to fly travelers to South America in half the time of its typical competitors. Given the lack of airfields available to commercial airliners, at the time, the flying boat was an ideal alternative.**

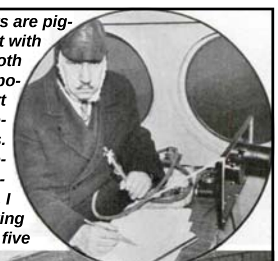
669

670

## More is More

671

***"…It appears that present-day transports are pigmies compared to what can now be built with available knowledge and materials. Both Sikorsky and Martin hold that a million-pound, thousand-passenger sky transport could be built. Such a vessel could cross the Atlantic in twenty-four hours. 'But,' says Sikorsky, 'a 500-ton ship would naturally reduce the frequency of schedules. So I do not look for such sizes. I do, however, predict land planes and flying boats of fifty to 100 tons within the next five years'…"***



***Popular Mechanics,*** **September 1937**

**<u>Caption</u>: "Circle, designer Sikorsky in flying laboratory. Bottom, one of the four-motored Boeing bombers being built for U.S. Army. It has 105-foot wingspread and weighs sixteen tons."**

672

## Speed and Comfort

673

*"…Sikorsky also foresees the boosting of speeds thirty to fifty miles-an-hour, establishing an ultimate practical operating speed of 200 miles-an-hour for flying boats and 250 miles-an-hour for land planes. Here again practical considerations, rather than engineering limitations, are foremost. At present, there is no good reason to have flying boats that travel five or six times faster than ocean greyhounds, or to have land planes that travel more than three or four times the speed of express trains…"*
***Popular Mechanics,*** **September 1937**

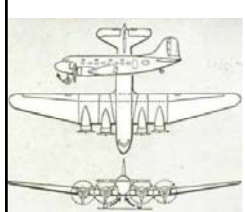
674

*"…After 200 and 250-mile-per-hour speeds have been attained, designers would give attention to more passenger comfort. High-lift devices and smaller engines with less cooling drag will reduce operating costs and increase comfort…"*
***Popular Mechanics,*** **September 1937**

675

**Caption: "Building the first all-metal transport – the 200-mile-an-hour Lockheed Electra. Here we see workmen busy on nose and wing."** 676


677



*"…Small diameter engines with wing radiators or blower cooling should enable transports to make the same speed with about thirty per cent less power. The direct operating cost per ton-mile of payload for tomorrow's airplane is figured conservatively at twenty-three cents."*
***Popular Mechanics,*** **September 1937**
**Caption: "How tomorrow's transport may be expected to look, complete to nose wheel, folding landing gear and smooth under surface"**

678

**Imagine**

679

**Imagine a rubber tire as high as an automobile and so heavy that three men can hardly lift it**
***Popular Mechanics,*** **February 1938**
**RE: introduction to an article entitled: "NEW GIANTS for the AIR LINES"**

680

**This is the Year!**

681

***"TIRES that size are being tested today for the giant four-engined passenger transports to be launched this spring. Each tire weighs 360 pounds, exclusive of the forty-five-pound tube. A pair costs nearly as much as a new car. The size of the tires alone will help give you an idea of how large these new planes are going to be…"***
***Popular Mechanics,*** **February 1938**

682

***"…The four engines will develop nearly twice the power of the average passenger locomotive and each plane will carry up to forty people, in addition to almost two tons of mail and express, which alone is more than the entire payload of most transport planes now in service…"***
***Popular Mechanics,*** **February 1938**

683

**Tangential Benefits**

684

***"…'Nineteen thirty-eight will mark the beginning of the four-engined era in overland air travel,' says C.L. Egtvedt, president of the Boeing Aircraft Company. 'The Model 307 land passenger transports under construction for TWA and Pan American have been preceded by the 'flying fortress' type of bomber adopted by the Army Air Corps. Many of the lessons and engineering principles learned in developing the big fighting plants are being incorporated in the new passenger transports'…"***

***Popular Mechanics,*** **February 1938**

**RE: the *Boeing Model 307* "Stratoliner" was the result of considerable R&D in high-altitude flying by test pilot *Tommy Tomlinson* of TWA. Cruising at 14K-feet, the Stratoliner cut two-hours off the DC-3's transcontinental time, reducing it to 13 hours, 40 minutes. Each aircraft cost $315K (in 1937). During WWII, Stratoliners were employed as C-75 military transports, flying principally to South America and across the Atlantic.**

685

**Above: the *Boeing Model 307* was the first fully pressurized airliner to enter commercial airline service. Able to fly 20K-feet higher than unpressurized airplanes of the era, it was said that it could "fly above the weather." It carried five crew members and 33 passengers and had a nearly 12-foot-wide cabin for overnight berths. The *Stratoliner* was also the first land-based airplane to have a flight engineer as a member of the crew. The Stratoliner first flew on December 31, 1938 and TWA put it into service on their transcontinental route on July 8, 1940. Including the prototype (which crashed on a test flight), only ten Stratoliners were ever built; three for PAA, five for TWA and a ninth for *Howard Hughes*.**

686

**Boeing's *Model 299* (prototype for the military bomber aircraft, which duly became the B-17 "Flying Fortress") was developed in parallel with a civil version of the same aircraft, which had the company designation "Boeing Model 300." The *Model 307 Stratoliner* was a straight-forward conversion from the successful B-17, employing the wings and tail surfaces of the *B-17C Flying Fortress.***

**Caption: "The Boeing Model 299 NX 13372 (XB-17), prototype four-engine heavy bomber"**

687

**Length**: 74 ft. 4 in.
**Wingspan**: 103 ft. 9 in.
**Height**: 19 ft. 1 in.
**Wing Area**: 1,420 ft²
**Empty Weight**: 36,135 lbs.
**Max Take-off Weight**: 65,500 lbs.
**Powerplant**: 4x Wright R-1820-97 "Cyclone" turbosupercharged radial engines, 1,200 hp each

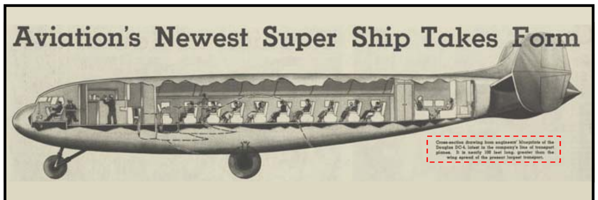
**Performance**
**Maximum Speed**: 287 mph
**Cruise Speed**: 182 mph
**Range**: 2,000 miles
**Service Ceiling**: 35,600 ft.
**Rate-of-Climb**: 900 ft./min.
**Wing Loading**: 38.0 lb/ft²

688

**689**

## Tricycle Planes

690




*"…Boeing is building eight of the super-transports and Douglas is at work on the first of a similar series. The Douglas will be the first large transport to have level landing characteristics, a nose wheel permitting the plane to land level with the ground so that sleeping passengers will not be disturbed at each landing…"*

***Popular Mechanics,*** **February 1938**

**Caption: "Cross-section drawing from engineer's blueprints of the Douglas DC-4, latest in the company's line of transport planes. It is nearly 100-feet-long greater than the wingspread of the present largest transport."**

691

**Here to Stay**

692

**The tricycle landing gear is here to stay. In three years this revival from the airplane's earliest days has proved its place in modern aviation, and virtually every category of airplane now has one or more types with this safe and simple form of landing gear.**

***The Chicago Tribune,*** **April 16, 1939**

**RE: introduction to an article entitled: "Tricycle Planes Arrive"**

693

**Advantage: Nose Gear**

694

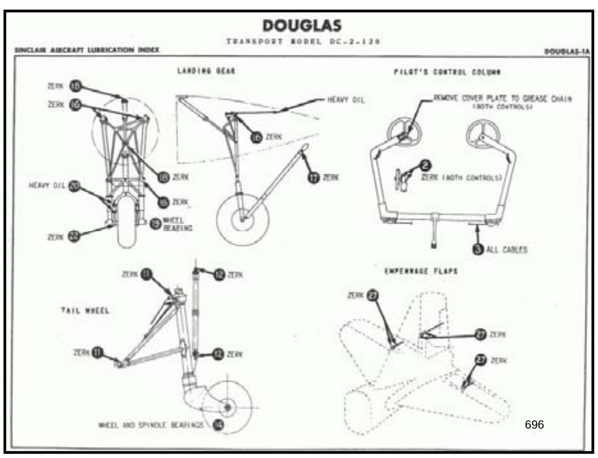
*"FLIGHT tests and experience have lulled the general suspicion that arises with both engineers and pilots when anything unusual is tried. Pilots like the tricycle gear because it permits them to make safe cross-wind landings, eliminates the dangers of nosing over, and, best of all, makes impossible the dangerous ground loop that has scored so many wing tips and smashed so many landing gear…"*

***The Chicago Tribune,*** **April 16, 1939**

**RE: for many years after the Wright brothers' first flight, nearly all aircraft had a tail wheel. The tail-wheel arrangement (a/k/a "Tail Dragger") was lighter, cheaper and lower drag (before landing gear were retractable) and more appropriate for landing on unprepared surfaces (i.e. farmers fields).**

**Above L&R: view/s of the tail wheel of the DC-3 at the *National Air and Space Museum***

695

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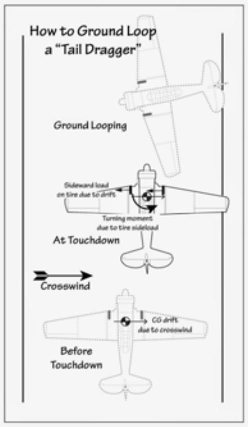



"Conventional" (tail-wheel) landing gear's only drawback was a lack of directional stability on landing rollout, which would sometimes result in what was known as a "ground loop," particularly if there was a crosswind (left). Tricycle landing gear with nose wheels were directionally stable on landing rollout and therefore less likely to turn ruin a pilot's day. Moreover, they provided an extra benefit on take-off for multi-engine airplanes. In the event of an engine failure in the take-off roll before the pilot raised the nose to lift-off, the nose landing gear provided increased directional control as compared to a tail-wheel, particularly if the tail wheel was off the ground for better acceleration. As a result, even before WWII, multi-engine bombers (i.e. ***B-24 Liberator***) and fighters (i.e. ***P-38 Lightning***) had nose landing gear.

697

698

**Bell Aircraft' single-engine P-39 had tricycle landing gear as well, in part because the engine was located behind the pilot, providing room for the landing gear in the nose. However, when *Bell* proposed a variant of the P-39 to the USN as a carrier-based fighter, one of the changes required by the USN was to include a tail-wheel in lieu of nose gear. The USN had evaluated a twin-engine airplane with a nose landing gear (the XJO-3) at-sea, in 1939 (above). Subsequently, all carrier-based multi-engine airplanes would have nose landing gear.**

699

**The USN also contracted with *Douglas* for two different single-engine torpedo bombers with nose landing gear during WWII; the BTD (above) and its big brother, the TB2D. "BT" meant that the plane's primary mission was as a dive or level bomber and its secondary mission was as a torpedo bomber; "TB" meant that its primary mission was as a torpedo bomber. The TB2D was to carry as many as four torpedoes, with its secondary mission as a level bomber.**

700

## Evolution of an Idea

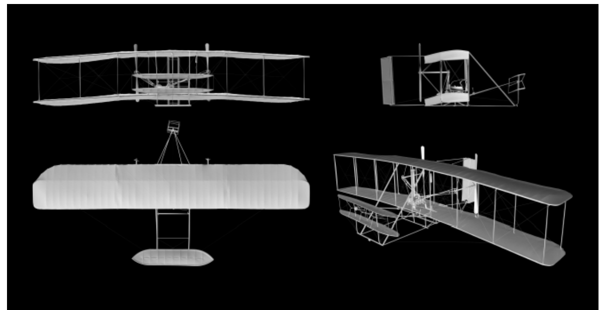
701

***"…The engineers who objected to this type of gear from the beginning because it demanded certain changes in the balancing of planes on the ground, and consequently demanded revisions of the placing of centers of pressure and gravity in the air, are now its most ardent disciples…"***
***The Chicago Tribune,*** **April 16, 1939**

702

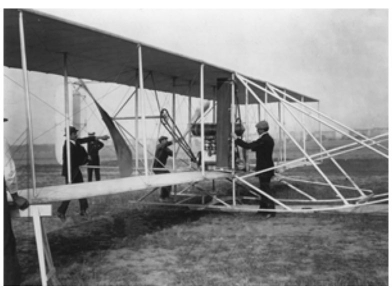
*"…It permits higher landing speeds with safety and thus makes possible better performance without power increases. And it prepares the way for the day when most airplanes will be pushed through the air by propellers acting behind the wing instead of pulled through the air by propellers ahead of the main lifting surfaces…"*
***The Chicago Tribune,*** **April 16, 1939**

703



*"…The Wright brothers in their earliest planes established the trend toward the nose wheel. On these ships, instead of wheels they used skids, and they had skids that extended far forward to the planes elevators, that were in the earliest models, ahead of the wings…"*
***The Chicago Tribune,*** **April 16, 1939**
**Caption: "As part of the Smithsonian's X 3D Collection, the 1903 Wright Flyer was scanned using a laser, producing an accurate 3D model"**

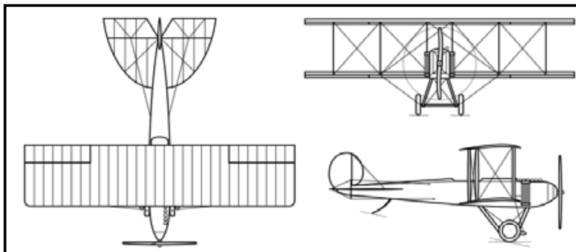
704



705

*"…When Glenn Curtiss added wheels to his airplanes the Wrights followed his example. Nose wheels were universal on all models until the vogue for tractor airplanes – those with motors and propellers ahead and with the rudder and elevators at the rear – forced designers to eliminate the nose wheel…"*
***The Chicago Tribune,*** **April 16, 1939**

706



**WRIGHT MODEL L (1916)**

First and last "second generation plane" from the *Wright Company,* the *Model L* was a single-seat tractor biplane with standard control surfaces which seems familiar to us in its general appearance. The Wright brothers idea was to make it a high speed military reconnaissance aircraft capable of reaching 80 mph. Critics would later say that greater speeds could have been achieved if the brothers would have deleted its oversized tail from the *Model K.* Its lack of streamlining and general drag made it, in the end, more sluggish that its competitors thus, the Model L failed to secure any orders by the military. The few produced were tested only. The Wright Company was acquired thereafter, but *Orville Wright* was retained as a consultant. In 1916, the brothers acquired the *Crane-Simplex Automobile Company* and the *Glenn L. Martin Aircraft Company,* which merged to form the *Wright-Martin Aircraft Corporation.*

707

## The Landing Manoeuver

708

*"…About five years ago, under the regime of Eugene Vidal in the old Bureau of Air Commerce, engineers began casting about for an ultra-safe plane. They finally decided that in addition to eliminating stall and spin they must simplify the landing manoeuver and stop ground looping…"*
***The Chicago Tribune,*** **April 16, 1939**

709

*"…Landing with a plane equipped with a tail skid or wheel is a sort of tight-wire balancing act. The plane is glided toward the ground, but before touching down the ship is flared off and held level until the speed begins to diminish. Then the nose is raised until just as the ship stalls the main wheels and the tail wheel touch together. This is a neat trick that takes a beginner weeks of practice to learn properly. Also it's a trick that cannot be performed in certain large airliners when their load distribution is unfavorable…"*
***The Chicago Tribune,*** **April 16, 1939**

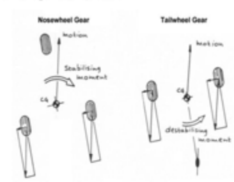
710

*"…With the nose wheel this delicate operation is eliminated. A plane is merely glided toward the ground and flared off enough to kill its speed. Then the nose wheel or the main wheels are allowed to touch and the brakes applied. The plane cannot nose over forward, and a very quick stop can be made…"*
***The Chicago Tribune,*** **April 16, 1939**

711

WHY TAILDRAGGERS SEEM SO HARD TO LAND

- CG IS BEHIND MAIN WHEELS
- WHEN MAIN WHEEL TOUCHES THE GROUND, AIRCRAFT DECELERATES
- CG KEEPS GOING AHEAD AND PIVOTS AROUND THE WHEEL CAUSING PLANE TO GROUND LOOP




*"…Ground loops are caused when the main mass of an airplane tries to get around in front of the main landing wheels. By putting the nose wheel on a plane and moving back the main wheels until they are behind the center of load the ground loop becomes impossible…"*
***The Chicago Tribune,*** **April 16, 1939**

712

**Theory Proven, Theory Applied**

713

*"…These theories were tried out first in the Stearman-Hammond pusher type plane and the earliest Welck high-wing pusher. The Stearman-Hammond was a successful machine, and from it the largest manufacturers in the country – Donald Douglas, Reuben Fleet of Consolidated, and others – learned lessons that have now been applied…"*
***The Chicago Tribune,*** **April 16, 1939**
**<u>Caption</u>: "Stearman-Hammond pusher plane that started the revival of tricycle gear as safety measure"**

714

***"…The DC-4, a forty passenger airliner that will be in service on the country's main air routes by 1941, has a nose wheel. So has the army's latest and certainly one of the world's fastest pursuit planes – the Lockheed XP-38…"***
***The Chicago Tribune,*** **April 16, 1939**
**Caption: "The Douglas DC-4 with tricycle gear down for a landing"**

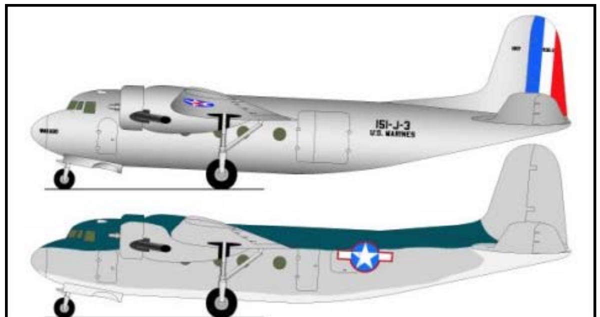
715

**Caption: "Lockheed XP-38 Lightning 37-457 at March Field, Riverside County, California, January 1939"**

716

## The Forgotten Douglas

717




***"…So successful has the nose wheel application on the DC-4 been found that the latest Douglas – the DC-5, a sixteen passenger twin-engine high-wing passenger plane with a top speed of 250 miles-an-hour – also has a nose wheel."***
***The Chicago Tribune,*** **April 16, 1939**
**Caption: "Douglas DC-5 civilian and military variants"**

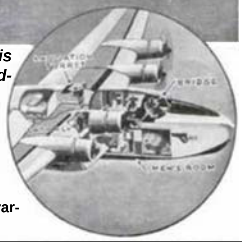
718

**Above: often referred to as "The Forgotten Douglas," the *Douglas DC-5* was the only "Douglas Commercial" aircraft to be designed and built in the El Segundo plant - the original home of the *Northrop Aircraft Corporation,* which *John Northrop* had set-up with the help of *Donald Douglas* in 1932. The aircraft was designed to meet a perceived need for a short-haul feeder liner to complement the *DC-3* being used on main routes with heavier traffic. It was to carry a crew of three and sixteen passengers, with the potential to carry twenty-two passengers in a high-density format. However, the type never was a commercial success; pilots complained about its flying characteristics, in particular the strenuous physical effort required to move the flight controls.**

719

## Ocean Liners of the Sky

720



***"…At the same time, Boeing is building half a dozen tremendous flying boats far larger than the land planes. These will be veritable ocean liners of the sky…"***
***Popular Mechanics,*** **February 1938**
**<u>Caption</u>: "Two sketches showing various details of the clipper ship"**

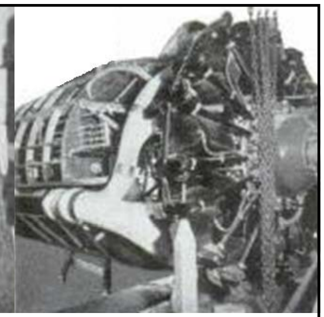
721

***"…At the Boeing factory in Seattle, where work on everything except four-motored airplanes has been discontinued, mechanics are swarming around huge hulls and are assembling gigantic wings that stretch from wall-to-wall. In other parts of the factory you find wood, metal, and cloth 'mock-ups,' full-scale facsimiles of the finished airplanes…"***
***Popular Mechanics,*** **February 1938**
**<u>Top</u>: caption: "Scaffolding allows craftsmen to work on hull at five levels"**
**<u>Bottom</u>: caption: "600-gallon wing tank"**

722

***"…One huge mock-up shows exactly what the exterior appearance of the new land transport will be. Another, looking like an unfinished motion-picture set on the outside, contains the complete cockpit and chart room of the new flying boat. A third represents a typical passenger compartment of the new land transport…"***
***Popular Mechanics,*** **February 1938**
**<u>Left</u>: caption: "Pilots and engineers studying mock-up of cockpit instruments and controls of the giant four-engine transport"**
**<u>Right</u>: caption: "Passenger compartment, as seen from center aisle"**

723



***"…Engineers, pilots, and department of commerce inspectors spend day-after-day in each of these structures, sitting in the seats, reaching for the controls, studying visibility, and suggesting minor changes…"***
***Popular Mechanics,*** **February 1938**
**<u>Left</u>: caption: "Engineers checking size of berth compartment"**
**<u>Right</u>: caption: "One of the giant engines installed in a wood and metal mock-up of nacelle"**

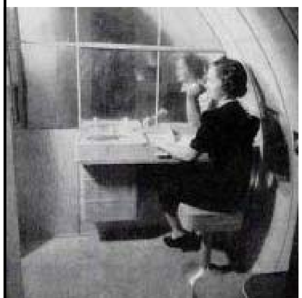
724

***"…The new overland passenger transports, which probably will go into service late in the summer, are to be all-metal low-wing monoplanes equipped with retractable landing gear and tail wheels. Perfect streamlining of the fuselage will give the planes the appearance of Zeppelins equipped with wings. Each plane will have a gross weight of 42,000 pounds, a wing span of 107 feet, a length of seventy-four feet, and will stand seventeen feet high. They will be powered with four 1,100-horsepower G-100 Wright Cyclones delivering a total of 4,400 horsepower…"***
***Popular Mechanics,*** **February 1938**

725

***"…In addition to a crew of four or five the transports will have accommodations for thirty-three passengers, or the interiors may be rearranged to carry twenty-five passengers on night flights, with sixteen passengers in sleeping berths and the others resting on reclining chairs…"***
***Popular Mechanics,*** **February 1938**

726



***"…Behind the enlarged cockpit and auxiliary control room is a passenger baggage compartment accessible in flight, and beneath the floor are large cargo compartments. A men's washroom is provided forward of the main passenger cabin, with a ladies' room and galley at the rear…"***
***Popular Mechanics,*** **February 1938**
**Caption: "Part of ladies' dressing room on plane being built for TWA"**

727

***"…At first appearance the cockpit of one of the new planes seems more complicated than ever before, but the instrument panels are arranged so that the pilot may control his plane with maximum ease. A compact group of flight instruments in front of the chief pilot's controls is duplicated by a similar set in front of the co-pilot. Between these two instrument groups is the automatic pilot panel with dials indicating the angle of the plane to the horizon and its direction of flight. Between the two pilot seats is a pedestal on which are mounted fuel and other engine controls and the controls that govern the automatic pilot…"***
***Popular Mechanics,*** **February 1938**

728

***"…The pilot may operate all four engines, either pair in the port or starboard bank, or any one engine individually, by means of hand controls. Overhead, above the cockpit's forward windows, are the ignition switches, light switches, and dials that show the position of the landing flaps and wheels. The radio operator will sit behind the chief pilot on the left side of the cockpit, reaching across to his instruments behind the co-pilot…"***
***Popular Mechanics,*** **February 1938**

729

## Sub-Stratosphere Operation

730

***"…These great airplanes are to be the first to be provided with sealed cabins for sub-stratosphere operation. Transports today have a passenger comfort ceiling of less than 14,000 feet. That confines them to altitudes containing rough air and dangerous mountain peaks. The new Boeings will be able to fly at 20,300 feet, far above rough air and the highest mountain peaks in continental United States, with the passengers enjoying the same comfortable air pressure that they would at altitudes of 8,000 to 10,000 feet, Two of the new planes will be equipped for this type of operation at the outset while the balance are being built so that the auxiliary pressure equipment can be installed at any time…"***
***Popular Mechanics,*** **February 1938**

731

***"…All passenger and crew compartments inside the planes are being sealed through the use of a pressure-tight skin, reinforced window's, and pressure doors. The sealed plane can withstand a design pressure of six pounds to the square inch, although an operating pressure of only two-and-a-half pounds to the square inch between inside and outside pressures is all that will be required…"***
***Popular Mechanics,*** **February 1938**

732

***"…Two newly developed mechanical superchargers, each operating on a fraction of the horsepower of one engine, will draw air in through intake valves far out along the leading edges of the wings to build up air pressure inside the cabin. Ducts will distribute the air uniformly throughout the cabin and the air will be drawn off into an anti-pressure chamber at the rear containing exhaust valves. In upper level operation cruising speeds up to 250 miles per hour will be possible because of the extremely low outside air pressure.…"***

***Popular Mechanics,*** **February 1938**

733

**Birth of the B-17**

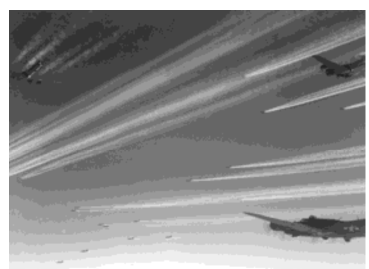
734

***"…Since building its first four-engined bomber in 1935 Boeing has turned out nearly a score of these flying fortresses. Having slimmer fuselages than the coming transports, these great fighting planes can fly even faster than the passenger transports will. With partial load they are able to cruise and maintain altitude on only two of their four engines. Nine men, including crews for manning five different machine-gun nests are required to operate the plane and its equipment. Each bomber can carry several tons of bombs…"***

***Popular Mechanics,*** **February 1938**

**RE: hardly ready for combat, the B-17 "Flying Fortress" benefited from the RAF's bitter experience with early models. The *Flying Fortress* was used in almost every theater in WWII, but the majority were used by the *U.S. Eighth Air Force,* based in the UK, for daylight precision strategic bombing against Germany. In fact, the B-17 dropped more bombs than any other U.S. aircraft during WWII.**

735



736

***"…Late in 1937 Boeing tested out its latest secret development, a thirty-ton big brother of the flying fortress, having a wing spread of 150 feet. This super-bomber contains heated living and sleeping quarters for the crew, a galley, and even two auxiliary gasoline engines inside the fuselage for driving 110-volt alternating-current generators that supply current over the more than seven miles of wiring which the plane contains. This plane, instead of ordinary landing gear, has double truck landing gear consisting of four huge tires as well as the usual tail wheel…"***

***Popular Mechanics,*** **February 1938**

**RE: the *Boeing XB-15* (a/k/a "Boeing 294") was designed in 1934 as a test-bed to see if it would be possible to build a heavy bomber with a 5K-mile range. In mid-1935, it was designated the "XBLR-1" and first flew in 1937. The XB-15 set a number of load-to-altitude records for land-based aircraft, including carrying a 31,205-pound payload to 8,200-feet.**

737

738

## Deutschland Uber Alles

739

### Berlin-New York Round Trip Takes Less Than Two Days

Forty-four hours and forty-six minutes from Berlin to New York and back again. Eight thousand miles over land and ocean in a four-motored land plane. That was the record written into the aviation books by the German air liner "Brandenburg" which, with its crew of four, made the first westward crossing of the Atlantic nonstop from the German capital to New York and then turned around to beat the previous record for the eastbound trip. Capt. Alfred Henke had figured on a twenty-hour eastward flight. He beat his schedule by five minutes, averaging 207 miles an hour. His westbound time had been twenty-four hours fifty-one minutes. The plane is a commercial type with a capacity for twenty-four passengers, and its quartet of 850-horsepower engines are of American type, built in Germany under license by an American firm. The plane weighs nineteen tons. Three hours' fuel supply remained when the ship landed on this side, and of 2,580 gallons of gasoline taken on at New York there remained ninety-two gallons when the return trip ended. (*Popular Mechanics,* November 1938)

740


**Caption: "Twenty-four-passenger German liner which made first westward air trip from Berlin to New York, then turned back to make it first round trip"**

741

## Part 9

## The Science of Flight

742

## Eyes on the Prize

743

**Aircraft that can speed at six miles a minute is goal of great flight laboratory**
***Popular Science,* April 1934**
**RE: introduction to an article written by *Arthur Grahame* entitled: "Faster, Safer Planes Developed in Biggest Wind Tunnel"**

744

## The Need for Speed

745

***"SPEED with safety in the air. Speed with economy of operation. Speed with comfort for air travelers. For the past few years these speed demands have been insistently made by the users of airplanes and especially by the airline companies whose existence depends on the swift, safe, dependable, and economical transportation of passengers, mail, and express…"***
***Popular Science,*** **April 1934**

746

## Meeting the Demand

747

***"…The builders of commercial airplanes are meeting this demand so successfully that the operating chief of an important air-transport line tells me that his ships never wear out – they are replaced by faster planes while they are still in excellent shape…"***
***Popular Science,*** **April 1934**

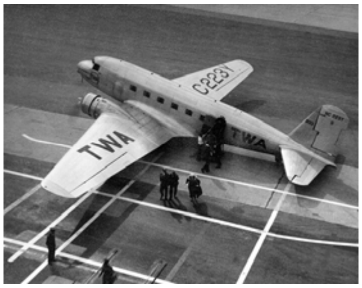
748

## Then and Now

749


***"…A year ago there wasn't a multi-motored transport plane manufactured that had a rated speed of more than 150 miles-an-hour. Today the Douglas DC-1 Airliner, carrying a pay load of twelve passengers and more than 1,000 pounds of cargo, has a top speed of 240 miles an hour, and an economical cruising speed in excess of 200 miles an hour…"***
***Popular Science,*** **April 1934**
**Caption: "The Douglas DC-1 was the first model of the famous DC (Douglas Commercial) commercial transport aircraft series"**

750



751

*"…The Boeing 247 Transport, carrying a pay load of 2,400 pounds, has a cruising speed of 171 miles-an-hour. The new Curtiss Condor biplane, that soon will go into service, has a speed of 170 miles-an-hour, and a cruising speed of about 150 miles-an-hour when carrying 3,200 pounds of revenue-producing load…"*
***Popular Science,*** **April 1934**
**RE: the *Curtiss-Wright Condor T-32* was a biplane transport designed in 1932 that continued in service well into the 1950s. Hardly state-of-the-art, its tail assembly and two-bay biplane wings were wire-braced. In an era of more and more all-metal designs, the Condor was part metal, part fabric.**
752
**Caption: "Curtiss-Wright Condor in its 1934 AT-32-A American Airways livery"**

**Above: although completely retractable landing gear was not uncommon, at the time, the Condor's wheels only partially nestled into its twin engine nacelles. On the bright side, the Condor's nine-cylinder *Wright Cyclone* air-cooled radial engines each produced 710 hp, sufficient to give the *Condor* a cruising speed of 190 mph at 8K-ft. With a range of more than 800 miles, the 12-passenger Condor had luxury status at *American Airways* and *Eastern Air Transport*. Twenty-one of the original T-32 configuration were produced as "The World's First Complete Sleeper-Planes."**
**Upper Left: caption: "Passengers sat two-and-one across, with large windows"**
**Lower Left: caption: "The Condor's flight deck offered plenty of glass for an excellent forward view. The pilot's principal instruments were artificial horizon, compass, directional gyro, altimeter, air speed, bank-and-turn and rate-of-climb."**
753

*"…The Martin B-10 monoplane, an adaption to commercial use of the Martin military ship, is another of the superfast transport planes now on the market. The Martin military plane, which can do 200 miles an hour while carrying a ton of bombs, won for its creators, in 1932, the Collier Trophy awarded to the year's outstanding achievement in aviation…"*
***Popular Science,*** **April 1934**
**Caption: "The Martin B-10 was a revolutionary design in the early 1930s. It was the first bomber to feature an all-metal construction, with monoplane rather than biplane wings and retractable undercarriage. Its performance exceeded that of contemporary fighters. It was also the first production warplane to be fitted with radio equipment."**
754

755

**Gain Without Pain**

756

*"…In developing today's high-speed commercial planes the manufacturers have not built ships with bigger engines to be operated at higher costs. Nor have they sacrificed airworthiness or comfort. They have achieved increased speed by turning out planes of improved design and increased aerodynamic efficiency…"*
***Popular Science,*** **April 1934**

757

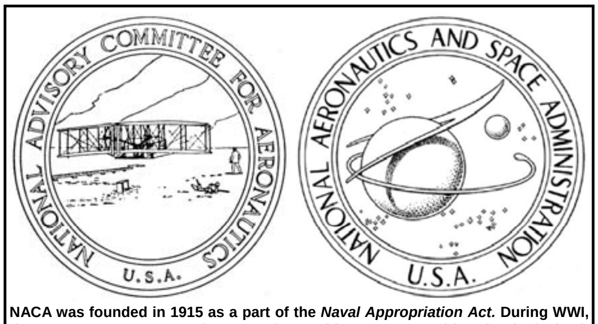
## For the Benefit of American Aviation

758

*"…In doing that they have followed the trail blazed by air scientists who work patiently for the advancement of aviation in the marvelously equipped Langley Memorial Aeronautical Laboratory of the National Advisory Committee for Aeronautics. The N.A.C.A. has its executive offices in the Navy Building in Washington, and its laboratories, workshops, and hangar on the Army Air Corps post at Langley Field, near Norfolk, Va. It is however, an independent government organization. Its fifteen members are appointed by the President of the United States and serve without pay. The job of its technical force, headed by Dr. George W. Lewis, director of aeronautical research, is the scientific study of the problems of flight for the benefit of all American aviation – commercial aviation quite as much as military aviation…"*
***Popular Science,*** **April 1934**

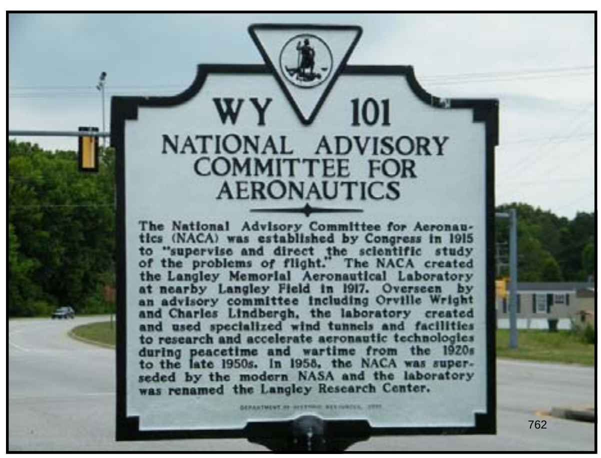
759

760




**NACA was founded in 1915 as a part of the *Naval Appropriation Act.* During WWI, the U.S. government sought to catch-up with Europe's rapid technological advancements in aviation due to wartime exigencies. For +40 years, NACA managed and conducted aeronautics research, experiments, flight tests and simulations, playing a major role in the growth of the aviation industry, leading to NACA contributing to U.S. efforts in both World Wars. Before the *National Aeronautics and Space Agency* (NASA) was established in 1958, NACA – NASA's predecessor – laid the foundation for NASA's mission to explore the heavens.**

761



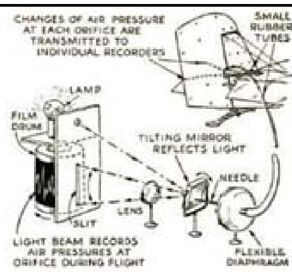

762

**Most Elusive Element**

763

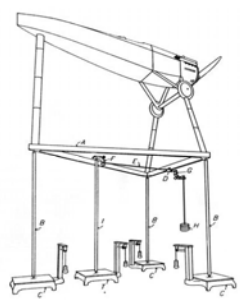
***"…Because aircraft operate in the air, N.A.C.A. flight-science pioneers realized, when they started their work nineteen years ago, that one of the first things they would have to learn was how to control, surely and accurately for experimental purposes, the most elusive of the elements…"***
***Popular Science,*** **April 1934**

764



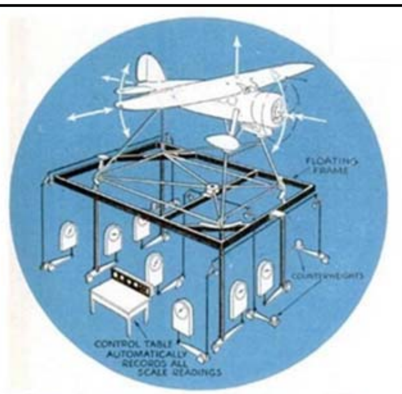

***"…Of course, much could be learned from actual flight. Ingenious and highly accurate instruments were developed to measure and record speeds, pressures, and the positions of control surfaces while an airplane is flying. But flight tests could not solve all the problems of aviation…"***
***Popular Science,*** **April 1934**
**Caption: "Measuring Air Pressure in Flight. Diagram shows how an automatic record is made of changing air pressure at various points on exterior of a plane during a flight. Note tiny orifices in rudder that admit air which affects flexible diaphragm."**

765



***"…So a five-foot wind tunnel was built at Langley Field. In it small-scale airplane models, or full-size small parts on planes, could be mounted on delicate scales and balances, subjected to a blast of air that simulated the conditions of actual flight, and pressures and strains measured…"***
***Popular Science,*** **April 1934**
**Caption: "Balance Setup of the Propeller Research Tunnel Building, May 1930"**

766




Cut-away view of room containing instruments that automatically record lift, drag, and force of cross winds as artificial gale buffets plane. Position of the recording dials is clearly shown in the illustration

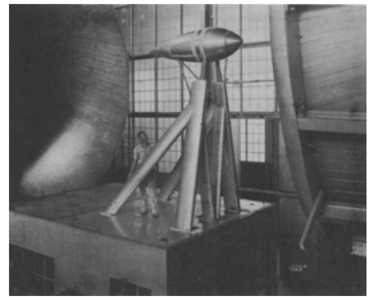
767

768

*"…Later on, other and much-improved wind tunnels were built. There are a dozen of them now. A vertical tunnel is used to study the spinning characteristics of small-scale models of various types of planes. There is a steel-tank-enclosed, variable-density tunnel in which models are tested in air that is compressed in inverse proportion to the model's scale. For example, a one-twentieth-size model is tested under twenty times normal air pressure. Means for studying and preventing the formation of ice on airplanes are studied in a refrigerated tunnel…"*

***Popular Science,*** **April 1934**

769



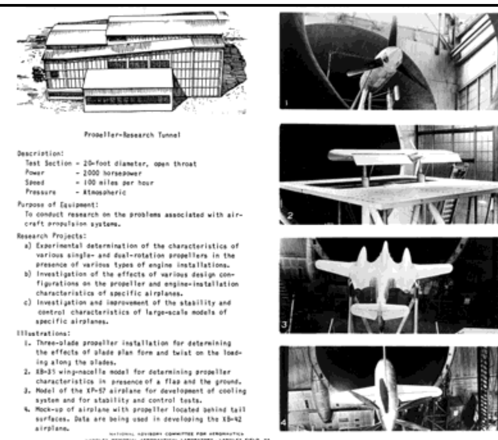
770

*"…A twenty-foot tunnel, with an air-speed of 110 miles-per-hour, is used for the testing of propellers, and also of other parts of the plane, including fuselage, engine, landing gear, and tail surfaces…"*

***Popular Science,*** **April 1934**

**RE: the *Propeller Research Tunnel* was built in 1927 to assist NACA researchers who were trying to correlate their data with tests conducted at *Stanford University*. The design was a radical change from previous wind tunnels, which were typically 5-feet in diameter. The 27-foot, 8-bladed propeller was powered by two diesel submarine engines (provided by the USN), allowing the 20-foot stream of air to reach 110 mph.**

771



Propeller-Research Tunnel

Description:

Test Section - 20-foot diameter, open throat
Power - 2000 horsepower
Speed - 100 miles per hour
Pressure - Atmospheric

Purpose of Equipment:

To conduct research on the problems associated with aircraft propulsion systems.

Research Projects:

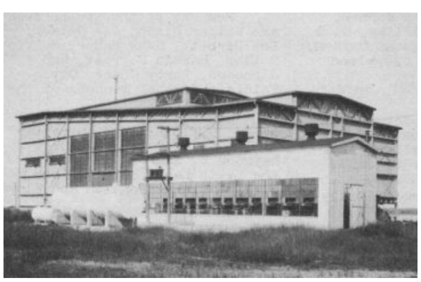
a) Experimental determination of the characteristics of various single- and dual-rotation propellers in the presence of various types of engine installations.
b) Investigation of the effects of various design configurations on the propeller and engine-installation characteristics of specific airplanes.
c) Investigation and improvement of the stability and control characteristics of large-scale models of specific airplanes.

Illustrations:

1. Three-blade propeller installation for determining the effects of blade plan form and twist on the loading along the blades.
2. XB-35 wing-nacelle model for determining propeller characteristics in presence of a flap and the ground.
3. Model of the XP-57 airplane for development of cooling system and for stability and control tests.
4. Mock-up of airplane with propeller located behind tail surfaces. Data are being used in developing the XB-42 airplane.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS
LANGLEY MEMORIAL AERONAUTICAL LABORATORY - LANGLEY FIELD, VA

772



773

**Full-Scale**

774

"Humdinger" Built.

The "humdinger" has made its appearance in aviation. That homely old word, long used to describe the difficult and rare, has at last found its true application. The humdinger of aviation is a part of a giant new wind tunnel now nearing completion at the National Advisory Committee for Aeronautics' laboratory at Langley Field, Hampton, Va. It is called a "humdinger," explained a local official of the committee simply, because it is a humdinger.

The giant tunnel, used for full-scale airplane tests, has a throat opening 60 by 30 feet, oval in shape. Wind current through the throat is provided by two immense propellers, each 32 feet in diameter, slightly overlapping and driven by great electric motors.

The throat of the tunnel is of wood, smoothly polished. The throat must change in shape from the oval of the opening to the double circle at the propellers, smoothly and in unbroken curves. This portion of the tunnel, the first of its kind ever built, is the humdinger. Though thousands of square feet of polished wood surface are involved and the curves are of bewildering intricacy, there is not a quarter of an inch of error in any part of the huge structure, final checking has revealed. It was extraordinarily difficult to design and build and there is no word so well suited to describe the finished product as the old but despised term adopted.

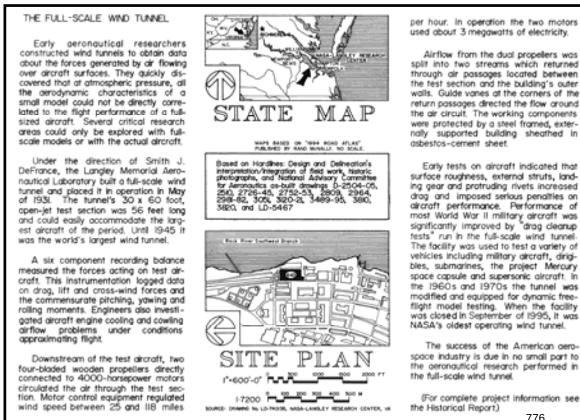
***"…Newest, and most impressive, is the full-scale tunnel, the world's largest, in which may be studied and measured accurately the flying characteristics of a complete full-size airplane, and in which engine and cowling problems may be investigated under conditions similar to those of actual flight…"***

***Popular Science,*** **April 1934**

**RE: commonly referred to as the "Full Scale Tunnel" (FST), *Building 643* was the site of historically significant activities from the time it opened in early 1931, spanning from the era of biplanes to NASA's *Apollo* program**

**Left: *Washington STAR* article on building of the Full-Scale Tunnel, January 18, 1931**

775



THE FULL-SCALE WIND TUNNEL

Early aeronautical researchers constructed wind tunnels to obtain data about the forces generated by air flowing over aircraft surfaces. They quickly discovered that at atmospheric pressure, all the aerodynamic characteristics of a small model could not be directly correlated to the flight performance of a full-sized aircraft. Several critical research areas could only be explored with full-scale models or with the actual aircraft.

Under the direction of Smith J. DeFrance, the Langley Memorial Aeronautical Laboratory built a full-scale wind tunnel and placed it in operation in May of 1931. The tunnel's 30 x 60 foot, open-jet test section was 56 feet long and could easily accommodate the largest aircraft of the period. Until 1945 it was the world's largest wind tunnel.

A six component recording balance measured the forces acting on test aircraft. This instrumentation logged data on drag, lift and cross-wind forces and the commensurate pitching, yawing and rolling moments. Engineers also investigated aircraft engine cooling and cowling airflow problems under conditions approximating flight.

Downstream of the test aircraft, two four-bladed wooden propellers directly connected to 4000-horsepower motors circulated the air through the test section. Motor control equipment regulated wind speed between 25 and 118 miles per hour. In operation the two motors used about 3 megawatts of electricity.

Airflow from the dual propellers was split into two streams which returned through air passages located between the test section and the building's outer walls. Guide vanes at the corners of the return passages directed the flow around the air circuit. The working components were protected by a steel framed, externally supported building sheathed in asbestos-cement sheet.

Early tests on aircraft indicated that surface roughness, external struts, landing gear and protruding rivets increased drag and imposed serious penalties on aircraft performance. Performance of most World War II military aircraft was significantly improved by "drag cleanup tests" run in the full-scale wind tunnel. The facility was used to test a variety of vehicles including military aircraft, dirigibles, submarines, the project Mercury space capsule and supersonic aircraft. In the 1960s and 1970s the tunnel was modified and equipped for dynamic free-flight model testing. When the facility was closed in September of 1995, it was NASA's oldest operating wind tunnel.

The success of the American aerospace industry is due in no small part to the aeronautical research performed in the full-scale wind tunnel.

(For complete project information see the Historical Report.)

STATE MAP

MAPS BASED ON "1994 ROAD ATLAS" PUBLISHED BY RAND McNALLY. NO SCALE.

Based on Hardlines: Design and Delineation's interpretation/integration of field work, historic photographs, and National Advisory Committee for Aeronautics as-built drawings D-2504-05, 2510, 2726-45, 2752-53, 2809, 2964, 2981-82, 3051, 3120-21, 3489-95, 3810, 3820, and LD-5467

SITE PLAN

1"=600'-0"

1:7200

SOURCE: DRAWING No. LD-74038, NASA-LANGLEY RESEARCH CENTER, VA

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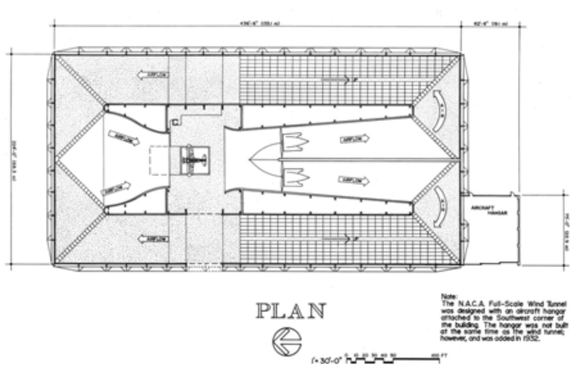


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**After NACA's *Variable Density Tunnel* (VDT) was placed in operation in the 1920s, it was recognized as a breakthrough accomplishment in wind-tunnel testing technology. By using higher than atmospheric pressure in its airstream, the VDT provided aerodynamic conditions more representative of those experienced in actual flight. However, the relatively small size of its test section required the use of relatively small aircraft models and severely limited testing of full-scale airplane components. Powered models could not be accommodated and the aerodynamic effects of real aircraft construction (i.e. rivets, fabric and other component details) were difficult and/or impossible to simulate. Of greater concern, however, was the recognition that significant aerodynamic turbulence was present in the tunnel air flow due to the geometrical shape of the VDT. As the concern over results from the VDT began to grow, several research leaders at Langley began to advocate for a new large wind tunnel capable of conducting tests of full-scale aircraft. Thus, NACA authorized the construction of the FST at Langley in February 1929; design work began immediately.**

778

**Because the FST was to be the first wind tunnel constructed with an elliptic throat and two drive propellers mounted side-by-side, the designers requested that a 1/16th-scale model of the FST be constructed for studies of the flow circuit and guidance in the shaping of the tunnel lines and airflow turning. The request was approved, however, NACA did not have sufficient shop space for construction of the model tunnel. Thus, the model was built outdoors, with a protective roof.**

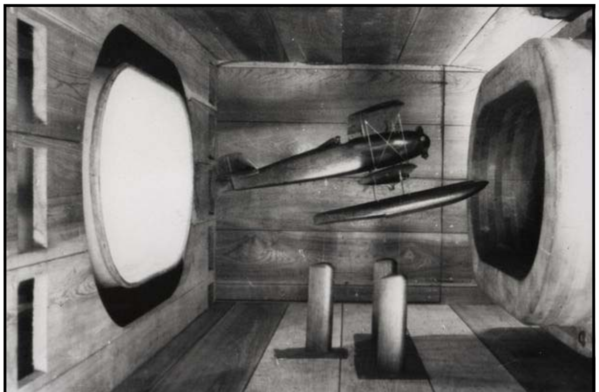
779

**In 1929, construction of the wooden model tunnel proceeded in a vacant area between two NACA power-plant buildings (behind the NACA administration building) using a lumber framework and a tarpaulin-covered roof. After a highly successful test program, which provided vital design information, the model tunnel was moved to the FST building upon its completion. The model tunnel was subsequently used at the FST for many years as a small-scale test facility. Subsequently, in the late 1950s it was given to Portugal for use in that nation's scientific programs.**

**Left: caption: "Full Scale Tunnel (FST) model under construction at NASA Langley Research Center, Building 643; September 3,1929**

**Right: caption: "Full Scale Tunnel (FST) model under construction at NASA Langley Research Center, Building 643; September 6, 1929"**

780



**Caption: "Model of the T.S. Seaplane in the Model Tunnel, Building 643; 1929"** 781

**House of Wind**

782

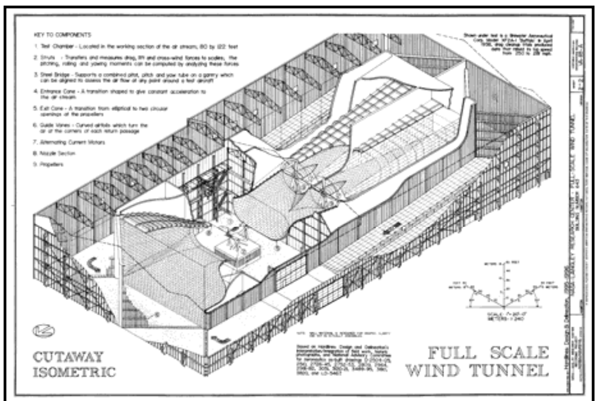
***"…At first glance the big structure that houses the gigantic apparatus looks as if it was built inside out, for the structural steel frame is outside the cement-asbestos sheets that form its walls. Of course, there has been no mistake. This building, 434 feet long and 222 feet wide, was designed to withstand wind blasts of hurricane force rushing through the inside of it…"***

***Popular Science,*** **April 1934**

**RE: work on the FST proceeded rapidly and it was completed and ready for operation in May 1931. The largest wind tunnel in the world, at the time, the FST had a unique design, with the building's steel framework visible on the exterior of the building. The enormous facility measured 434-feet-long, 222-feet-wide and 97-feet-high, becoming immediately a recognizable landmark at Langley. The semi-elliptical test section measured 30-feet-high by 60-feet-wide with an open jet (no walls immediately adjacent to the test section) and allowed the installation of aircraft with wingspans up to 40-feet. The tunnel was powered by two 35'-5" diameter propellers, each driven by a 4K-hp electric motor, which could circulate air through the test section at speeds between 25 and 118 mph. The air circuit was of the double-return type, in which the airflow from the propellers was split right and left into two streams, doubling back between the test section and the building's walls, then reuniting before entering the throat of the test section. Extensive tuning of airfoil-shaped turning vanes in the tunnel circuit resulted in satisfactory flow properties in the test section. In addition to testing full-scale aircraft the FST had considerably lower turbulence than the VDT.**

783

**Caption: "View from Back River of the Full Scale Tunnel, NASA Langley Research Center, Building 643; October 31, 1930"** 784

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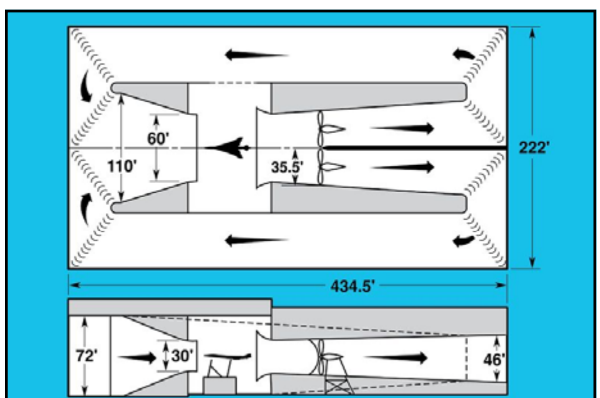
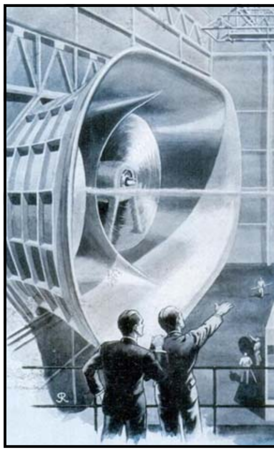



**Caption: "Full Scale Tunnel Plan View Cutaway, Langley Research Center Building 643; 1965"** 786



***"…Standing in the lofty test chamber of this house of the winds, I saw, far above my head, the mouth of a smoothly planked elliptic cone sixty feet wide and thirty feet high. Directly opposite it, and fifty-six feet away, is a similar cone, split by a smooth fairing into two circular passages. In each of these passages is mounted a four-blade, cast-aluminum-alloy propeller thirty-five feet, five inches in diameter driven by a 4,000-horsepower electric motor…"***

***Popular Science,*** **April 1934**

**<u>Caption</u>: "Exit cone with dual circular passages containing four-bladed 35-foot, 5-inch dia. propellers"**

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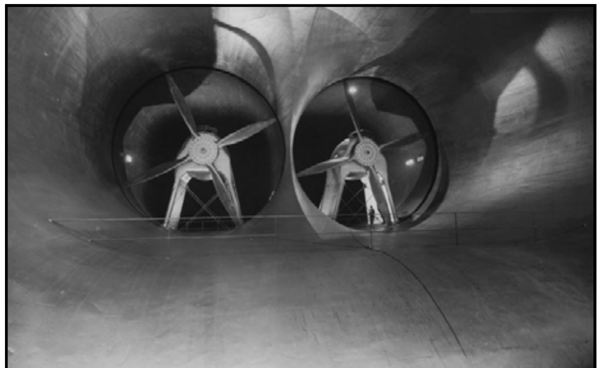

**<u>Caption</u>: "Langley full-scale tunnel exit cone and tunnel drive fans. Each fan is 35-1/2 feet in diameter and is powered by a 4000-hp electric motor."**

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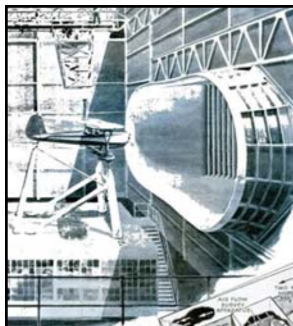
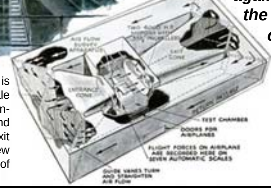


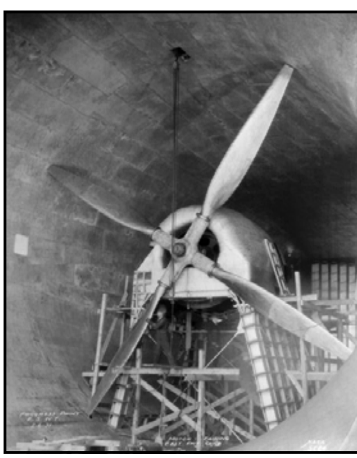


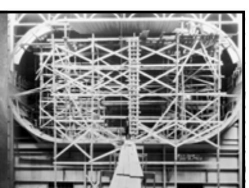
Above, full-size plane is tested in the path of a gale that sweeps out of the tunnel at 118 miles an hour and is carried away by the exit cone. Right, cut-away view of tunnel showing course of the air.

***"…Beyond the propellers the circular passages gradually change their shape and grow larger, until at the end of the building they are forty-six feet square. At their ends a series of wind vanes, that look like airplane wings set on end, are adjusted carefully to turn the airstreams smoothly into the fifty-foot-wide return passages that run the length of the building. At the other end more vanes turn the airstreams again, so that they join in the 110 by 72-foot entrance cone that narrows gradually to sixty by thirty feet at its mouth…"***

***Popular Science,*** ***April 1934***

790





**<u>Above</u>: caption: "Entrance cone looking north from exit cone, Full Scale Tunnel Langley Memorial Aeronautical Laboratory of the National Advisory Committee for Aeronautics, Building 643; October 31, 1930"**

**<u>Left</u>: caption: "Full Scale Tunnel Propeller Installation, Langley Memorial Aeronautical Laboratory of the National Advisory Committee for Aeronautics, Building 643; February 6, 1931"**

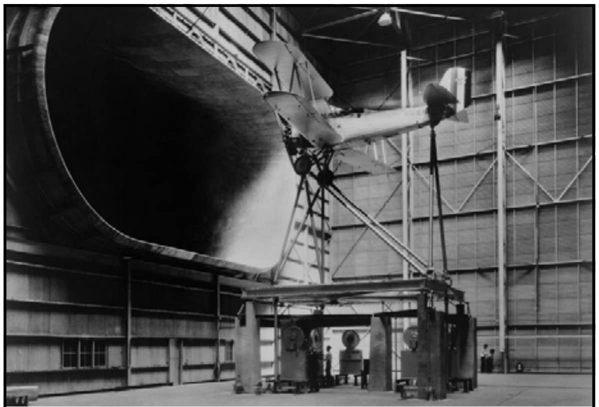
791

***"…In the big test chamber, between and beneath the gaping mouths of the wind cones, stands a glassed-in control room, its roof about level with the lower lips of the cones. Struts, protected by streamlined fairings attached to the roof, protrude from the roof of the control room. On them is placed a plane ready for testing in the artificial hurricane…"***

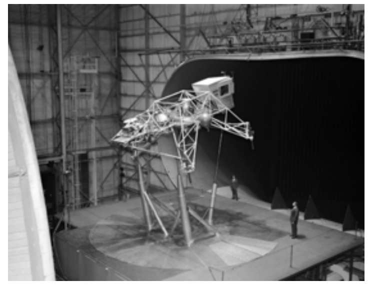
***Popular Science,*** **April 1934**

**RE: full-scale aircraft were mounted onto a six-component strut support system which used linkages connected to dial-type force scales to measure air loads on the test subject. Early calibrations were conducted with aircraft that also underwent flight tests permitting correlation with FST results. Early testing in the FST focused on the aerodynamic effects of aircraft geometry and construction methods on aerodynamic drag and engine cooling. Results of testing indicated unexpectedly high performance penalties from seemingly negligible aircraft protrusions and construction methods.**

792



Caption: "643 Test 1 - Vought O3U-1; Vought O3U-1 First Aircraft Tested, NACA 5553, L-05553 Building 643; May 20, 1931" 793



794

*"…Inside the control room, protected from wind currents, is the balance that measures the air forces to which the plane under test was subjected – a balance large enough to weigh a big airplane, and yet delicate enough to serve as a postal scale…"*
*Popular Science,* April 1934 795
Caption: "FST Balance House, Building 643; April 17, 1936"

*"…The struts on which the axles of the plane were mounted, and the triangular frame to which its tail was attached, are secured, inside the control room, to a turntable attached to a floating frame resting on struts that transmit the lift forces to four scales. A linkage attached to the floating frame, and acting against a counterweight, transmit the drag forces to another scale. Two other linkages, attached to the frame at its front and back, and also working against counterweights, transmit the cross-wind forces to two other scales. The turntable allows the airplane to be yawed from twenty degrees left to twenty degrees right, and the frame on which the plane's tail rests can be raised or lowered, altering the wings' angle to the airstream…"*
*Popular Science,* April 1934

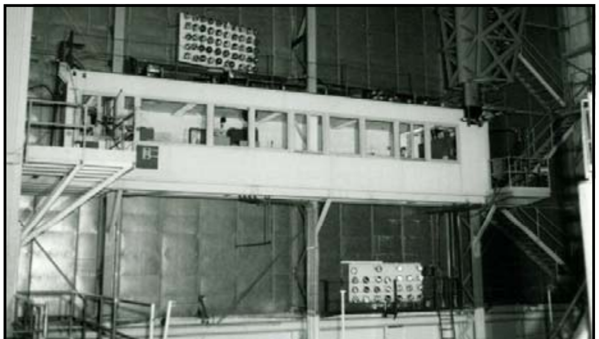
796

## Reaping the Whirlwind

797

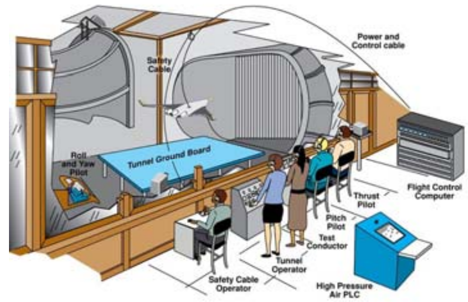
*"…With everything ready for a test, the flight scientist in charge pushed a controller handle. The big propellers began to purr. A brisk breeze leaped across the test chamber. He pushed the handle over another notch. The wind began to howl and soon reached full gale force. The dials of the seven scales were registering its pressure on the plane. The operator pushed a button, and the reading of each scale was recorded. He pushed the controller handle over another notch and then another and another, until a mighty blast was roaring across the test chamber at the hurricane speed of 118 miles an hour…"*
*Popular Science,* April 1934

798



***"…Inside the control room the air forces acting on the stationary plane from three directions, much as they would in high-speed flight, were being registered by the dials of the scales, which also recorded the intensity of the rolling, pitching, and yawing tendencies about the plane's three axes…"***
***Popular Science,* April 1934**
**Caption: "FST - Balcony Control Room for Free-Flight Models, Langley Research Center"**

799




800

***"…Outside, stationed in a car mounted on a movable bridge above the path of the man-made hurricane, another engineer was intent on measuring, with a delicate instrument suspended from the car, the air flow around the plane…"***
***Popular Science,* April 1934**

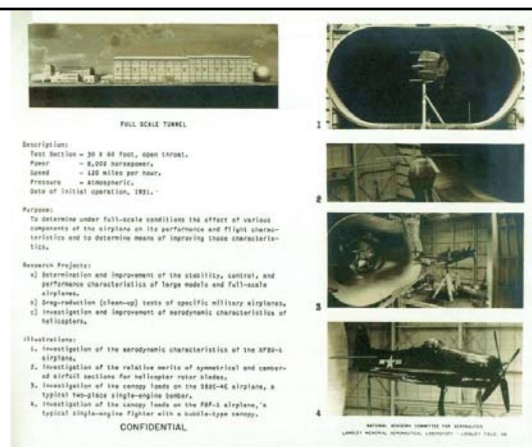
801

## Advancing the Science of Flight

802

***"…Much of value has been learned through this method of studying the downwash behind the wings and the air flow around the tail surfaces of planes. Not all of the many problems of flight can be solved by full-scale wind-tunnel research. But some of them have been thus solved, and in the two years of its existence the big N.A.C.A. tunnel has played an important part in the advancement of the science of aviation…"***
***Popular Science,* April 1934**
**RE: in 1938, the USN sent its *Brewster F2A-2 Buffalo* to Langley for analysis of the aircraft's aerodynamic performance, which had resulted in a disappointing top speed of only 250 mph. After a number of drag-producing items such as the landing gear, exhaust stacks, gun installations and other details were analyzed, recommendations for modifications to the design were made by the FST staff that were subsequently adopted and resulted in a 31 mph increase in top speed. The tests were such a success that both the USN and USAAC subsequently sent a steady stream of military aircraft to Langley for "drag clean-up tests." In the next 18 months, 18 different aircraft were tested and improved in the FST. The FST operated around the clock, 24/7/365, during WWII conducting not only drag cleanup tests, but engine cooling methods, stability and control and unexpected operational problems. Early versions of virtually every high-performance fighter aircraft were evaluated in the FST, allowing for countless design improvements.**

803



FULL SCALE TUNNEL

Description:
Test Section = 30 x 60 foot, open throat.
Power = 8,000 horsepower.
Speed = 120 miles per hour.
Pressure = Atmospheric.
Date of initial operation, 1931.

Purpose:
To determine under full-scale conditions the effect of various components of the airplane on its performance and flight characteristics and to determine means of improving those characteristics.

Research Projects:
a) Determination and improvement of the stability, control, and performance characteristics of large models and full-scale airplanes.
b) Drag-reduction (clean-up) tests of specific military airplanes.
c) Investigation and improvement of aerodynamic characteristics of helicopters.

Illustrations:
1. Investigation of the aerodynamic characteristics of the XF8U-1 airplane.
2. Investigation of the relative merits of symmetrical and cambered airfoil sections for helicopter rotor blades.
3. Investigation of the canopy loads on the SB2C-4E airplane, a typical two-place single-engine bomber.
4. Investigation of the canopy loads on the F8F-1 airplane, a typical single-engine fighter with a bubble-type canopy.

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CONFIDENTIAL

804

*"…In other buildings of the Langley Memorial Laboratory, there are many other things as interesting as the gigantic wind tunnel. Instruments of uncanny ingenuity, machines that do model-making work of marvelous precision, electric-photographic apparatus that takes pictures of fuel sprays in engine cylinders with glass walls at the rate of 4,000 a second, and with a time exposure of one-millionth of a second!..."*
***Popular Science,* April 1934**

**RE: a daunting engineering design challenge in aviation is the development and validation of methods to predict air loads experienced during flight in gusts and turbulence. This capability is extremely important, not only from a safety-of-flight perspective, but also to prevent an overdesign of aircraft structures which would result in unnecessarily large weight penalties. Early research in the 1920s and 1930s at NACA's Langley laboratory had included theoretical studies of loads generated in specific gust fields, but flight data to substantiate the predictions were extremely difficult to obtain, at the time. In order to experimentally investigate gust loads under controlled conditions, in 1937, NACA designed and constructed a pilot gust tunnel within an area of the FST (outside the tunnel flow circuit). This first gust-tunnel facility operated for almost a decade. The tunnel produced valuable information on gust loads as affected by primary aircraft design variables and results from the facility were used to justify reducing the structural design criteria that had led to overdesign of wing structures for certain types of aircraft configurations. In 1945, the pilot gust tunnel was replaced by a new *Langley Gust Tunnel* (LGT) which was similar in operational concept, but capable of testing larger 6-foot-span models at speeds up to 100 mph.**

805

## Achieving Results

806

*"…More important than the instruments, and quite as interesting, are the results that the N.A.C.A. scientists have achieved with them…"*
***Popular Science,* April 1934**

807

*"…Startling recent increases in the speed of commercial airplanes are the result of two major improvements in plane design. Among these important changes are:*

- **The use of fillets where fuselage and wings, or nacelles and wings join.**
- **Efficient placing of engines in the wings of multi-engine planes, which is considered the most important single contribution to the progress of airplane efficiency since flying began.**

*Back of each of these improvements in airplane design lies much valuable research work by the N.A.C.A…"*
***Popular Science,* April 1934**

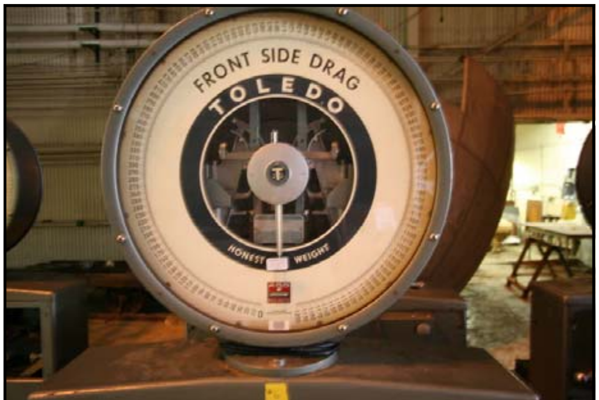
808

## Decreased Drag = Increased Speed

809

*"…Five years ago it was suggested at the National Advisory Committee's annual engineering research conference with the aircraft industry at Langley Field, that a study of the effect of placing fillets between wings and fuselages be undertaken. Tests were made in a high-wing cabin monoplane with a stub wing, in the twenty-foot wind tunnel, with an air speed of 100 miles-per-hour. From them it was learned that when fillets of six-inch radius were used to fair the lower surface of the wing into the fuselage, the plane's drag of 300 pounds was reduced two pounds, and that when twelve-inch fillets were used the drag was reduced by a little more than five pounds. It also was determined that the use of the twelve-inch fillets increased the plane's propulsive efficiency by about one per cent…"*
***Popular Science,* April 1934**

810




**Caption: "N.A.C.A. Langley – Building 643, Full Scale Tunnel; Front Side Drag Scale"** 811

***"…These advantages seem small, but the N.A.C.A. engineers knew that designers soon would be producing planes with lessened drag, and that filleting would become increasingly important. So they continued their researches. Last year tests of a low-wing monoplane in the full scale tunnel showed that the use of fillets, in combination with the N.A.C.A. engine cowling, reduced the tail-buffeting oscillations to which this plane was subject to one-quarter of their original intensity, increased the ship's maximum lift eleven per cent, and decreased its minimum drag nine per cent…"***
***Popular Science,* April 1934**

812

***"…Decreased drag means increased speed without increased power. Fillets, which prevent the premature breaking down of the air flow in the region of the intersection of the wing with the fuselage, now are used on all the super-fast planes. Experts say that this simple and inexpensive improvement has added twenty miles-an-hour to the speed of the newest airliners…"***
***Popular Science,* April 1934**

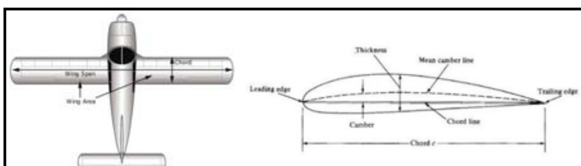
813

## All Positions Considered

814

***"…Most modern large airplanes have been powered by two, three, or even four engines. There has been the usual number in recent years – one in the nose of the fuselage, and two in separate bodies called nacelles, attached to the wings. At the 1928 Engineering Research Conference at Langley Field several manufacturers requested the N.A.C.A. to conduct a series of tests on various nacelle positions…"***
***Popular Science,* April 1934**

815



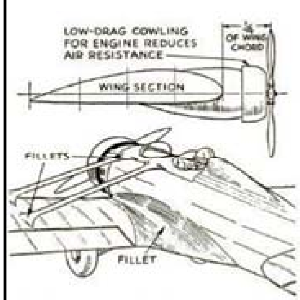

***"…The Advisory Committee's engineers started work on this problem in the twenty-foot propeller research tunnel. They built a wing with a fifteen-foot span, a five-foot chord – the chord of an airplane wing being the straight-line distance between its entering edge and its trailing edge – and a maximum thickness of twelve inches. They also built a four-ninths-scale model of a nacelle, in which they installed a detailed wooden model of a radial air-cooled engine…"***
***Popular Science,* April 1934**
**Caption (L&R): "Airfoil is the cross-sectional shape of a wing. As shown in the figure at left, the wing span is the distance between the two wing tips. From both figures (L&R), the line joining the leading edge and trailing edge is the chord line. The aircraft wings are of different shapes depending upon the aircraft type. In case of a rectangular wing, the chord remains constant throughout the wing span. But for a tapered wing, chord varies across the wing span."** 816

***"…Tests were made to determine the lift and drag of the wing alone. Other tests determined the drag of the nacelle alone. Then tests were made with the nacelle in twenty-one positions in reference to the wing. Without the propeller, it was found that when the nacelle was located above and forward of the wing, the drag of the wing, the drag of the wing-nacelle combination was greater than the sum of the drags of wing and nacelle; while if the nacelle was located below and forward of the wing, the drag of the wing-nacelle combination was less than the sum of the drags of the wing and the nacelle…"***
***Popular Science,* April 1934**

817

***"…With the propeller operating at full power, the wing's lift was increased when the nacelle was placed above the wing, decreased when below the wing, and unaffected when directly ahead of the wing. The tests also showed that propulsive efficiency is highest when the propeller is placed directly forward of the wing…"***
***Popular Science,* April 1934**

818




***"…Taking into consideration the factors of lift, drag, and propulsive efficiency at both high speeds and cruising speeds, and in climbing and landing, it was found that the best all-around location for the nacelle is in line with the wing, with the propeller about twenty-five per cent of the wing's chord ahead of the leading edge. The best results were achieved when the nacelle was efficiently cowled, and faired smoothly into the wing…"***
***Popular Science,* April 1934**
**<u>Caption</u>: "How speed of modern aircraft has been increased by cowling, fillets, and proper placing of propeller with regard to the wing is made clear in this diagram. Use of fillets has raised speed 20 miles-an-hour."**

819

## The "Flapping Wing" Principle

820

**Sensational German Paddle Plane Built On "Flapping Wing" Principle**

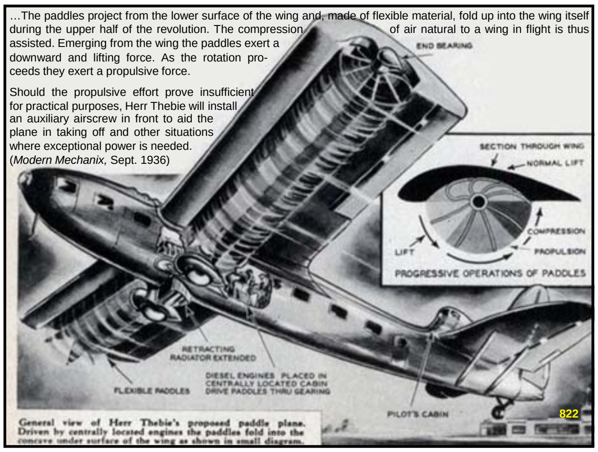
FROM Germany comes the news of another attempt to produce a plane of the rotating wing, or "paddle" variety. Unlike the well-known Dr. Rohrbach's paddle-plane design, the latest attempt to get away from conventional airscrews as a means of propulsion does not depend upon the paddles as a sole means of lift as well as propulsion. Rather, it seeks to adapt the paddle principle to an otherwise normal airfoil.

The inventor, Herr Engineer R. Thebie, of Chemnitz, after studying wing-flapping flight as practiced by birds, has introduced the results of his observations in his airplane…(*Modern Mechanix,* September 1936)

821

…The paddles project from the lower surface of the wing and, made of flexible material, fold up into the wing itself during the upper half of the revolution. The compression of air natural to a wing in flight is thus assisted. Emerging from the wing the paddles exert a downward and lifting force. As the rotation proceeds they exert a propulsive force.

Should the propulsive effort prove insufficient for practical purposes, Herr Thebie will install an auxiliary airscrew in front to aid the plane in taking off and other situations where exceptional power is needed.
(*Modern Mechanix,* Sept. 1936)




General view of Herr Thebie's proposed paddle plane. Driven by centrally located engines the paddles fold into the concave under surface of the wing as shown in small diagram.

822

## More Lift, Less Drag

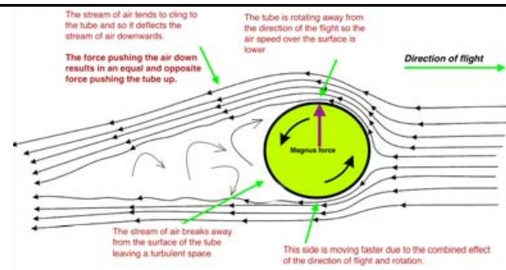
823

**More wing lift and less drag are the major aims of aviation's researchers. Maybe the Magnus Wing will supply the answers.**
***Mechanix Illustrated*, August 1950**
**RE: introduction to an article entitled: "Spinning Wing Airliner"**

824

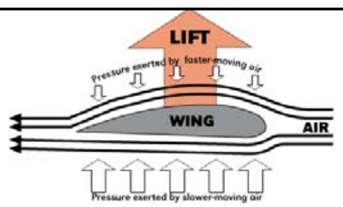
## The Magnus Effect

825




***"ENGLAND'S aeronautical scientists may have a surprise in store for the rest of the flying world. Some years ago a prominent investigator, Anton Flettner, formulated the Magnus Effect - the strange behavior of a drum spinning in an airflow. Today with modern materials, equipment and wind tunnels, interest is once more directed toward this strange phenomenon…"***
***Mechanix Illustrated*, August 1950**
**<u>Caption</u>: "The force perpendicular to the flight path and the axis of rotation is called the 'Magnus Force'"**

826




***"…The lift of an airplane wing is caused by the fact that the air passing over the top of a wing travels faster than that passing over the bottom. A law of science says that the faster air travels, the more its pressure is reduced. This difference in air pressure between the top and bottom of the wing results in lift…"***
***Mechanix Illustrated*, August 1950**
**<u>Above</u>: *Bernoulli's Principle* states that as the speed of air increases, the pressure decreases. This principle is partially responsible for the ability of an airplane to lift off the ground. When an airplane moves through the air, the wings push against the air, so that the airflow is slower under the wing than above it. As a result, Bernoulli's principle tells us that there will be more pressure on the bottom of the wing than on the top. The slow, high pressure air underneath the wing creates lift.**

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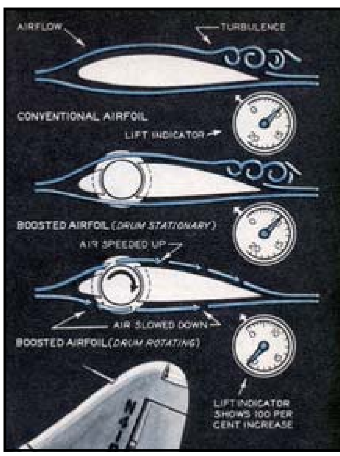
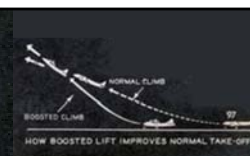



***"…The addition of a rotating drum speeds up the air over the wing and slows up the air under the wing still more, resulting in still greater pressure difference and hence, greater lift. Early tests show an increase of 100 to 200 per cent…"***
***Mechanix Illustrated*, August 1950**

828

*"…Here is how one of tomorrow's airliners may appear should further experiments prove the idea practical. The ship is powered by a conventional gas-turbine jet engine, while the drums are revolved by a separate piston engine. Small wings, heavy loads and quick take-offs would be its great advantages."*
***Mechanix Illustrated*, August 1950**

829

**And the Winner is…**

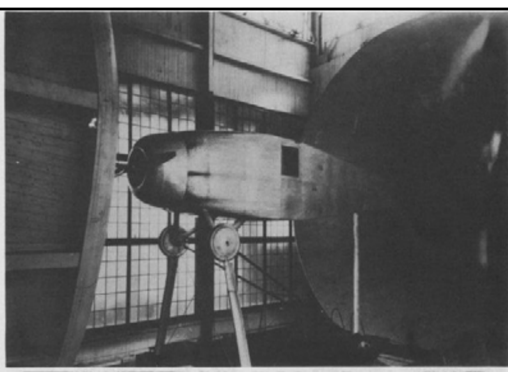
830

***"…More than five years ago the N.A.C.A. made a pioneering investigation of the effects of cowling radial air-cooled engines. It proved that a large reduction of drag, resulting in a great increase of speed with the same power, could be obtained by the use of a cowling which completely enclosed the engine, the cooling air being admitted through an opening in the front and discharged through another opening in the rear of the engine…"***
***Popular Science*, April 1934**
**RE: developed by NACA in 1927, the "NACA cowling" is a type of aerodynamic fairing used to streamline air-cooled radial engines used on airplanes. A major advance in aerodynamic drag reduction, it paid for its R&D and installation costs many times over by enhancing speed through drag reduction while delivering improved engine cooling.**

831

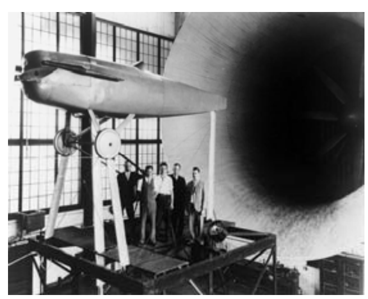
***"…Further research resulted in the development of a N.A.C.A. cowling that in 1930 won the Collier Trophy. Since then many cowling researches have been made, and low-drag cowlings developed that have decreased engine drag by two-thirds and greatly increased speeds…"***
***Popular Science*, April 1934**
**RE: the test aircraft was a *Curtiss AT-5A Hawk* biplane, featuring a *Wright Whirlwind J-5* radial engine. It reached an airspeed of 137 mph equipped with the NACA cowling, as compared to 118 mph without the NACA cowling.**
**Left: caption: "Curtiss AT-5A Hawk with NACA cowling at the Langley Memorial Aeronautical Laboratory, October 1928"**
**Right: caption: "Close-up of the cowling on the NACA AT-5A"**

832



The NACA won the Collier Trophy in 1929 "for development of cowling for radial air-cooled engines." Several forms of cowling were tested at Langley during the NACA's program of research and development on this important phase of aircraft design. NACA Cowling No. 10 is shown in this photograph, undergoing tests in 1927 in the Propeller Research Tunnel.

833



834

**Size *<u>Doesn't</u>* Matter**

835

***"…An Airliner carrying a dozen passengers and a thousand pounds of cargo at a cruising speed of more than 200 miles-an-hour seems sensational today. But that speed will be commonplace in the near future. The N.A.C.A. engineers who have blazed the trail to the present high flying speeds have learned that size has little, and shape much, to do with resistance in the air – that a big plane has little more drag than a small one…"***
***Popular Science,*** **April 1934**

836

**The Edge of the Possible**

837

***"…Looking forward, these scientists of flight place the ultimate speed limit at 600 miles per hour before the tremendous drag, caused by every added horsepower, will make further increase impossible. That speed would be possible only for straightaway flying, for no human tissue could stand the strain of changing direction at that breathtaking pace."***
***Popular Science,*** **April 1934**
**RE: the historical significance of the FST and its many contributions to aviation technology were recognized when it was designated a *<u>N</u>ational <u>H</u>istoric <u>L</u>andmark* (NHL) in 1985. With deterioration of the structural integrity of the FST, lack of funding for repair and maintenance and no current or future need for its testing capabilities, NASA decommissioned the FST in October 1995. However, the facility gained a new lease-on-life when it was transferred to *<u>O</u>ld <u>D</u>ominion <u>U</u>niversity* (ODU), which began operations at the FST in October 1996, providing engineering research facilities for graduate students and private clients in the field/s of aircraft and automotive transportation.**

838


839

**The FST performed its last test on September 4, 2009 and was demolished on May 2, 2011. Artifacts were salvaged for displays, including the Smithsonian's "Milestones of Flight" exhibit. The FST was officially removed from its NHL listing in August 2014.**

840


841

**Tunnel-Testing the DC-3**

842

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

WARTIME REPORT

ORIGINALLY ISSUED
June 1942 as
Memorandum Report

FREE-SPINNING-TUNNEL TESTS OF A 1/23.75-SCALE MODEL
OF THE DOUGLAS DC-3 AIRPLANE

By Oscar Seidman and George F. MacDougall, Jr.

Langley Memorial Aeronautical Laboratory
Langley Field, Va.



NACA

WASHINGTON

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https://archive.org/details/NASA_NTRS_Archive_19930092702

843

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

MEMORANDUM REPORT

for the

Army Air Forces

Bureau of Aeronautics, Navy Department

and

Civil Aeronautics Authority

FREE-SPINNING-TUNNEL TESTS OF A 1/23.75-SCALE MODEL
OF THE DOUGLAS DC-3 AIRPLANE

By Oscar Seidman and George F. MacDougall, Jr.

SUMMARY

A model of the Douglas DC-3 airplane was tested in the 20-foot free-spinning tunnel for several loading conditions. The load factor for the airplane as a whole, the load on the horizontal tail, and the force required to start moving the elevator downward were estimated for some of the steady spins. The altitude loss in the recovery from a spin and in the pull-out from the ensuing dive was also determined. Although recoveries were fairly rapid, it was concluded that, because of possible structural overload and high control forces, it would not be safe to put the DC-3 airplane into an established spin.

INTRODUCTION

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TEST CONDITIONS

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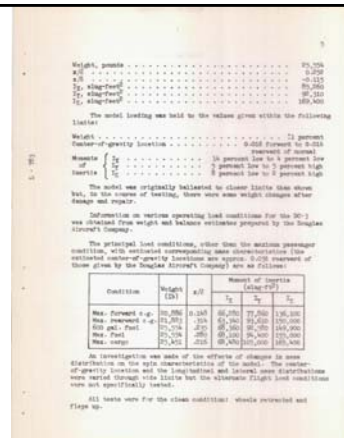

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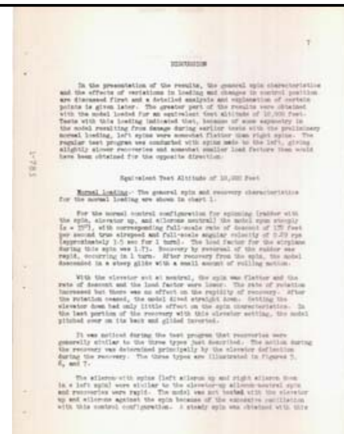

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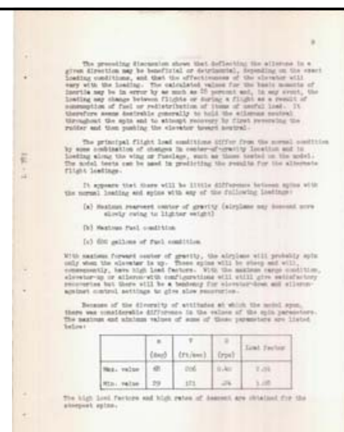

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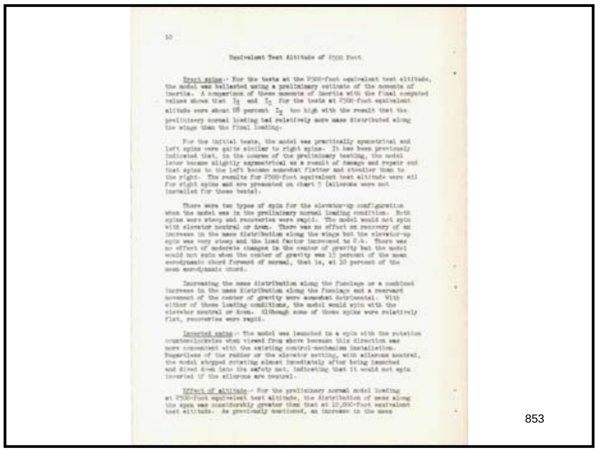

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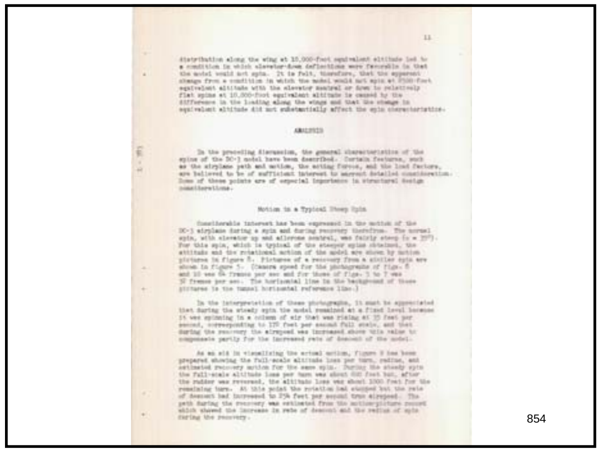

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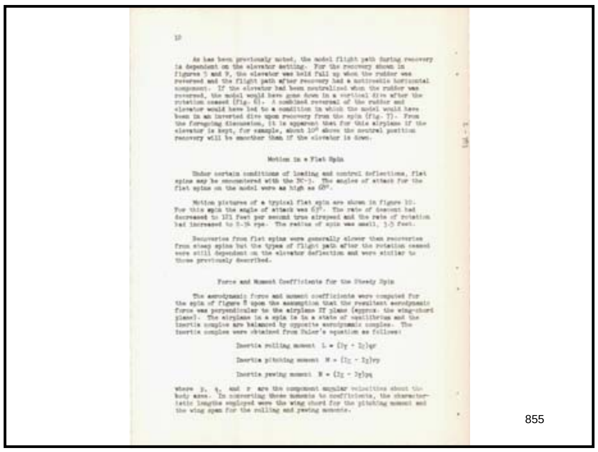

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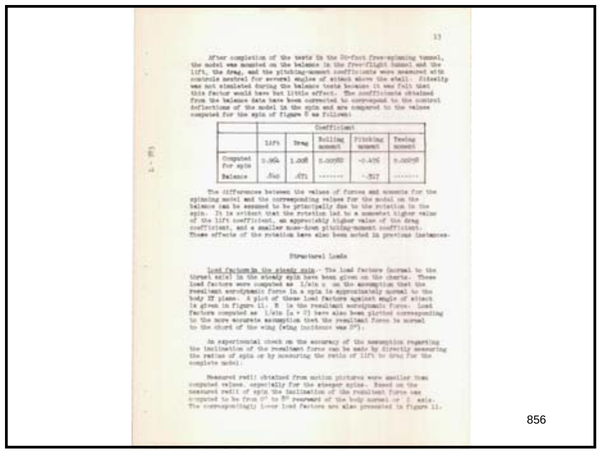

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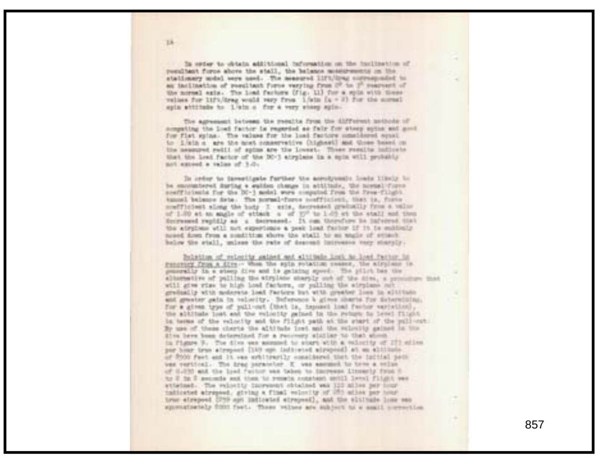

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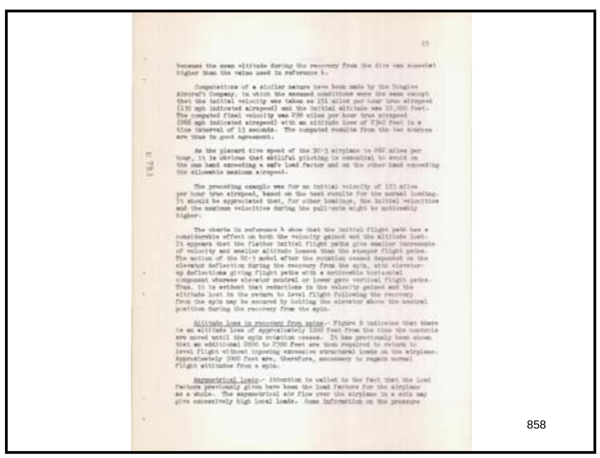

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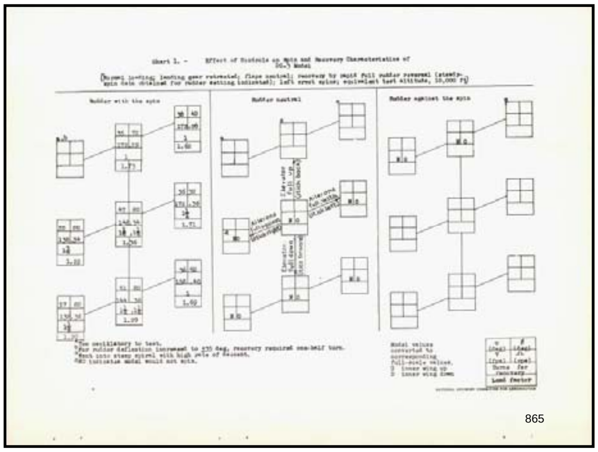

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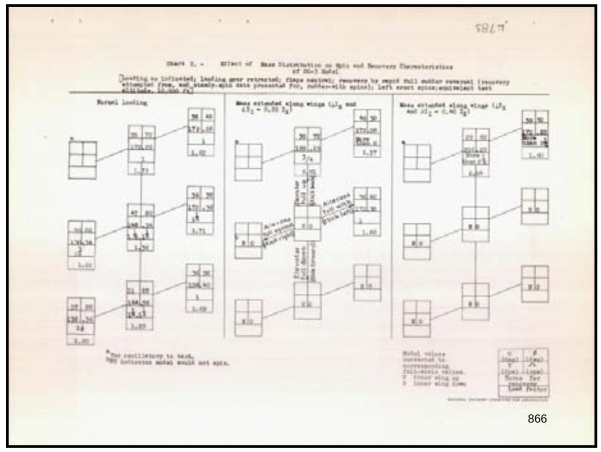

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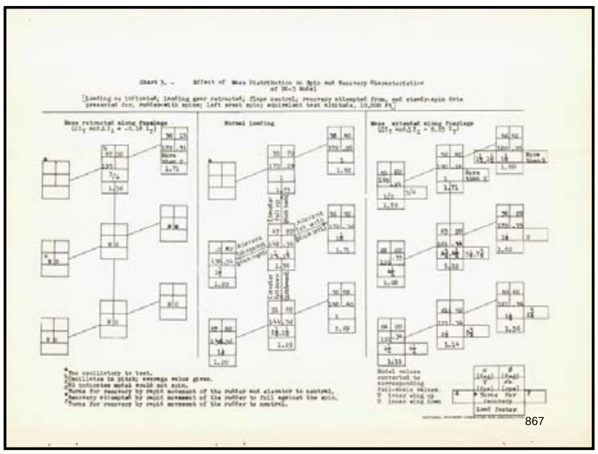

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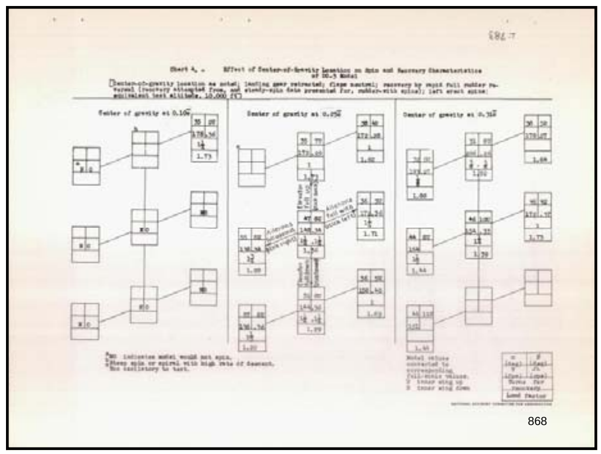

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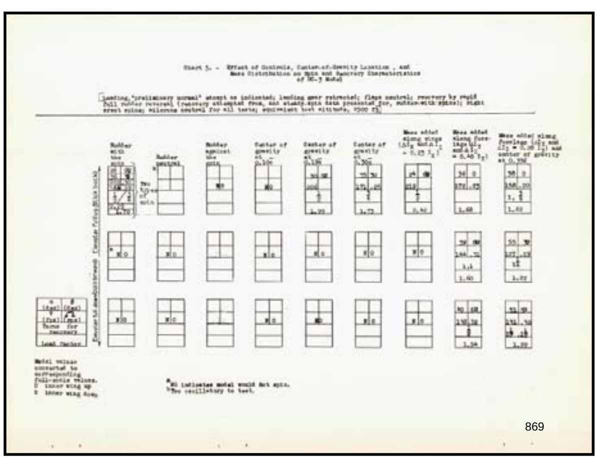

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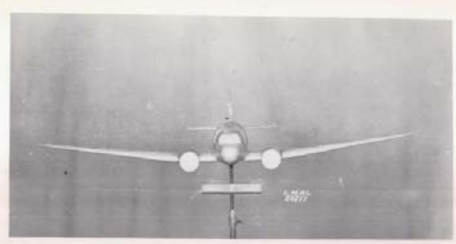

Figure 1.- Front view of the $\frac{1}{23.70}$-scale model of the Douglas DC-5 airplane.

870

Figure 2.- Three-quarter front view of the $\frac{1}{23.75}$ -scale model of the Douglas DC-3 airplane.

871

Figure 3.- Side view of the $\frac{1}{23.75}$ -scale model of the Douglas DC-3 airplane.

872

Figure 4.- Three-quarter rear view of the $\frac{1}{23.75}$ -scale model of the Douglas DC-3 airplane.

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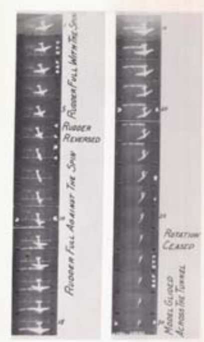


Figure 5.- Recovery from an elevator-up spin. Control settings: rudder as noted, elevator full up, ailerons neutral. Recovered in $\frac{1}{2}$ turn (frames 6 to 16).

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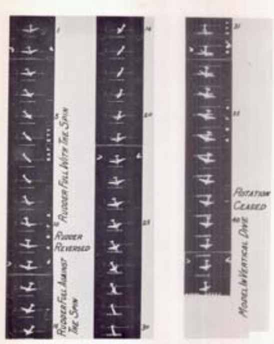


Figure 6.- Recovery from an elevator-neutral spin. Control settings: rudder as noted, elevator neutral, ailerons neutral. Recovered in 1 turn (frames 11 to 30).

875

Figure 7.- Recovery from an elevator-down spin. Control settings: rudder as noted, elevator full down, ailerons neutral. Recovered in $1\frac{1}{2}$ turns (frames 6 to 37).

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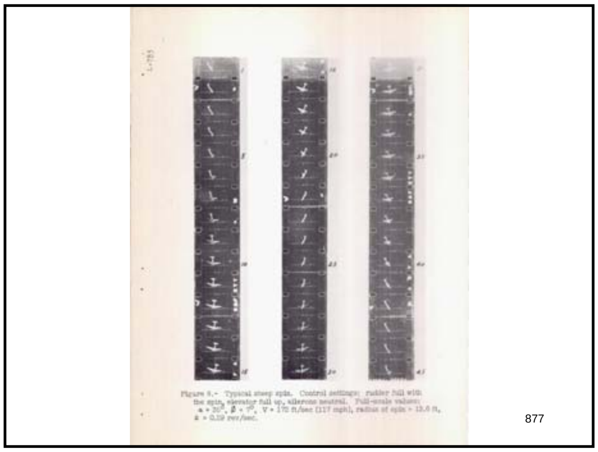
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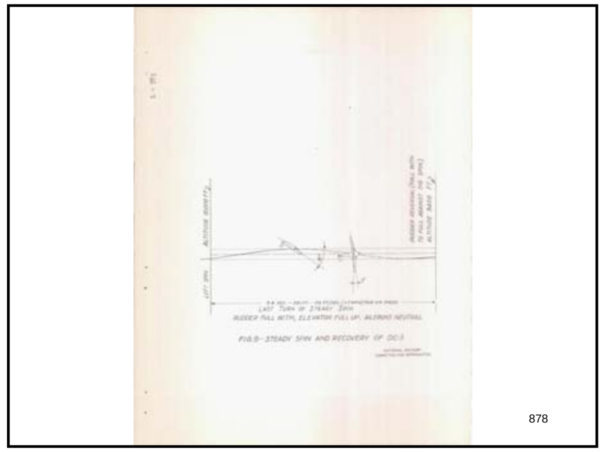
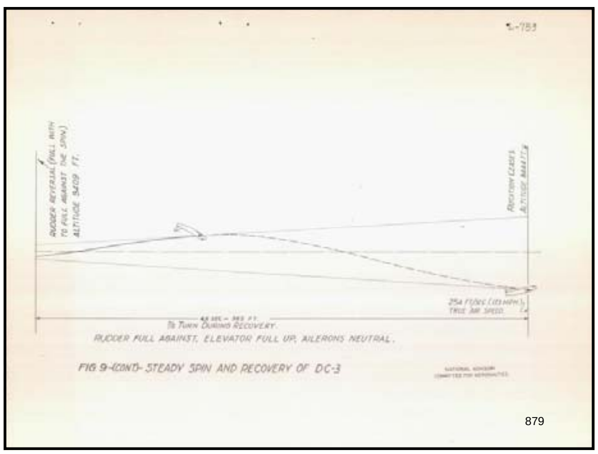


FIG.9 - STEADY SPIN AND RECOVERY OF DC-3
878


RUDDER FULL ABAFT, ELEVATOR FULL UP, AILERONS NEUTRAL.
FIG 9-(CONT)- STEADY SPIN AND RECOVERY OF DC-3
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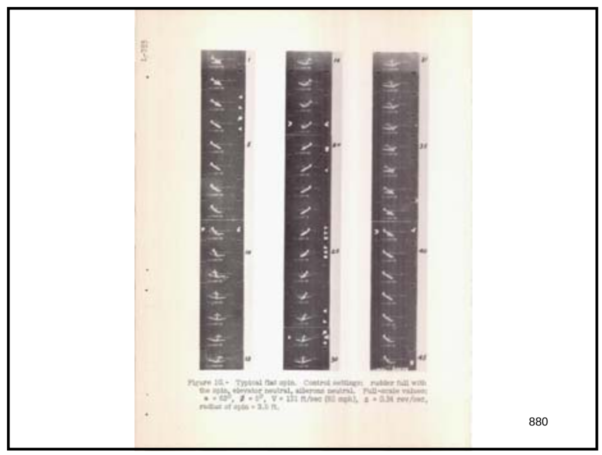
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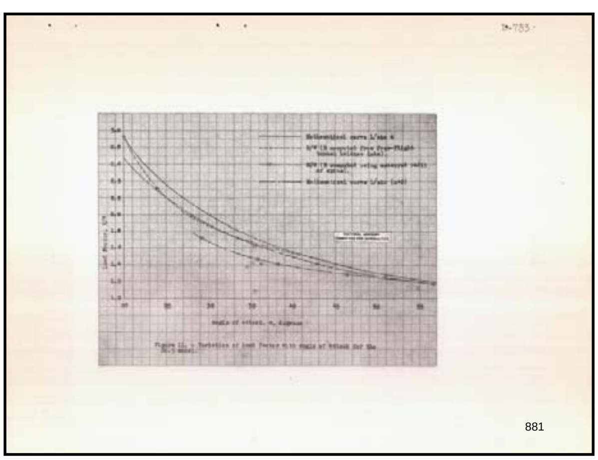
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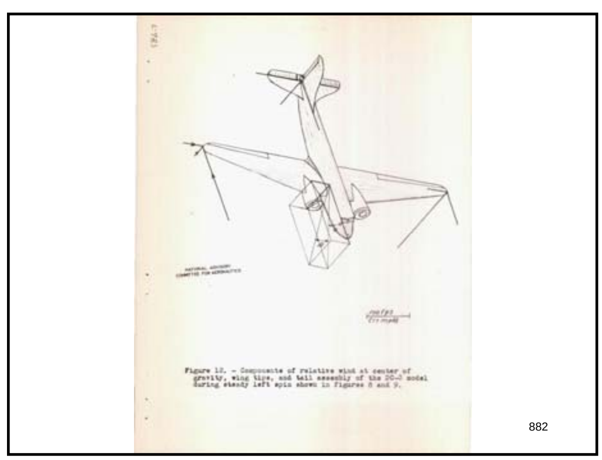
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883

# Part 10

# A New Era

884

**Latest Achievement**

885

**Aviation's latest achievement, the new, high-speed Boeing, brings a new era in transportation**

***Popular Mechanics,*** **October 1932**

**RE: introduction to an article entitled: "From "Mock-Up" to the Latest Air Liner"**

886

**Truly Remarkable**

887

***"…NOT only does this truly remarkable plane possess great speed, safety and unapproached economy of operation, but it affords unprecedented comfort to passengers…"***

***Popular Mechanics,*** **October 1932**

**<u>Caption</u>: "Boeing 247 cabin. Note that wing center section obstructs aisle."**

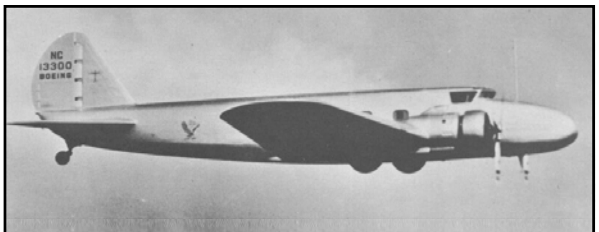
888

**Revenue Service**

889


***"…This 1933 transport is a twin-engine, metal, low-wing monoplane, to carry a crew of two pilots, ten passengers and bag-gage, and four hund-red pounds of air mail. Sixty of these ships have been ordered for the New York-Chicago-Pacific coast, Chicago-Southwest, Intermountain and west-coast airways, and shortly will be placed in service on schedules speedier than ever before…"***
***Popular Mechanics,*** **October 1932**
**RE: in 1933, the *Boeing Model 247* twin-engine, all-metal transport made its debut. A fleet of these low-wing monoplanes established overnight, coast-to-coast passenger and cargo schedules.**
**Caption: "UAL Boeing 247 NC13369"**

890




***"…Five hours, for example, will be slashed from the present schedule of twenty-eight hours between San Francisco Bay and New York, and proportionately rapid services will be co-mmenced on the other airways named. With a top speed of 175 miles-an-hour and a cruising speed of 155 miles, these new ships rank as the fastest multi-motored commercial pl-anes in the world…"***
***Popular Mechanics,*** **October 1932**
**Caption: "Boeing 247 NC13300 in flight"**

891

**Sky's the Limit**

892

***"…Each one is powered by two engines developing 550 horsepower and carries two hundred gallons of fuel to insure a normal cruising radius of five hundred miles. It weighs over six tons loaded, yet it can climb 950 feet-per-minute and re-ach a ceiling of 19,000 feet, 8,000 feet higher than the loftiest point on the transcontinental route…"***
***Popular Mechanics,*** **October 1932**
**Left: caption: "Boeing 247D"**
**Right: caption: "Boeing 247A. Note double row radial engine."**

893

**Mocking-Up**

894

***"…It was modeled in wood and paper in the 'mock-up' room of the Boeing plant before a single part was made. This mock-up was a full-size replica, and enabled both the engineers and the transport officials to visualize any changes which might have been advisable…"***
***Popular Mechanics,*** **October 1932**

895

**Schools of Thought**

896

***"…There are two well-defined schools of thought, the one which upholds huge planes with many motors, capable of greater pay loads and longer flights, and the other which favors relatively smaller planes with greater speed. American experience is in favor of the smaller plane, not only for the flexibility of schedules it affords, but for its mobility as well…"***
***Popular Mechanics,*** **October 1932**

897

***"…A 'small' plane – a ten-passenger ship being considered small – will be able to get through under adverse weather conditions where a large airliner would be turned back. More frequent schedules and saving of time on short hauls also favor a small plane. Twenty-passenger planes are considered overly large for economy, while four and six-place ships are too small for practical purposes…"***
***Popular Mechanics,*** **October 1932**
**Caption: "UAL Boeing 247 loading passengers at terminal"**

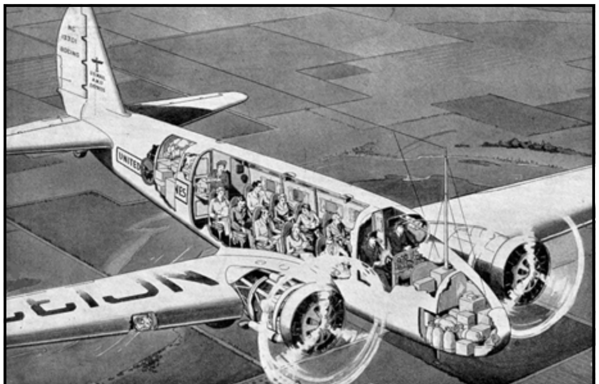
898

**The New Ship**

899

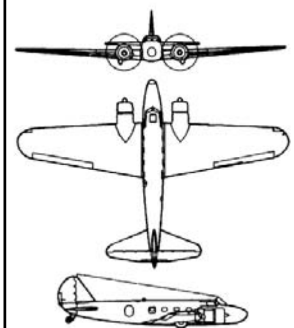
***"…With a gross weight of 12,210 pounds loaded, including 200 gallons of fuel, two pilots, ten passengers and their baggage, and 400 pounds of mail, the new ship will have a wing span of seventy-four feet and overall length of fifty-one feet five inches…"***
***Popular Mechanics,*** **October 1932**
**Above: caption: "Boeing 247D. Note nose baggage compartment (open)"**
**Left: caption: "Refueling a big transport during one of its stops on a coast-to-coast run"**

900



Caption: "Interior arrangement of a Boeing Model 247. The Boeing 247 was operated by a pilot, co-pilot and a flight attendant and carried up to ten passengers. The airplane was 51-feet, 5-inches long, with a wingspan of 74-feet, 1-inch and overall height of 12-feet, 5-inches. The empty weight was 8,921 pounds with a maximum take-off weight of 16,805 pounds."

901



**Specifications: Boeing Model 247D**

| | |
|---|---|
| **Wing span:** | 74 ft. (22.6 m) |
| **Length:** | 51 ft. 7 in (15.7 m) |
| **Height:** | 12 ft. 6 in (3.8 m) |
| **Wing Area:** | 836.44 sq. ft. (77.70 sq. m) |
| **Empty Weight:** | 8,940 lb. (4,055 kg) |
| **Gross T/O Weight:** | 13,650 lb. (6,192 kg) |
| **Maximum Speed:** | 200 mph (322 km/h) |
| **Service Ceiling:** | 25,400 ft. (7,740 m) |
| **Rate of Climb:** | 1,150 ft. (350m)/min |
| **Normal Range:** | 800 miles (1,297 km) |
| **Engines:** | Two Pratt & Whitney Wasp S1H1-G, 550 hp, 9-cylinder radial engines. |

902

***"…Chairs larger than ever used before will be spaced forty inches apart in the cabin. Hot-water heating systems replace hot-air 'stoves' formerly placed around the exhaust stacks of transport planes, and the new heating plants will effectively eliminate any engine odors from the cabin…"***
***Popular Mechanics,* October 1932**

903

***"…Conventional passenger conveniences to be incorporated in the cabins, which are to be six feet in interior height, include soundproofing, dome lighting and individual reading lamps, and main and individual ventilating systems. There is to be the usual lavatory facilities…"***
***Popular Mechanics*, October 1932**

904

905

## First Step

906

*"…The first step in constructing these planes was to mock-up, or complete wood and paper replica of the cabin, pilots' cockpit and wing stubs, constructed exactly to full scale. This is the place where ideas are checked and changes are agreed upon, if necessary. In it traffic men studied the arrangement of the seats, all of which were duplicated in wood, the all-important leg room, the location of the seats by the windows, the doors, and the installation of lights, ventilators and heaters…"*
***Popular Mechanics,*** **October 1932**

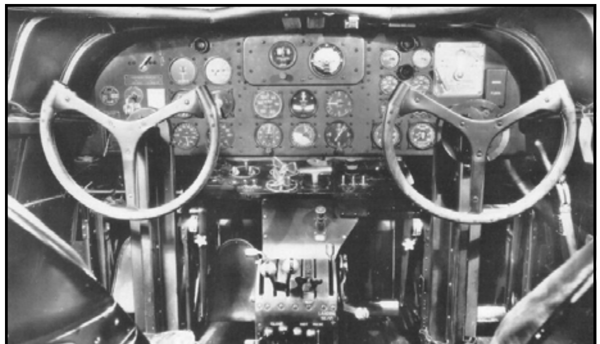
907

## Mock-Up Sessions

908

*"…Likewise the pilots spent hours in the cockpit, in which everything was arranged as it will be in the completed plane, with the instrument panels completely diagrammed, the controls and switches mocked-up in wood. Here the pilots discussed the location of every instrument and every control, and before their work was completed they had identified the ideal spot for each item…"*
***Popular Mechanics,*** **October 1932**

909



*"…Here it was decided that the most important instruments would be supplemented by others practically duplicating their functions; for example, the compass would be paired with a directional gyro, the turn-and-bank indicator would be mated with an artificial horizon, and the rate-of-climb indicator would be complemented by a sensitive altimeter recording in tens rather than hundreds of feet…"*
***Popular Mechanics,*** **October 1932**

910



*"…Then operations executives minutely examined the location of hatches in the rear and forward baggage compartments, the facilities for loading and unloading the passenger cabin, the provisions for refueling, and so on. Maintenance experts studied the mock-up with a view toward the accessibility of engines, controls and other vital parts which are subject to inspection and service during regular operations. Radio men checked the location of the radio-receiving and transmitting apparatus, all of which was duplicated in wood, the radio antenna, the wiring, and the placing of the control switches in the pilots' cockpit…"*
***Popular Mechanics,*** **October 1932**

Interior and exterior views of the "Mock-Up," the original wood and paper model of the new ship

911

*"…After the mock-up sessions were completed, the engineering department set to work on the detailed drawings necessary for production purposes. In step with this section was the purchasing department, charged with material planning and procurement…"*
***Popular Mechanics,*** **October 1932**

912

## Birth of the All-Metal Era

913

*"…And so the new Boeing transports, which will soon be flying over more than 6,000 miles of air lines in this country, marks the inauguration of all-metal era in medium-sized commercial plane building; the speeding up of air transport schedules over a nation-wide network; a new standard in passenger comfort and a new basis for economy."*

***Popular Mechanics,*** **October 1932**

**RE: in 1934, this revolutionary commercial transport appeared as the *Model 247-D*. Planes of this type were used by UAL, *Pennsylvania Airlines, Western Air Express, Wyoming Air Service, National Parks Airways* and *Deutsche Lufthansa.* The Model 247 is recognized as the first "modern" airliner, offering travelers unmatched speed and comfort with a sturdy, all-metal design.**

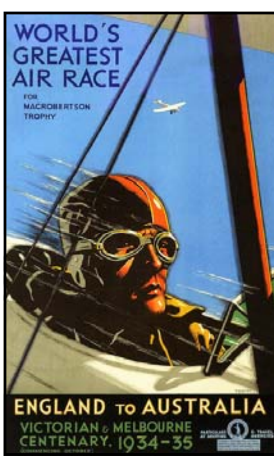
**Caption: "Western Air Express 247"**

914

915

## The Great Race

916





***"…As further proof of the rapid advancement of commercial aviation toward the goal of around-the-world airlines, let us take a glimpse at what happened in the 11,323 mile MacRobertson race - the greatest one in the history of aviation - from London to Melbourne, Australia…"***

***Capt. Eddie Rickenbacker,*** **Feb. 1935**

917


***"…It is true our British cousins, C.W.A. Scott and C. Black, were the winners and we offer them our heartiest congratulations on their success…"***

***Capt. Eddie Rickenbacker,*** **February 1935**

**RE: the 1934 air race from London-to-Melbourne was sponsored by Melbourne businessman and philanthropist *Sir Macpherson Robertson,* founder of the *MacRobertson Confectionary Company*. The race was initiated as part of the *Melbourne and Victorian Centenary* celebrations. A gold trophy, cash prizes of £15K and gold medals (left) for all crew and passengers who reached Melbourne were provided by Robertson. There were more than sixty entrants when the race was announced, however, that number was narrowed down to just twenty by the start of the race.**

918

*"…However, their plane, a twin-engine De Haviland Comet, was a specially built speed plane. They made the trip in 70 hours, 54 minutes, 18 seconds elapsed time, averaging 159.1 miles an hour, making six stops enroute, which is in itself a marvelous record…"*

***Capt. Eddie Rickenbacker,*** **February 1935**

**RE: the race was run by the *Royal Aero Club* of London. It started at Mildenhall, England and ended in Melbourne, Australia a distance of 18,200-km. There were compulsory stops in Baghdad, Allahabad, Singapore, Darwin and Charleville. Fuel, oil and supplies were provided in an additional seventeen locations which did not attract a time penalty. However, landing in other locations did attract a time penalty.**

919

**Caption: "DH-88 Comet 'Grosvenor House,' refueling in Darwin, Northern Territory, 1934"**

***"…Second to arrive at Melbourne was the Royal Dutch Airlines Douglas transport ship powered with two Wright Cyclone engines, piloted by K.D. Parmentier and J.J. Moll, carrying three passengers with a crew of two as well as 30,000 air mail letters. While it took Parmentier 90 hours, 17 minutes and 30 seconds to reach Melbourne, or approximately 19 hours longer than the winner, he made sixteen stops enroute and flew over a route some 1,000 miles longer than that flown by Scott and Black…"***

***Capt. Eddie Rickenbacker,*** **February 1935**

**RE: on day-one of the race (October 20, 1934), KLM's DC-3 "Uiver" led to Athens, with the *Boeing 247D* "Warner Bros. Comet" second. DH-88 "Grosvenor House" took the lead by the time they arrived at Allahabad. On day-two, *Grosvenor House* led to Singapore. *Uiver* was only 8-hours behind despite making more stopovers. Grosvenor House had an engine problem requiring shutdown over the *Timor Sea*. In Darwin the engine was inspected, with no fault found. Grosvenor House continued and arrived at Charleville about the time Uiver landed at Darwin. Grosvenor House then set-off for Melbourne. Uiver arrived at Charleville at night and then headed south.**

920

**Caption: "The *Uiver* at Charleville"**

921


***"…The American team, Roscoe Turner and Clyde Pangborn, flying a Pratt & Whitney Wasp-powered Boeing 247-D transport ship, which is being flown in regular transport service by United Air Lines, Inc., arrived third in the race - 2 hours and 44 minutes after the Dutch ship. They, too, took a much longer route than the winners…"***

***Capt. Eddie Rickenbacker,*** **Feb. 1935**

**Above: caption: "Roscoe Turner and Clyde Pangborn's Boeing 247-D, the third-place winner in the 1934 MacRobertson Trophy Air Race, as exhibited today in United Air Lines markings at the National Air and Space Museum"**

922

***"…No wonder that the British aviation experts, while thrilled with the success of Scott and Black, were the first to acknowledge that the flights of the two American-built and powered transports were more significant commercially than the flight of the winner…"***

***Capt. Eddie Rickenbacker,*** **February 1935**

**RE: just 300 km from Melbourne, *Uiver* became lost at night in an electrical storm. The people of Albury came to the aid of the plane, in what is now a legendary story and Uiver was able to make a landing on *Albury Racecourse. Grosvenor House* was first to arrive at Melbourne, crossing the finishing line at Flemington racecourse at 3:34 pm on October 23, 1934; a record time in the air of 70 hours, 54 minutes and 18 seconds.**

923

**After its forced landing at Albury, *Uiver* was freed from the mud on the morning of the October 24, 1934, and, minus two crew, passengers and cargo, was able to take-off and fly to Melbourne to finish the race in second place, overall, taking the handicap prize, despite the dramatic events of the night before. Uiver's flying time was 90 hours, 18 minutes and 51 seconds.**

924

**Caption: "Uiver being pulled out of the mud by Albury residents"**

Thus, the world's great intercontinental air race came to a close just 31 years after the Wright Brother's first powered flight at Kitty Hawk, in 1903.
Caption: "The Duke of Gloucester presents Charles Scott and Tom Campbell Black with the gold air race trophy at Melbourne, Sir Macpherson Robertson at right"

925

**After many years of speculation as to the whereabouts of the *Melbourne Centennial Air Race* trophy (left), an article appeared in the *Sydney Morning Herald,* dated January 24, 1941, which stated that the trophy was donated to the *Red Cross* by *Mr. A.O. Edwards,* owner of the DH-88 that won the race, to be melted down for the war effort.**

926

**10-to-1**

927


**THE thousands of passengers who travel millions of miles annually by plane usually credit the success of air transportation to the veteran pilots who sit at the controls. But the nation's airlines could not pile up a total of 55,000,000 miles annually without the aid of a group of earth-bound men who know nothing about flying a ship. For each pilot in the air there are ten men on the ground engaged in keeping the transport planes flying.**
***Popular Mechanics,* July 1935**
**RE: introduction to an article entitled: "Keeping Them in the Air"**
**Caption: "LATEST type of Boeing transport flying above the clouds with Mount Rainier showing in the background"**

928

**All O.K.**

929

***"IT is the skilled hand of the experienced engine mechanic, the watchful eye of the airplane inspector and the careful and painstaking work of other experts on the ground that make it possible for the pilot to write an 'All O.K.' report at the end of his run…'***
***Popular Mechanics,* July 1935**

930

## Overhaul and Repair Base

931

*"…United Air Lines, operating coast-to-coast and border-to-border, flies 1,350,000 miles per month, and the mainspring of this far-flung air network is an airplane 'round house' at Cheyenne, Wyo. Here, on the roof of the continent, is the world's largest airplane overhaul and repair base manned by 500 expert plane mechanics, engine mechanics, instrument technicians, sheet-metal workers, machinists, riggers, battery men, radio experts, seamstresses, inspectors and foremen. To this base, built on a mile-square airport more than a mile above sea level, comes each of United's fleet of fifty-five transports for complete overhaul and repair after each 350 hours of flight duty. Five days later, the ship goes back on the line, virtually as fit mechanically as the day it was delivered from the factory…"*
***Popular Mechanics*, July 1935**

932

*"…The mobility and flexibility of airline operations have given aviation an advantage over earth-bound transportation agencies and have enabled United Air Lines to consolidate its overhaul and repair activities at one point nearly 2,000 miles from New York and more than 1,000 miles from San Francisco. Here the airline erected a plant larger than the average airplane factory and just as well equipped to build planes from the drawing board to flight tests…"*
***Popular Mechanics*, July 1935**

933

## Cream of the Crop

934

*"…It staffed this plant with the cream of aviation's crop of ground men. Supervisory jobs were filled by veterans of ten years and more of experience in air transportation; but among the mechanics are progressive young men, trained in the best aeronautical schools, whose qualifications have been certified by government license. This Cheyenne staff represents one-third of the company's 1,500 employees…"*
***Popular Mechanics*, July 1935**

935

## Eliminating Guesswork

936

***"…This plan of eliminating guesswork from the mechanical operation of an airline, which reaches its zenith at the Cheyenne overhaul base, is carried out along the entire 6,000-mile system. After every scheduled flight made by a transport plane, it is inspected at the terminal, where mechanics make 190 different checks on engines, propellers, fuel system, electrical system, fuselage, controls, landing gear, instruments and other parts…"***
***Popular Mechanics*, July 1935**

937

**40-80-300-350**

938

***"…After each forty hours of service the ship is given a more thorough inspection. At the eighty-hour period spark plugs are changed, electrical accessories are serviced and changed and brakes are overhauled. The forty and eighty hour overhauls are continued until the airplane has flown 300 hours when it is withdrawn from its particular route and transferred to the Salt Lake-Cheyenne-Chicago sector. It is flown on this run until it reaches 350 hours, when it is landed at Cheyenne and turned over to the overhaul and repair station…"***
***Popular Mechanics*, July 1935**

939

**The Full Monty**

940

***"…Immediately the maintenance crews begin lo function like clockwork. First, the airplane is given a thorough bath of soap and water so dirt and grease cannot mask flaws. The engines are removed by hydraulic hoists and conveyed to the engine overhaul department, the propellers being routed to the propeller department. Radio apparatus goes to the radio service crew. The cabin is stripped of its furnishings for cleaning and necessary replacements. A crew of inspectors examines every inch of the fuselage and wings. Portions of the wings are removed so examination of the interior construction can be made…"***
***Popular Mechanics*, July 1935**

941

***"…The inspectors check the different parts of the plane on charts, and where service or replacement is necessary, the work is assigned to specialists in the different fields. Fuel lines and oil lines are removed and replaced with new systems, control wires are checked, and the flying instruments are removed from the cockpit and assigned to the instrument overhaul and repair shop. Landing wheels are removed and the shock-absorber units are serviced, brakes tested and tires are examined and changed if necessary…"***
***Popular Mechanics*, July 1935**

942

*"…The three-bladed controllable pitch propellers, weighing 242 pounds each, are taken apart, the blades are ground with special buffers, and then dipped in an acid bath which reveals flaws. The blades are examined under microscopes and slight nicks are ground away carefully to prevent them from developing into serious flaws…"*
***Popular Mechanics,*** **July 1935**

943

*"…The intricate assembly of the hubs, which contains the controllable mechanism for setting the pitch of the blades, is examined carefully, the bearings are inspected under microscopes, and parts showing wear are replaced…"*
***Popular Mechanics,*** **July 1935**
**Caption: "EXAMINING bearings under a microscope to detect flaws, one of the many pain-staking tests of the parts of a plane being overhauled at Cheyenne"**

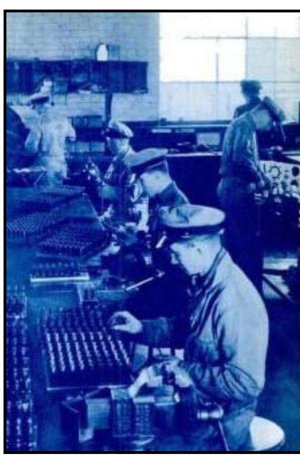
944

*"…The propeller is then reassembled and placed on a balancing stand where perfect balance is obtained. After checking the angle with protractors, it receives the final examination from the chief of the department…"*
***Popular Mechanics,*** **July 1935**

945

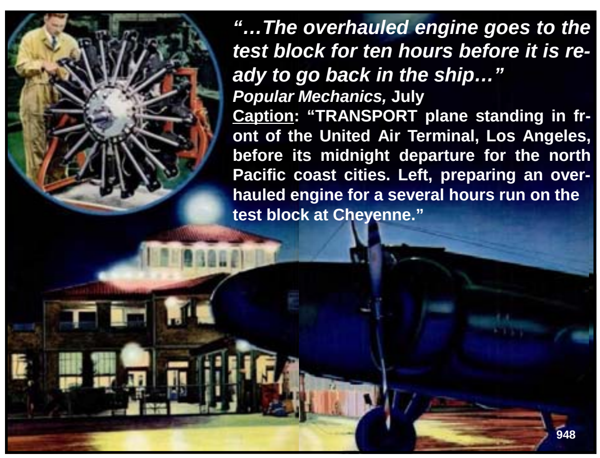
*"…The 887-pound Wasp engines are cleaned with a special compound in steam vats, then routed into the overhaul department. Here they are torn down and the component parts are placed on large portable racks on rollers, each large enough to accommodate all the parts of one engine. The parts are examined for wear, and some, such as crankshafts, are magnetized and then dusted with special metal powder. The pattern the powder takes clearly reveals hidden flaws. Engine cylinders are re-bored, then enameled and the finish is baked on in special electric ovens…"*
***Popular Mechanics,*** **July 1935**

946



*"…Spark plugs, one of the biggest items of engine maintenance, are inspected carefully. From 2,000 to 3,000 spark plugs are handled every week. Dynamotors, starters, generators and other electrical accessories also are tested with special equipment…"*
***Popular Mechanics,*** **July 1935**
**Caption: "SERVICING and testing the hundreds of spark plugs at the air transport 'round house' at Cheyenne, one of the many operations involved in overhauling and repairing the transport planes"**

947



*"…The overhauled engine goes to the test block for ten hours before it is ready to go back in the ship…"*
***Popular Mechanics,*** **July**
**Caption: "TRANSPORT plane standing in front of the United Air Terminal, Los Angeles, before its midnight departure for the north Pacific coast cities. Left, preparing an overhauled engine for a several hours run on the test block at Cheyenne."**

948

*"…In the instrument department are experts whose talents rank with those of skilled watchmakers. In one section, the men disassemble, inspect and service the artificial horizons and directional gyros. Another section handles compasses, rate-of-climb indicators and turn and bank indicators. An important part of the airplane fuselage and wing overhaul and repair work is handled in a sheet-metal department. Samples of every consignment of gasoline and oil also are carefully analyzed…"*
***Popular Mechanics,*** **July 1935**

**Caption: "TESTING a directional gyro which has been removed from one of the transports for inspection and service"**

949

**Journey's End**

950

***"…The overhaul is completed when the various units are returned to the main assembly hangar where the engines, propellers, instruments and other parts of the plane are put back in place. For several hours the test pilot puts the airplane through its paces. When satisfies with the performance, he signs the test report and the ship is ready for 350 more hours of service."***
***Popular Mechanics,*** **July 1935**
**Left: caption: "INSTALLING motor in an overhauled ship at Cheyenne"**
**Right: caption: "A TRANSPORT plane leaving the Cheyenne 'round house' after a complete overhaul, ready to go back into service on the coast-to-coast run"**

951

## Part 11

## Sentimental Journey

952

**Forever Flying**

953

**Pilots call it the Gooney Bird, and they expect the 50-year-old DC-3 to fly forever**
***Popular Mechanics,*** **May 1986**
**RE: introduction to an article written by *Dennis Eskow* entitled: "Sentimental Journey"**

954

## A DC-3 by any Other Name

955

***"EVERY pilot who touched her controls fell deeply in love. They gave her pet names like Gooney Bird, Dowager Duchess, Doug, Dizzy Three and a half-dozen others…"***
***Popular Mechanics,* May 1986**
**RE: known in various versions as the C-47, the R4D, the C-53, the *Dakota* or *Dak* (by the British), the *Skytrain*, the C-49, the *Doug*, the *Old Three,* the *Gooney Bird* and by many other designations and nicknames, the DC-3 earned a worldwide reputation for dependability and durability**

956

## Golden Anniversary

957

***"…With her 50th anniversary as an airliner coming up next month, fan clubs all over the nation are planning a nonstop party for the DC-3…"***
***Popular Mechanics,* May 1986**

958

## First Flight

959

***"…The maiden flight of the Douglas Sleeper Transport, later known as the DC-3, took off from a Douglas Aircraft Co. plant at Santa Monica, California, on Dec. 17, 1935, the 32nd anniversary of the Wright brothers' flight at Kitty Hawk…"***
***Popular Mechanics,* May 1986**
**Caption: "On December 17, 1903, in Kitty Hawk, North Carolina, Orville Wright performed the first ever airplane flight, providing the breakthrough for airplane Development"**

960

## Making History

961


*"…By June 1936, American Airlines had its first DC-3. History was to be made time and again by a twin-engine plane that was flightworthy in storms and, eventually, in combat…"*
*Popular Mechanics,* May 1986
RE: the DC-3's two *Pratt & Whitney R-1830 Twin Wasp* 14-cylinder radial engines produced 1200 hp each, providing thrust enough to lift crew, passengers and their baggage (or a +6K-pound cargo load) off the ground. Cruising at 160 to 180 mph, the DC-3 could fly about 1,600 miles, land in less than 3K-feet and take-off in less than 1K-feet. Its low-speed handling and ruggedness would make it the go-to airplane for a myriad of jobs, including military special operations.

962

## Running on Empty

963

*"…'I believe she can run on empty,' Charles Lindbergh declared prophetically after flying as a passenger in one of the first Douglas Sleepers. The plane he flew in was equipped with a bed and bar in first class. But it had full fuel tanks and the flight was troublefree…"*
*Popular Mechanics,* May 1986

964

*"…Prophesy came true in 1962, however, when a DC-3 cargo plane did run out of fuel over Missouri. Only the crew was aboard. The pilot set her on a glide path toward a large open area, then joined his crew in bailing out. Miraculously, the Gooney Bird sailed into a farmer's field and slid to a halt in the open. Its underbelly was severely damaged, but the plane was repaired and re-entered service the next year…"*
*Popular Mechanics,* May 1986

965

## The Realm of the Impossible

966

***"…Such is the history of the DC-3. Its greatness is recounted in story after story…"***
***Popular Mechanics,*** **May 1986**
**RE: Supreme Allied Commander Europe, General *Dwight D. Eisenhower,* said of the DC-3 that it was "one of the most important weapons" for victory in WWII. Former USAF Secretary *Harold E. Talbott* said it "unquestionably ranks as the best single airplane ever built." Some of the situate-ions the DC-3 has survived approach the realm of the impossible; no aircraft in aviation history has been so abused by both man and nature and come out on top over and over again.**

967

## War Stories

968

***"…In World War II, a China National Aviation Corp. DC-3 was caught on the ground at Suifu, China, by Japanese aircraft. The pilot and passengers fled to a nearby wood and watched as the field was bombed repeatedly. A hole was blown through the right wing. Within days, a DC-2 spare wing stored in Hong Kong was delivered to Suifu, secured beneath the wing of another DC-2. The DC-2 wing was 5 feet shorter than the downed plane's wing, but it was installed ad hoc. Following a short test flight, the repaired DC-3 was flown all the way to Hong Kong, with the right wing dipped. So much force was needed to keep the wounded Gooney Bird on a stable flight pattern that a heavy wrench was tied to one spoke of the control wheel to keep it in place. The pilot flew the plane safely with hands-off the wheel except for take-off and landing. That DC-3 was affectionately dubbed DC-2-1/2…"***
***Popular Mechanics,*** **May 1986**

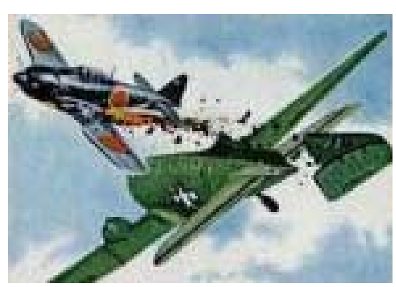
969

***"…The Old Three had a military version called the C-47, a plane that saw service as a troop carrier, flying ambulance and jump plane in World War II and Korea. But one military flight was made aboard a commercial version. Major General Jimmy Doolittle rode out of China after his 1942 Tokyo raid in a Chinese airline DC-3. Pilot Moon Chin set the craft down in Burma on the way to India to pick up refugees. After 60 people were crowded aboard, Chin shut the door, sensing the plane was overloaded. Chin didn't know who Doolittle was, so he didn't ask him into the cockpit. The Chinese pilot got into his seat, and took-off. When he landed in India, 12 additional refugees climbed out of the baggage compartment. The plane was supposed to carry 21 passengers…"***
***Popular Mechanics,*** **May 1986**
**RE: designed to operate at a gross weight of 25K pounds, the DC-3 has repeatedly been overloaded, particularly by the military (especially over the "Burma Hump" during WWII) to gross weights exceeding 31K pounds and still managed to become airborne**

970

***"…Perhaps the most unbelievable DC-3 war story involves the incident in which a Gooney Bird made a kill in a dogfight with two Japanese Zeros. Capt. Hal Scrugham was about to take his C-47 up for a flight over the Himalayas. At cruising altitude, he found he had company: a pair of Zeros. Scrugham put the plane into a dive with the Zeros in hot pursuit. The first fighter made a pass, but the C-47 was too close to the ground and the fighter zoomed up without making a hit. The second Zero made a run kamakazi style, intent on ramming the fat C-47. Scrugham slammed the throttles wide open and almost dodged the Zero. The fighter did hit the tail, ripping off most of the rudder. Then the Zero went out of control and slammed into a mountain in a ball of fire. But the C-47 managed to reach its destination…"***
***Popular Mechanics,*** **May 1986**
**RE: during WWII, the DC-3 was adapted for military use, becoming the C-47 "Skytrain" transport. It's ability to absorb otherwise catastrophic damage became legendary.**

971



972

*"…Another C-47 also downed an enemy aircraft, but apparently was not officially credited with the 'kill.' An attacking Japanese kamikaze pilot first attempted to shoot down the lumbering, unarmed C-47. After several unsuccessful passes, however, he rammed the defenseless transport, leaving a huge, gaping hole in the top of the fuselage. The kamikaze went down in flames: the C-47 merely shrugged and continued on its way. An account of the incident describes the remainder of the flight as uneventful though a bit drafty…"*
***Popular Mechanics,*** **June 1978**
**RE: on this occasion, the C-47 was rammed by a Japanese *Zero* fighter plane over Burma in 1944. The C-47 survived the ramming, returning to base while the Zero crashed and burned.**

973

974

## First in Peace

975

*"…If the DC-3 was first in war, it also has been first in peace…"*
***Popular Mechanics,*** **May 1986**

976

## Buried Alive

977


*"…In 1950, a fledgling Icelandic Airline was perilously close to financial disaster with its principal asset – a four engine DC-4 – down for good on a glacier in Iceland called Vatnajokull. A ski-equipped USAF Air Rescue Service C-47 with only about 10 hours on it was dispatched from the NATO base at Keflavik to pick up the stranded DC-4 crewmen. The rescue plane, however, itself became bogged down in the glacial ice, necessitating the evacuation of all personnel by a ground party. Before a salvage mission could be mounted, bad weather closed in, burying the C-47 under so much snow that only the tip of its rudder was visible from the air. The USAF abandoned the plane…"*
***Popular Mechanics,*** **June 1978**
**Caption: "Douglas C-47B Skytrain of the USAF Air Rescue Service"**

978

***"…But two intrepid Icelanders – Alfred Eliasson and Kris Oleson, the then hard-presses operators of Icelandic Airlines – didn't give up. They bought the salvage rights to the abandoned C-47 for $600 and, in the following spring, dug it out with shovels and a bulldozer. After hauling the craft 43 miles down the glacier to an improvised airstrip, Oleson climbed up into the cockpit and discovered, happily, that despite the aircraft's being buried in snow for months, its batteries had enough juice left to turn over and start both engines. He flew it back to Icelandic's headquarters at Reykjavik and the airline suddenly had itself a valuable new asset…"***
***Popular Mechanics,* June 1978**

979

980

***"…The plane was then flown to England for modification to commercial airline use. But before the work could even begin, Iberia, the Spanish airline, offered Icelandic $75,000 for it, just as it sat. Including the salvage fee, rescuing the C-47 had cost Icelandic about $6000. The Spanish offer was too good to refuse, and Icelandic found itself not only out of the financial woods, but with enough cash left over for a down payment on a replacement DC-4…"***
***Popular Mechanics,* June 1978**
**<u>Caption</u>: "Icelandic Airlines DC-4"**

981

## DC-3 vs. Mountain

982


***"…In April 1957, a Frontier Airlines DC-3 out of Phoenix defied the wind. Pilot Dave Welling received clearance to climb from 6500 to 9000 feet to get above a storm. As the plane started climbing, it hit a tremendous downdraft and began plummeting to earth. Welling struggled hard for control of the plane. It was only after he safely brought the plane back to Phoenix that Welling noticed that 10 feet of the left wing had been torn off. A few days later, the missing section was found on the side of a mountain about 50 miles north of Phoenix, where the DC-3 had brushed a mountaintop. The 26 passengers never realized how close they were to disaster…"***
***Popular Mechanics,* May 1986**

983

To: All Pilots

Subject: Quick Decision

Report of Flight Irregularity - Captain Dale R. Welling - Flight 8, 4-21-57

On April 21, 1957, trip 8 and 7 departed Phoenix. I was in command of the Phoenix, Arizona-Farmington, New Mexico - Phoenix segments. This is our Denver trip, however, the crews connect at Farmington and return to their respective origins. The trip was planned as VFR to Farmington and back to Winslow, then IFR to Phoenix. We were anticipating a frontal passage by late morning or early afternoon. The trip was flown as planned in every respect to connection point (FMN) and back to Winslow, Arizona. At that point it was evident that the frontal area had not approached as rapidly as expected and I elected to continue VFR through Flagstaff and Prescott, Arizona. Upon arriving at Prescott, I could see down the valley enroute to Phoenix. I requested deletion of Prescott refuel from Denver Control and would proceed VFR…

984

…The trip departed Prescott at 1321 hours - eleven minutes behind schedule. We were grossed out at 24,368 lbs. and had 22 revenue and 1 non-revenue passengers on board. The flight continued in mild turbulence, similar to what we had been experiencing all day. At approximately 1335 about 45 miles south of Prescott, I requested and received latest Phoenix weather via VHF as I could see build-up and converging layers ahead. I was told latest weather available was 3 thousand broken, 10 thousand overcast. Changing frequency to 118.1 to request approach control clearance, and being unable, returned to Company frequency and requested and received clearance from El Paso ATC. This clearance in part "cleared from Knob intersection to Phoenix Omni, maintain 7 thousand." Being at 65 hundred at the time, I started to climb to assigned altitude before contacting cloud bank ahead. The time now is about 1340. As climbing power was applied, still in VFR conditions, the airplane seemed to settle slightly. No particular notice was taken of this - it had been happening all day in light turbulence. Settling continued so 25 hundred RPM and 35 inches was applied. Aircraft still settled down. Maximum emergency power applied at 41-42 inches and 2700 RPM. Aircraft still settled. Aircraft speed at this tine was 90 knots indicated. We settled into a light snow squall below. It was light, fine, dry, snow restricting visibility…

985

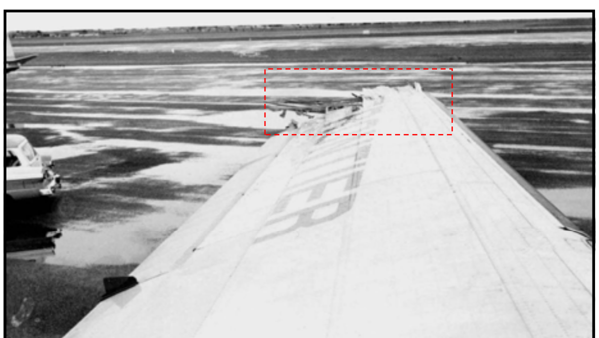

…The mountain peak below was hazily visible through storm. Prior to this, it crossed my mind to make 180-degrees out, but hesitated to lose the lift I had because of low airspeed and sluggishness of control. Aircraft still settled uncontrollably, contacting west slope of mountain peak on my left wing. Measurements showed that 12 feet of wing was sheared on this contact, as no pieces were blown off later. The aircraft skipped and tumbled on its left side. Slightly decreased right engine power and full right rudder was immediately applied. Plane staggered and slowly returned to level flight. Left aileron (the piece that was still with me) was frozen and immobile. Right aileron later disclosed as having 7 degrees up-travel and restricted to 2 degrees down travel. Air speed at this time started to increase and nose was lifted and maximum power continued…

986


987

…At 1345 I declared emergency conditions through Company then contacted Phoenix tower for emergency information, clear weather area, etc. I was on solid instruments by now, but able to climb gradually under full power. Aircraft returned to assigned altitude at 7 thousand where power was reduced as best trim and controllability speed was found to be 130 knots. Vibration and trembling encountered above 130 knots, sluggishness or wallowing below 130 knots. Flight was continued to Phoenix. Enroute emergency measures were taken for arrival at field. Approach was made at 130 knots as reduced speed felt inadvisable…

988



…Copilot and myself discussed briefly as to whether a chance should be taken on lowering gear or 'belly' it in. We elected to try a fast landing with gear down at last moment. We were over the fence at 125 to 130 knots. Touchdown after power reduction at estimated 115 to 120 knots. The plane was taxied to the loading ramp and shut down.

989

off, this crippled airliner with 26 persons aboard was flown 55 miles to a safe landing at Phoenix.

23 PASSENGERS LANDED SAFELY

## Airline Hunts Wing End Torn Off On Phoenix Hop

Frontier Airlines officials today started a search for a 10-foot section of wing from one of its passengers planes, sheared off in turbulent weather over rugged mountain country 55 miles northeast of Phoenix.

The wing section disappeared in flight late yesterday as a Frontier DC-3 — loaded to near-capacity — bucked strong winds and downdrafts en route to Phoenix from Prescott.

NONE OF THE plane's 23 passengers or crew of three was injured. They landed safely at Sky Harbor Airport just 25 minutes after the accident.

Carlton Foster, ground operations manager for Frontier, said a light plane carrying F. L. Aden of Denver, chief pilot for the airline, Capt. E. T. Burson, division chief pilot, and Capt. Dale Welling left for the Green River Mountain Country northeast of Phoenix in an effort to locate the sheered wing section.

Welling, of 3102 E. Mariposa, was piloting the DC-3 when the accident happened. He said the wing tip disappeared when the plane, caught in a downdraft,

DALE WELLING

THE BLUE-EYED stewardess who had only completed her hos[...] tess training in February, said tha[...] outside of the initial noise of th[...] plane's wing breaking there wa[...] no change from the passenge[...] standpoint in flight.

"The smoothness of the rid[...] never varied," she said.

Miss Bailey returned to her r[...] tine duties this morning, leav[...] Phoenix at 6:40 a.m. for a rou[...] trip flight to Winslow in anot[...] Frontier plane.

FOSTER SAID an inspec[...] from the Civil Aeronautics Adm[...] istration was expected to arr[...] in Phoenix from Los Angeles [...] Denver to try to determine w[...] caused the plane's wing tip [...] snap off.

There was speculation it m[...] have been caused by the sh[...] violence of the downdraft. And[...] er theory was that the wing stru[...] some object, perhaps a mount[...] peak or tree.

If the missing wing sect[...] can be located, Foster said, it w[...] help determine the exact ca[...] of the accident.

WELLING SAID the wing [...] snapped off about 1:45 p.m. y[...] terday while the plane was o[...] rugged country mostly north a[...]

990

## Part 12

## Taking Flight

991

## A Legend is Born

992

***"…The DC-3 was born in the first big expansion of airline passenger service. American Airlines President C.R. Smith called Donald Douglas in the summer of 1935 and said American needed a large, comfortable plane that could lure the luxury trade. Douglas engineers went right to work, using the basic DC-2 design to work up the new luxury model. Six months later, the first Gooney Bird was being test-flown…"***

***Popular Mechanics,*** **May 1986**

**RE: the *Douglas Aircraft Company* entered the fledgling aviation industry (in rooms behind a barber shop on Los Angeles' Pico Boulevard) at a time when the promise of the "Transportation Age" was yet to be realized. Among the dreamers was *Donald Douglas.* As an MIT aeronautical engineering student, Douglas envisioned the troika of efficiency, safety and passenger comfort that would make air transportation feasible. A decade later, in 1934, when the first "Douglas Sleeper Transport" (DST) went on order from *American Airlines,* Donald Douglas' vision was realized. In time, the DC-3 would come to be known as "the machine that taught the world to fly."**

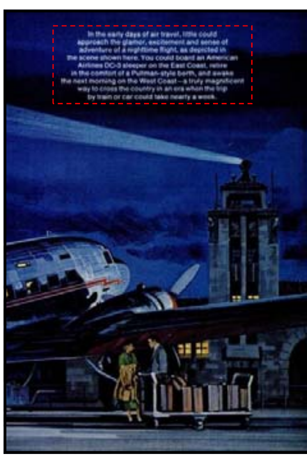
993

***"…The first model carried seven upper and seven lower berths with a private passenger cabin up front. It was later dubbed 'the honeymoon hut'…"***

***Popular Mechanics,*** **May 1986**

**RE: the DC-3's maiden flight was made on December 17, 1935, lasting 1 hour and 40 minutes. It was described as "routine." The DC-3 began its career as an airliner as the DST; a luxurious airborne "Pullman Car" purpose-built for *American Airlines.* It featured seven upper and seven lower berths plus a private cabin in front.**

994



***"…Following the maiden flight, Smith ordered 20 DC-3s for $110,000 each. On June 25, 1936, the first DC-3 began flying the New York-Chicago route nonstop. Later that year, American started Skysleeper service coast-to-coast. The first ticket was sold to child film star Shirley Temple…"***

***Popular Mechanics,*** **May 1986**

**Caption: "In the early days of air travel, little could approach the glamor, excitement and sense of adventure of a nighttime flight, as depicted in the scene shown here. You could board an American Airlines DC-3 sleeper on the East Coast, retire in the comfort of a Pullman-style berth, and awake the next morning on the West Coast – a truly magnificent way to cross the country in an era when the trip by train or car could take nearly a week."**

995

## The Height of Luxury

996


*High above the trail the stagecoach and Pony Express used to travel, a flying palace mightily wings its way from New York to Los Angeles. It's the "American Mercury," fourteen-passenger sleeper plane of American Airlines which crosses the continent from dusk to dawn – speeds you from ocean to ocean while you sleep. From the "sky room," a private dining room up front, in the semi-private drawing room up front, in the six semi-private sections in its spacious cabin, it is the height of luxury – and no pun intended. Riding a sleeper plane is a novel experience for most persons, and believing you might enjoy an overnight journey by proxy, we told one of our staff artists to make the trip and do a little sketching between naps. He boarded the flying Pullman at Newark and before he was long in the air, saw the stewardess making up the "uppers" and "lowers" and tucking in her sleepy passengers…*

997

*…There's no "box lunch" on the flying sleeper. Instead it's a six-course chicken dinner served piping hot from the flying kitchen – and there's real china and silverware…*

998

*…Over her private telephone the stewardess hears the pilot announce you're nearing Glendale and sixteen hours after leaving New York, you land in California.*

999

## Lying vs. Sitting Down

1000

***"…Most airliners flew 14 passengers in those days, but Smith realized that by removing berths, he could add seats. An additional 21 DC-3s fitted for 21 passengers were orders at the end of 1936…"***

***Popular Mechanics,*** **May 1986**

**RE: it soon became apparent that by removing the bunks a DC-3 could carry 21 passengers (in three rows of seven seats); a significant increase in seating capacity over other airliners then in service.**

**<u>Left</u>: caption: "American Airlines inaugurated DC-3 luxury flights in '36"**

**<u>Right</u>: caption: "The DC-3 offered the first luxury accommodations. Until the DC-3, planes carried 14 passengers – the DC-3 carried 21"**

1001

***"…Increased cabin space in the DC-3 brought all sorts of innovations to passenger flying. Hot meals served on comfortable tables or trays were introduced, and so was comfortable air-conditioning and soundproofing. The change worked magic with the general public…"***

***Popular Mechanics,*** **May 1986**

**RE: for passengers, the DC-3 represented a drastic improvement in service. Gone were the cold feet, vibration, the debilitating effects of constant loud noise and box lunches. Instead, DC-3 passengers were served hot meals on trays, sat in cushioned seats in a comfortable soundproof, heated cabin.**

1002

1003

***"…Within two years, air travel doubled in the United States. 'The DC-3 freed the airlines from dependence on government mail pay,' American's Smith said in 1939. 'It was the first airplane that could make money just by hauling passengers'…"***

***Popular Mechanics,* May 1986**

**RE: soon after its introduction, the DC-3 became a huge hit with the airlines** 1004

**<u>Caption</u>: "TWA stewardesses in front of a Douglas DC-3, 1938"**


**At speeds of from 165 to 180 mph, the plane's endurance allowed a coast-to-coast flight in just 15 hours, making just three enroute refueling stops. First placed in nonstop service between New York and Chicago on June 25, 1936, by 1938 the DC-3 was the standard equipment of all major U.S. airlines. As well, it was being operated in several foreign countries. In fact, the world's airlines were desperate to place orders for the DC-3 with Douglas, which couldn't fill orders for the plane fast enough.** 1005


1006

**By the outbreak of WWII, 90% of the world's air travel was on DC-3s. In all (exclusive of an indeterminate number of copies made by the Russians during WWII), nearly 11K DC-3s, in various versions were produced. The last DC-3 rolled-off the assembly line in 1946.** 1007

DC-3s boasted crew of three – pilot, co-pilot and one real, live stewardess. On short hops, you got a sandwich and apple; longer flights included luxury of a hot meal. First DC-3s were outfitted as sleepers with Pullman-style berths (center left). In later versions, seats replaced bunks (top left). After WWII, many went into corporate service with plush interiors (bottom left). 1008

Above: "Flagship Detroit" is one of the oldest DC-3s still flying. *American Airlines* took delivery in 1937 and the airplane is now owned, maintained and operated by *Flagship Detroit Foundation*.

1009

## A Flight Crew's Delight

1010

*"…If the plane pleased passengers, it simply delighted pilots and flight crews. It was a grandson of the DC-1, a superbly engineered craft itself. The twin-engine design was a low-wing monoplane with wings that had innovative honeycomb construction. That made them sturdy but lightweight and resilient in high winds. The wheels retracted into the engine nacelles for better flight aerodynamics…"*
*Popular Mechanics,* May 1986

1011

The DC-3 was a pilot's delight, featuring constant-speed propellers, an autopilot, power brakes and manageable flight controls. Douglas introduced real-world, usable performance charts with the DC-3; an innovation that not only added to safety but also allowed pilots to most efficiently operate the plane. Rather than having to guess the best altitude for a given flight, pilots could calculate that altitude based on actual conditions. This was a revelation for aviators accustomed to learning by trial-and-error. Douglas knew that providing these details would help the airlines make more money with the DC-series thus, they would buy more aircraft. This business model proved highly successful up through and including the company's DC-9 series of commercial airliners.

1012

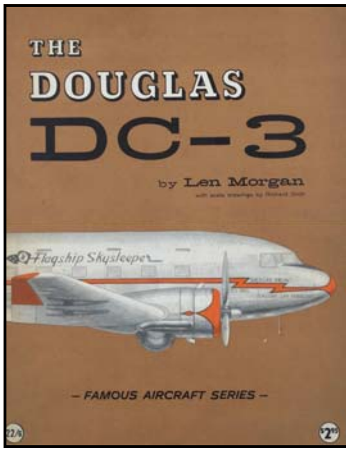
*"…A retired airline pilot with many hours at DC-3 controls, tells about checking out a young Navy lieutenant one sunny afternoon before the U.S. entry into World War II. Seated on the co-pilot's side, the young fellow looked out to his right and noted the extent to which the DC-3's wings flexed on take-off. 'Wow,' the kid said, look at it breathe!'…"*
*Popular Mechanics,* June 1978

RE: a pilot new to airline flying would first attend ground school for five or six weeks to refine his general aviation knowledge in meteorology, flight planning, aerodynamics, systems and instrument flight. After ground school, the freshman pilot got a few cycles in the DC-3 and then he was paired-up with a senior captain for his first few months of flying. Eventually, he'd move over to the left (pilot's) seat. Although the DC-3 could be flown with relative ease and confidence on the part of the pilot and co-pilot, its wings tended to flex and flap excessively.

1013

## A Craftsman of the First Order

1014




*"…The Three performed well with 21 fares and a surprising volume of freight. It was easy to fly, stable, and could continue flight on one engine at maximum weight. If an engine packed up leaving a small airfield, however, you had to do everything just right. The ship demanded a pilot's very best when the chips were down. Taxiing was a knack in itself, requiring coordinated use of rudder and throttles with minimum braking. You 'flew' from chocks-to-chocks. A true DC-3 artist was a craftsman of the first order, a wonder to watch…"*
***Len Morgan,*** **veteran airline pilot and author of "The Douglas DC-3" (left)**

1015

***"…Our ships had no autopilots so it was hand flying all the way. We'd file visual flight plans in good weather, climb to 300 feet above cruising level, then drift back down to pick up speed and get her 'on the step.' We flew as high as 12,000 feet…"***
***Len Morgan***

1016

1017

*"…Prop synchronization was done by ear and a tiresome day it was when one kept wandering off speed. The fuel selectors were used as footrests, the elevated knee being a natural brace for the arm holding the wheel, but care was needed to prevent shutting off fuel on your side. It was funny only when the captain's foot slipped…"*
***Len Morgan***
**Left: DC-2 cockpit**

1018


*"…Inside the cockpit, the pilot could control the pitch of the plane's tri-blade Hamilton propellers. The 710-hp Wright Cyclone air-cooled radial engines would give the plane the kind of power needed to beat out two Japanese Zeros. The pilot also had the luxuries of Sperry's new gyroscope and autopilot. The DC-3 also had a bigger, more flexible fuselage…"*
***PM,*** **May 1986**
**Caption: "The DC-3 was the first of the big-body airliners. Air-to-air photo shows an early model still in use after 50 years."**

1019

1020

***"…Trimming for hands-off flight was no trick, but it all went for naught when a 110-pound stew began serving lunch. Forward pressure, back pressure until she was done. 'Here comes our coffee,' the pilot flying would say before the door opened, rolling in a half turn of elevator trim if it was her custom to stay for a cigarette. A scoop in the nose was the sole source of fresh air so on hot days we'd climb with cockpit side windows open, the reason some of us are hard of hearing now…"***
***Len Morgan***

1021

1022

***"…I can still hear that pair of Pratt & Whitney 1830s roaring – and winding down on the ramp with a rattle of reduction gears. Piston engines spoke in subtle ways and it was wise to pay attention. An intermittent tremor felt through the rudder pedals, a minor compass swing in smooth air, the not-quite-right bark of exhaust could be a warning long before anything showed up on the gauges…"***
***Len Morgan***

1023


1024

***"…Landings were usually made on the mains with tail low. A three-pointer was not difficult, but you had better have her more than six inches above the concrete when you sat her down. We used full flaps in all but extremely strong winds and left them down until clear of the runway. The pilot who yanked flaps up on contact was usually afraid of the plane – afraid that the lift of the flaps might make her come unstuck again and difficult to control. Crosswinds required expert cross-controlling, and the man too quick at unlocking that tail-wheel eventually had a wild ride over airport property not normally used by airplanes…"***
***Len Morgan***

1025

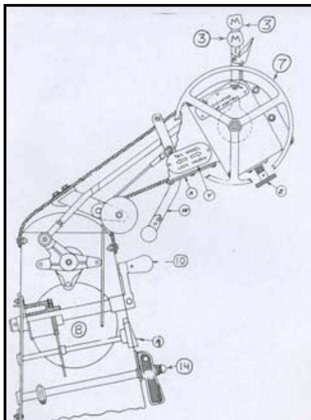
1026

***"…Flight in rough air was sheer hard work; ice and thunderstorms could be nightmares. The least of our trials was getting soaked to the skin. The windshield caulking leaked badly and poured cold water into your shoes. But who remembers the bad? My fond recollection is of padding through a calm autumn evening with cockpit lights turned down low, the familiar glittering landmarks sliding toward us on schedule, the welcoming glow of our final destination just visible on the horizon. Ah, but those were great times!..."***
***Len Morgan***

1027


***"…As the new Convairs arrived, the old Threes were sold to begin new careers with feeder lines. One day they were all gone, the colorful chapter was complete, and we moved ahead in an industry that spends little time looking back…"***
***Len Morgan***

1028



Cross Section (slice through) Control Pedestal

***"…Only a few snapshots, entries in logbooks and memories remain. Does anyone know where I can find a DC-3 control wheel?"***
***Len Morgan***
**Caption: "Cross-section through DC-3 Control Pedestal:**
**3. Mixture Control levers**
**7. Elevator Trim Tab Control wheel**
**10. Rudder Trim adjustment crank**
**14. Autopilot control Valve**
**W. Tail Wheel Locking Lever**
**Z. Throttle (friction) Brake Knob"**

1029

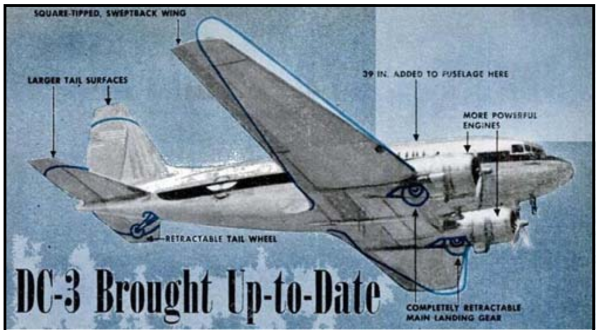
1030

**Super-Three**

1031

***"…With a decade of trustworthy passenger and military flight behind it, the DC-3 became known as the Super DC-3. But the airlines were now looking for bigger and more powerful planes to do their work. Most of the Super Threes went to the Navy as transports. The airlines ordered only 11. By 1948, Douglas halted production with 11,000 DC-3s to its credit. For most airplanes, this is where the story ends. But the DC-3 is a durable die-hard aircraft…"***
***Popular Mechanics,* May 1986**
**RE: the "Super DC-3" (or DC-3S) of the late 1940s met with little airline sales success, though it was used by the Navy and Marines as the R4D-8/C-117D**

1032




**THE DC-3**, famous old wheel horse of air transport, is getting a shiny new harness, The Douglas Aircraft Co. is offering civilian and military operators of some 6,000 of the twin-engine planes an overhaul from nose to tail. A choice of more powerful Wright or Pratt & Whitney engines will give the Super DC-3 a speed of 234 m.p.h., an increase of 45 m.p.h. A new take-off weight of 28,300 pounds, 3,000 pounds more than formerly, will boost passenger capacity from 21 to 31. Only outward differences will be 39 in. added to fuselage, sweptback, square-tipped wings, and larger tail surfaces (old version shown in color outline). (*Popular Science,* April 1949)

1033


Think what this means to your profit picture – a fast, modern version of the dependable DC-3 that will operate at *less cost per ton mile!*

At modest cost your present DC-3s can be converted to the new Douglas Super DC-3. New swept-back wings . . . New powerful engines that increase speed to 250 mph . . .built-in stair ramp to facilitate loading and unloading . . . New rear cargo compartment . . . New large, self-service baggage racks – these are just a few of the features of the Super DC-3.

Whether your airline is large or small – it will pay you to get the full facts on the new faster Douglas Super DC-3 – modern version of the most famous, time-tested airliner ever built.

1034

## Blockade Buster

1035

***"…In 1948, the Soviet Union stunned the world with their Berlin Blockade, but Harry Truman decided to stun the Soviets. Starting in June, a fleet of C-47s took part in the historic 3-momth Berlin Airlift, making more than 12,000 trips to Berlin and bringing in almost 40,000 tons of food, fuel and materials. The blockade was broken…"***

***Popular Mechanics,* May 1986**

**RE: during the *Berlin Airlift* of 1948-49, USAF C-47s lined-up to unload supplies at Berlin's *Tempelhof Airport,* breaking the Russian blockade of the city**

1036

1037

## The Bottom of the World

1038

*"…On May 3, 1952, a C-47 specially fitted with skis became the first airplane to land at the South Pole. It carried the first three men ever to set up camp at that pole. A second plane, a 4-engine Navy transport, landed at the South Pole a short time later and got stuck in the ice. A DC-3 had to be flown to their aid with a mechanic and spare parts…"*
***Popular Mechanics,*** **May 1986** 1039
**Caption: "The DC-3 was first plane to land at the South Pole"**

**A Regular Schedule Keeper**

1040


*"…More than 1000 DC-3s remain in service today. Almost 400 of these are in regular airline service, a tribute to the survivability of a plane built to last indefinitely. Several airlines around the world use the DC-3 as a regular schedule keeper. But many who want to fly in the Gooney Bird are not as interested in the destination as they are in the plane itself…"*
***Popular Mechanics,*** **May 1986** 1041
**Caption: "DC-2 'Congo Queen'"**

1042

## Part 13

## Déjà vu All Over Again

1043

**Museum Pieces**

1044

***"…A small West Virginia company called 'Sentimental Journeys' has a completely renovated DC-3 called 'Skytrain.' From the logo on the aircraft to the flight crews dressed in 1940s costumes, the plane is a trip into the past. Passengers see an in-flight videotape on the history of the beloved craft while on special charter trips. The plane flies to Hilton Head Island, South Carolina; Atlantic City, New Jersey; and other American playgrounds…"***

***Popular Mechanics,*** **May 1986**

**RE: *Don Elmore,* President of *Appalachian Flying Service* (AFS) based in Bluefield, WV, purchased *DC-3 N97H* in 1983 for use in a luxury air charter service known as "Sentimental Journeys" (SJ). SJ provided luxurious nostalgic air transportation to charter groups in the mid-1980s. N97H also visited many air shows during her short career at AFS. N97H was built in 1945 and saw only corporate/private use. At the time of its sale in 1988, she had just 8,900 hours logged on her airframe, making her the second-lowest time DC-3 in the world, at the time.**

1045


**In December 1985, *N97H* was the centerpiece for the National Aeronautics Association's (NAA) *Wright Memorial Dinner* at Page Avjet's *Washington-Dulles* complex. An entire hangar was transformed, with N97H as the centerpiece. Luminaries such as *George* and *Barbara Bush, William Shatner, Neil Armstrong, Senator John Warner, Charlie Gatesand* and many other aviation notables, along with the SJ's crew, were in attendance. The special occasion was the annual NAA awards and celebration of the 50th Anniversary of the rollout of the *Douglas DC-3*. AFS operations were discontinued in 1986 due to the exorbitant cost of insuring a vintage airliner in charter service. In 1988, N97H was sold to the *Otis Spunkmeyer Cookie Co.* for use in Bay Area tours out of Oakland, Calif. N97H was sold in March 1999 to *Jim Gabbert* (owner of San Francisco's television station *KOFY Channel 20*). It was later sold to the *Vintage Aviation Museum* in Stockton, Calif. Since 2007, N97H has resided at the *Hiller Aviation Musuem* in San Carlos, Calif., outside of San Francisco (above).**

1046

***"…The fifth DC-3 ever delivered is still on the FAA register as N133D. Originally delivered to American Airlines in 1936, the plane now is flown by the Air Academy of Griffin, Georgia. Provincetown Boston Airlines (PBA) establishes a record for the DC-3 every time its N136PB takes-off. In 1985 it had a flight history of 87,000 hours, the longest log for any DC-3, and perhaps for any plane…"***

***Popular Mechanics,*** **May 1986**

**RE: by the late 1970s, many still-flying DC-3s had accumulated +70K flight hours. *North Central Airlines* donated a DC-3 with 84,875 flight hours recorded to Henry Ford's *Edison Museum,* in Dearborn, MI.**

1047

1048

## Adaptive Reuse

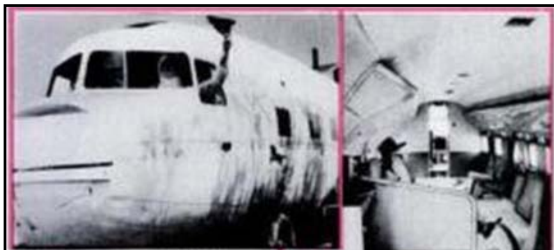
1049

***"…Some people can't bear being away from the Gooney Bird. H.L. 'Smokey' Rolland of Cardiff-by-the-Sea, California, bought a DC-3 from a junkyard in 1973. He made it into a mobile home. Another famous craft serves as a shelter at the airport in Whitehorse, Canada…"***

***Popular Mechanics,*** **May 1986**

**Caption: "In 1956, Swedish owners Carl and Amy Ostman converted a USAF DC-3 into an exclusive restaurant in Stockholm"**

1050




Old DC-3s never die, but they become some strange things, including restaurants and bars. Now Smokey Rolland, a retired flagpole painter in Cardiff, Calif., is turning a junked DC-3 fuselage into – would you believe? – a motor home. Powering the 42-1/2-foot-long camper has yet to be worked out, but the interior (right) is already comfortably equipped with reclining lounge chairs (from a 727), bunks, complete kitchen and bath facilities. Is a DC-3 street-legal? Rolland will soon find out.

1051

## Out of the Ashes

1052

***"…No one is taking bets on how long the DC-3 will continue flying. But in a recent PM interview, Doolittle said he expected 'the thing to fly as long as they can find sheetmetal.' That may be true. When the Argentinian internal airline lost a DC-3 in a freak fire two years ago, it decided to rebuild the plane. The ground fire caused no injuries and only the rear cabin and tail were damaged. It will be flying again next year. Maybe they'll nickname it the Phoenix."***
***Popular Mechanics,* May 1986**

1053

## Old Bird, New Beak

1054

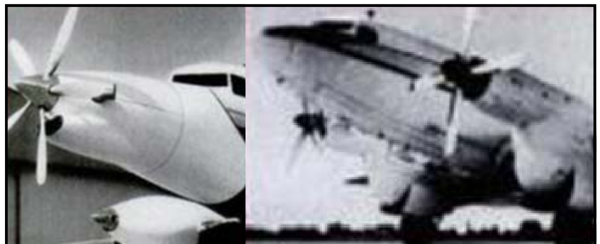
***"…Even today, DC-3s are proving remarkably adaptable. In California, for example, an outfit called Specialized Aircraft Co. has fashioned and ancient DC-3 airframe into a flashy trimotor turboprop, putting a new look on the bird. One Pratt & Whitney PT-6 engine is mounted smack on its nose, along with two more in the regular engine nacelle in the wings…"***
***Popular Mechanics,* June 1978**
**RE: two *Pratt & Whitney R-1830 Twin Wasp* radial engines (left) power most DC-3s and their military variants, but early versions (including the DST) originally featured the *Wright R-1820 Cyclone* which, by 1932, had increased to 700 hp. The company also adopted a forged crankcase, which was used on both the *P&W Wasp* and *Hornet* radial aircraft engine/s.**

1055

1056

In the early 1930s, Wright had been manufacturing a variety of both air and liquid-cooled engines. It was at this time that they decided to concentrate their efforts on the R-1820, stopping development on every other engine type. The *Wright Cyclone R-1820* was a 9-cylinder, single-row, air-cooled radial engine. Horsepower ranged from 700 to 1,500 hp (depending on the model and configuration). Wright Cyclone R-1820 engines were produced from 1931 until well into the 1950s by several companies under license that included *Studebaker, Lycoming* and *Pratt & Whitney.* It was also built in the Soviet Union as the M-25 and in Spain as the *Hispano-Suiza 9V*. It powered a range of aircraft that included the *Boeing B-17 Flying Fortress, Grumman J2F Duck, Curtiss P-36, Boeing 307 Stratoliner* and *Douglas SBD Dauntless.* Today, modern conversions ply the skies using turboprop engines, in place of and in addition to, the original twin radial piston engines.

1057



Left: caption: "New beak for an old bird: Yep, it's a DC-3, though you have to look closely to tell. This modernized version, Tri Turbo 3, sports three turboprops in place of two original piston engines – with one perched smack on the nose, giving the normally docile craft a sharp-beaked, hawkish look. The three Pratt & Whitney PT-6s, turning five-bladed props, develop 3600 hp for a cruising speed of 230 mph and 3000-mile range. The developers, Specialized Aircraft, Camarillo, Calif., hope it will add another 25 years' life to the 2500 or so aging DC-3s still flying. Cost of remodeling: about $575,000."
Right: caption: "Another modified DC-3 is this Super Turbo-Three with longer 'stretched' fuselage and turboprop engines. Its designed for short-haul commuter runs and cargo jobs."

1058


Caption: "This tri-motored DC-3 was registered to Polair and sported a black and yellow color scheme. At one point this aircraft was fitted with skid and leased to the U.S. Navy in Alaska. One writer, who claims to have seen the logs of this aircraft, surmised that it was also used by a government intelligence agency for some odd flights. This airplane went into storage in 1980 and was seen (in 1993) engineless in storage in the Mojave Desert. At last report this aircraft was registered to Warren Basler of Oshkosh, Wis."

1059

## New and Improved

1060

***"IN 1957, Warren Basler opened his Fixed Base Operation (FBO), Basler Flight Service, at Wittman Regional Airport (OSH), about 90 miles north of Milwaukee, in Oshkosh, Wisconsin…Six years after he opened his FBO, Warren Basler bought his first DC-3. He refurbished it and sold it to a customer with whom he would become a partner in a charter flight service…"***
***airportjournals.com,*** **January 1, 2007**

1061

Caption: "Basler built a $3 million, 75,000-square-foot modification facility adjacent to Wittman Regional Airport for his conversion work. Seen here are ships number 49 and 50 undergoing conversion."

1062

***"…Before Warren Basler formed Basler Turbo Conversions in 1988, Basler Flight Service had reworked hundreds of DC-3s, modifying interiors, restoring airframes and overhauling engines. Today, Basler Flight Service is a division of Basler Turbo Conversions LLC…"***
***airportjournals.com,*** **January 1, 2007**

1063

***"…In 1982, Basler spent $2.5 million to build a DC-3 turboprop conversion for Friendship Air, in Fairbanks, Ala. He replaced the standard 14 cylinder radial engines with two PT6A 45R turbojets, which boosted the speed from 165 to more than 200 miles per hour. By 1989, those engines had accumulated more than 5,000 hours of trouble free operation…"***
***airportjournals.com,*** **January 1, 2007**

1064

***"…Basler recognized that aging DC-3s needed engine and airframe enhancements and became involved with several modification concepts. Later, with two aircraft and a wish list, he began the modification and certification process. The FAA granted Basler Turbo Conversions a parts manufacturing approval for the parts it manufactures in-house. The FAA's Manufacturing and Inspection District Office still retains manufacturing oversight…"***
***airportjournals.com,*** **January 1, 2007**

1065

## The Making of a BT-67

1066

***"…The major modifications to convert a DC-3 to turbine power are made under a supplemental type certificate SA48-40NM, which was issued in Feb. 1990. Full certification was granted in Dec. 1990. That year, Basler had 10 orders for the converted DC-3, called the Basler BT-67…"***
***airportjournals.com,*** **January 1, 2007**

1067

***"…In the course of six months, the modification of a DC-3 takes place in three major areas: airframe, engines and props. The airframe is returned to its original specification. The radial engines are replaced with new Pratt & Whitney Canada PT6A-67R turboprop engines, certified to FAR Part 33, Amendment 10. Less maintenance is required for these engines, because overhaul time is at 6,000 hours versus 1,200 for the radial engines. Hartzell five-blade metal propellers replace the three-bladed props. Basler-converted airframes are 'zero-time,' with respect to mandated inspections…"***
***airportjournals.com,*** **January 1, 2007**
**Caption: "The BT-67 is a 'zero accumulated fatigue' (new) aircraft when it is completed, and boasts a truly indefinite service life, combining the most reliable airframe in history with the industry's most reliable engines. It has been meticulously redesigned to serve our customers for generations to come. Every day the BT-67 carries on the remarkable and historic Douglas legacy and adds to the amazing achievement record of the world's most reliable airframe."**

1068

*"…The company inserts a 40-inch plug in the fuselage, forward of the wing. This increases the airframe's volume by 35 percent, and moves the cabin bulkhead forward five feet. Without this plug, the new props would be right outside the pilot's window. 'We didn't think it was a good idea to have the ice shields in line with the cockpit,' said Tom Weigt, president of Basler Turbo Conversions. 'A fully loaded BT-67 has a slower approach speed than a comparably loaded DC-3. At 10,000 feet, the PT6A 67R engines pull the BT-67 along at 230 mph, and burns 150 gallons-per-hour of jet fuel,' said Weigt…"*
*airportjournals.com,* January 1, 2007

1069

*"…The FAA required improved wing performance, and longitudinal stability and control for the new engines. 'On the old DC-3, the wing stalls as a whole, and you lose aileron control,' explained Weigt. 'Adding a wing cuff (a leading edge droop) increased the wing area effect. The cuff causes the outer wing to stall last, and keeps airflow over the aileron, which improves stall behavior'…"*
*airportjournals.com,* January 1, 2007

1070

*"…An old expression stated that everything on the DC-3 had been changed except its shadow. 'Since we've lengthened the airframe, and modified the outer wing leading edge, wing tip and tail, the BT-67 even has a new shadow,' Weigt said…"*
*airportjournals.com,* January 1, 2007

1071

*"…Basler can convert an owner's existing DC-3 airframe, or provide an airframe for conversion. 'We're getting fewer requests to covert the owner's airframe,' said Weigt. 'The airframe condition is probably more important. Airframes with relatively little corrosion and a good maintenance history are what we are more interested in. We recently obtained the Miami Valley Aviation (Ohio) fleet of six DC-3s. All but one is in airworthy condition'…"*
*airportjournals.com,* January 1, 2007

1072

## The Low-Cost Alternative

1073

*"…The performance of the BT-67 is well known, and others are now looking at it for specialized applications. 'We have customers telling us, 'This is a good platform for survey work, for maritime patrol activities and even tactical maritime patrol,' Weigt said. 'We're seeing expanded interest in those applications. I think that's because we live in a very troubled world. The official U.S. product for those operations is the AC-130 Hercules, which is a high-dollar product. We're the 'low-price spread,' but we can still get the job done'…"*
*airportjournals.com,* January 1, 2007

1074

***"…The airplane has proven itself to be such an excellent platform for surveillance and tactical interdiction activities, Basler is concentrating on new military applications, such as search radar and advanced communications and intelligence equipment. 'The BT-67 can loiter over an area for ten hours, monitoring and downloading information,' said Weigt. 'It's low cost, and it keeps human intervention in the mix. We're a low-altitude application, at around 5,000 to 15,000 feet, where our infrareds are most effective. We do, however, have the capability to fly at 25,000 feet'…"***
***airportjournals.com*, January 1, 2007**

1075

**Caption: "The bubble below the nose of this BT-67 gunship is the forward looking infrared camera. All BT-67s have overwing exhausts to minimize their infrared signatures."**

1076

## In the Game

1077

***"…Basler Turbo Conversions is currently working on its 50th conversion. 'What distinguishes us from other companies is we keep improving our product,' said Weigt. 'Often a company goes through a strenuous development period, and then it becomes a fixed product. We've kept ours fluid. We keep making little improvements and small changes. We're a lot more agile, and that's what has kept us in the game'…"***
***airportjournals.com*, January 1, 2007**

1078

## Another Satisfied Customer

1079

***"…Basler Turbo Conversions is active in international markets, including Europe, the Far East, the Pacific Rim and Africa. 'In the last six months, we've delivered two BT-67 aircraft to Colombia, one to Colombian police, and a new gunship to their air force,' said Weigt. 'In addition to our Central, South American and Antarctic customers, we also serve the U.S. Forest Service, U.S. Air Force, Thailand, the Republic of South Africa, Mali and Mauritania…"***
***airportjournals.com*, January 1, 2007**

1080

Caption: "Basler's first BT-67 turbo conversion was sold to Policia Nacional of Colombia. Seen here, it's back for systems upgrades. The ship was used in the initial flight test program."

1081

***"…Our number-one driver has been the customer asking, 'Can you do this?' he said. 'A lot of companies talk about listening to their customers, but it's a lot tougher to practice it than to talk about it. When you're able to do it, it's worthwhile'…"***
***airportjournals.com,*** **Jan. 1, 2007**
**Caption: "The side-facing seats fold up, as seen on the right. Removing the forward-facing seats allows seating for 40 troops."**

1082

***"…The basic BT-67 aircraft costs $4.5 million, and an aircraft equipped with maximum capability would run $13-plus million. Such an aircraft is classified, but it would probably contain search radar, infrared, intelligence of some level, listening devices, secure communications, night vision compatibility, an on-board oxygen generation system and probably a gun capability. 'Every year we make some changes,' said Weigt. 'Most of them come from our customers who ask, for example, 'Can you build a glass cockpit? Can you take some weight out of the aircraft? Can you improve the performance? Can you give us a military flight manual?' they'll ask. The good thing is we can respond to them. When the request comes in, we take action'…"***
***airportjournals.com,*** **January 1, 2007**

1083

## From Spooky to Fantasma

1084

***"…One area where change has made a significant difference is in the gunship (nicknamed Fantasma). The gunship can climb to 15,000 feet, and isn't pressurized. 'With the old oxygen bottle system, we had four bottles,' Weigt said. 'If someone was shooting at you and hit one of the bottles, you became a flying bomb. To give the crew some protection, we had to add armor protection around the bottles. Then you had 600 pounds of weight added to the airplane, and the oxygen was still dangerous. The new OBOG is very low in pressure, around 40 psi, compared to the 1,800 psi in the bottles'…"***
***airportjournals.com,*** **January 1, 2007**

1085

## Lighter and Stronger

1086

*"…Basler trimmed more weight by re-engineering the floor. 'We used to use the old Fruehauf-style heavy duty truck floor, out of truck trailers,' said Weigt. 'It was a good floor, but it was too heavy. We took that concept and retooled it. Now, we make our own floor. It is much lighter, reducing the weight by 350 pounds'…"*
***airportjournals.com*, January 1, 2007**

1087

## Seeing in the Dark

1088

*"…He said next year they'll introduce a cockpit that's totally night vision compatible. 'All of the panel lights had to be modified, so they wouldn't interfere with night vision goggles,' he said. 'Every switch has its own light source. With just one switch, everything goes from day to night or from normal to night. Everything is filtered. Even at night, you'll see color on the weather radar'…"*
***airportjournals.com*, January 1, 2007**

1089

**Caption: "The cockpit on a BT-67 is clean and orderly, and some glass instruments make piloting chores easier"**

1090

## Single Engine Performance

1091

*"…The military wanted better single-engine performance, so Basler Turbo Conversions introduced a new propeller that improves performance, particularly in a single-engine emergency. In military situations, it allows the aircraft to carry large loads in and out of high-altitude airports. With that change, Basler also introduced a military operations flight manual…"*
***airportjournals.com*, January 1, 2007**

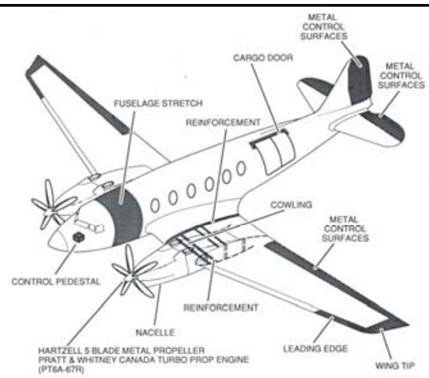
1092

## Polar Operations

1093

*"…The BT-67 is certified to colder temperatures, below -50C, for Antarctic customers. 'That, combined with a new battery system exclusive to Basler, is important for our customers,' said Weigt. 'It's a non-hazmat battery that's virtually maintenance free. We tried the recombination technology batteries, and found them to be 80 percent stronger, lighter and more durable. They cost less, and don't require special procedures for hazardous shipping. More importantly, they suffer far less power depletion in extreme cold than we found with lead acid batteries. The polar applications are an important market for us. Things like that keep the business refreshed and our customers coming along…"*
***airportjournals.com,* January 1, 2007**
**RE: from the polar ice caps to the sun-baked dunes of sub-Saharan Africa, the BT-67 is adaptable to any environment. From passenger, to cargo, to military and/or special purpose missions, the BT-67 is a high-performance *STOL* (Short Take-Off and Landing) aircraft that is versatile, rugged, simple, spacious and reliable.**

1094




**Caption: "This line drawing of the BT-67 shows the external changes made to the old DC-3. Metal control surfaces replaced the old fabric surfaces, greatly reducing maintenance."**

1095

## Founding Father Knew Best

1096

*"…He said a lot of the credit for the company's success has to go to the founder. 'Warren got us to the starting point, and we've built on it,' Weigt said. 'We haven't altered it. The way to recognize his work is to make something out of it and keep improving it'…"*
***airportjournals.com,* January 1, 2007**

1097

*"…Weigt said aviator and entrepreneur Jack Goodale, Basler's new owner, recognizes the value of what they do. 'He's built an incredible infrastructure,' Weigt said. 'We have an unbelievable stockpile of DC-3 parts. The barn is full, so we have 18 'C' containers out back, filled with more DC-3 parts. That's the beauty of the DC-3; a lot of parts are still around'…"*
***airportjournals.com,* January 1, 2007**

1098

**Caption: "The Basler DC-3 parts inventory is enormous. Tom Weigt is opening just one of the 18 'C' containers that store DC-3 parts."** 1099

***"…Warren Basler once described the DC-3 as a 'beautiful, stable and virtually indestructible airframe going to waste.' 'We realized that by turbinizing and modernizing the airplane, it would go on for many years,' Weigt said. He was right. The turbo conversion should take the old DC-3 to its 100th birthday and beyond…"***
***airportjournals.com*, January 1, 2007**

1100

**Caption: "Tom Weigt, president of Basler Turbo Conversions, LLC, says, 'The philosophy inherent in our manufacturing process is to exceed industry standards by following an uncompromising approach to excelence that produces a product of the highest quality'"** 1101

**24/7/365**

1102


***"…Basler Flight Service grew quickly and soon spun off the Basler Airlines division, flying passengers and cargo in DC-3s and other twin-engine airplanes. Basler became a well-known and highly respected name in this area. Basler Airlines helped make aviation an affordable tool for businesses, both large and small, which had the need to move people and cargo around the world…"***
***airportjournals.com*, January 1, 2007**
**Caption: "The clamshell cargo door is similar to one used on the C-47 version of the DC-3. Basler added an upper lip on the door that allows five LD3 containers to be loaded. FedEx and UPS use the LD3 containers."** 1103

***"…Today, Basler Airlines operates as an on-demand cargo airline, under FAR Part 135. Basler Airlines flies the first Basler turbine DC-3 (DC-3TP), an earlier version of the BT-67, with the same airframe design but differences in systems, engines and performance. The DC-3TP turbo conversion can haul up to 7,500 pounds, with room for cargo six feet tall in 42 feet of cargo space. A flight crew is on call 24 hours a day, 7 days a week."***
***airportjournals.com*, January 1, 2007**

1104

**Long-Live the DC-3!**

1105

***"…The DC-3 may never fade away. Social scientists of the future may one day reckon the impact on 20th century society to be about on a par with television and the automobile. In any case, the DC-3 will live as long as there are airmen to tell stories about it…There's life in the old girl yet!"***
***Popular Mechanics,*** **June 1978**

1106


1107

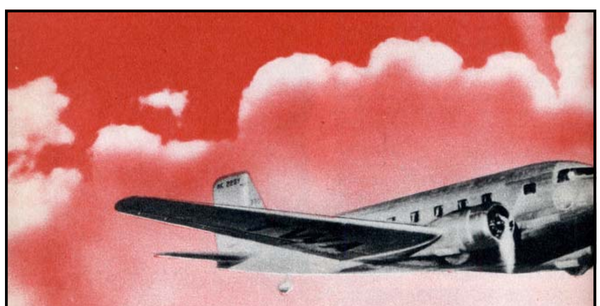
## Part 14

## Around the World in 18 Days

1108

**Girdling the Globe**

1109



**It took a flight around the world, entirely by air, to bring home to me the tremendous strides made by commercial aviation in the last ten years**
***Modern Mechanix,*** **January 1937**
**RE: introduction to an article written by *H.R. Ekins* entitled: "Around the World by Air"**
**Caption: "The TWA Douglas transport plane that carried Elkins part way on his around the world dash"**

1110

## A Study in Aviation

1111

Above – The German airship, Hindenburg, over N.Y. City. Elkins started his now famous trip from Lakehurst, N.J., aboard the giant dirigible on Sept. 30. Little more than 18-1/2 days later, he circled Lakehurst in a TWA transport plane en route to Newark, N.J., having girdled the globe. The route followed by Elkins on his record making flight, using only commercial airlines, is graphically shown at left. The safety and comfort of American airplanes was Elkins' outstanding impression of the flight.

***"FOR me the journey of little more than 18-1/2 days, during which I flew a route of approximately 26,000 miles, was a study in aviation as it is today compared to what it was only a few years ago. On my journey I used eight aircraft in all. The first was the German dirigible Hindenburg, the latest development in the science of lighter-than-air craft. The designers, builders and operators of the Hindenburg expect, however, that soon it will be surpassed by new giant ships of the air…"***
***H.R. Ekins,*** **Jan. 1937**

1112

## The Heavier-Than-Air Type

1113

***"…The other seven aircraft were of the heavier-than-air type. Three were used in the United States. They were twin-motored Boeings of the United Airlines and Douglas DC-2's of TWA-Transcontinental and Western Airways. The three planes which took me all the way from Frankfort, Germany, to Manila were made by Douglas, and the long trans-Pacific hop was aboard Pan-American Airways' 'Hawaii Clipper,' the big four-motored flying boat built by Martin and powered by Pratt and Whitney…"***
***H.R. Ekins,*** **January 1937**
**Caption: "Pan American Airways (PAA) Martin 130 'Hawaii Clipper' at anchor; ca. 1936"**

1114

## A Study in Contrasts

1115


***"…These aircraft are the most modern and most efficient available to the civilian traveler. The study in contrasts, in so far as airplanes were concerned, began at Frankfort when I boarded a big Douglas airplane operated by KLM - Royal Dutch Airlines…"***
***H.R. Ekins,*** **January 1937**

1116

## Exceeding Expectations

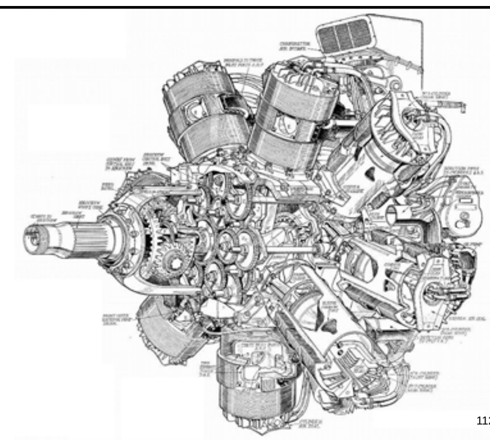
1117

***"…Six years ago, when I was flying around the Far East as a war correspondent for the United Press, the most powerful of the air-cooled radial engines of the Wright Cyclone type, were rated at about 525 horsepower. In 1930 it was believed, on the basis of experience and research with the material then available, that it would be decidedly impractical to build an engine rated at more than 600 horsepower and still maintain even a vestige of dependability. Dependability in those days meant an engine that would operate for 250 hours between routine overhauls…"***
***H.R. Ekins,*** **January 1937**

1118

***"…By 1931 the power of the Wright Cyclone was increased to 575 horsepower by using slightly larger cylinders to obtain increased cubic-inch displacement. During the same year advances in metallurgy and knowledge led engineers to believe that they had underestimated the possibilities of engines of the radial type…"***
***H.R. Ekins,*** **January 1937**
**Caption: "The radial engine was commonly used for aircraft engines before turbine engines became predominant. This type of engine is a reciprocating type internal combustion engine configuration in which cylinders radiate outward from the central crankcase."**

1119



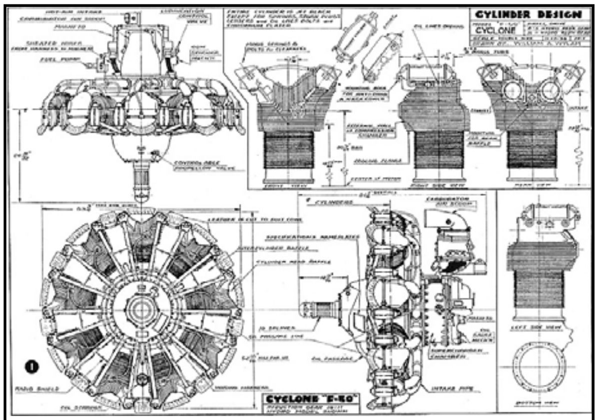
1120

## Monarchs of the Sky

1121

***"…To jump a bit to the advances which had been made by the time I was ready to take-off from Frankfort for the Orient I should like to point out the following: All the way from Frankfort, Germany, to Batavia, Java, flying in only two planes, I flew behind 890 horsepower F-50 Cyclone engines. The plane of the Royal Netherlands-Indies Airways, which took me from Batavia, Java, to Manila, was powered with 715-horsepower Cyclones…"***
***H.R. Ekins,*** **January 1937**

1122

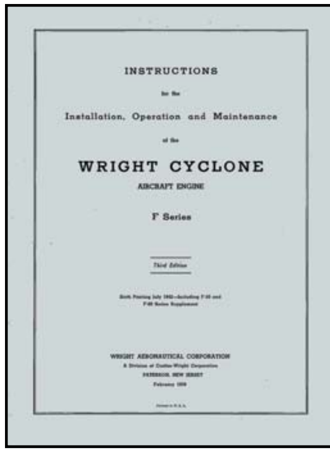



1123


***"…When TWA flew me across the continent on the last leg of the journey they used a Douglas pl-ane, the Sky Chief. It was powered with F-50 Cycl-ones of an 890-horse-po-wer rating…"***
***H.R. Ekins,*** **January 1937**
**Caption:** "OVERNIGHT – AND EVERY NIGHT – this Monarch of the Skies crosses America. Other TWA luxury Skyliners offer daylight flights between Califor-nia, Chicago and New York in both directions. And every plane is equipped with three radio re-ceiving sets and a transmitter, operating on four frequencies – two day and two night…"" 1124

## Series F

1125



INSTRUCTIONS
for the
Installation, Operation and Maintenance
of the
WRIGHT CYCLONE
AIRCRAFT ENGINE
F Series
Third Edition
WRIGHT AERONAUTICAL CORPORATION

***"…The series F engines go back to 1932 when the Wright Aeronautical Corp-oration announced the de-velopment of engines rat-ed at 700 horsepower at sea-level. They weighed only two-tenths of a pou-nd-per-horsepower more than the one pound per horsepower weight which the late Thomas A. Edis-on said was ideal for an aircraft engine…"***
***H.R. Ekins,*** **January 1937**
**Caption: "Wright R-1820-F Cyc-lone Aircraft Engine Maint-enance Manual, 1938"** 1126

***"…The success of the Cyclone F was immediate. Its first commercial application was in the fleet of Douglas Airliners with which TWA equipped itself in 1934. The American and Eastern Airlines followed suit. Strangely enough, most of this I learned while flying with Dutch pilots across Europe, the Near East, and India to the Far East…"***
***H.R. Ekins,*** **January 1937**
**RE: although of the same displacement (1,820 cubic-inches) as the F and the F-50, the *Wright G Cyclone Series* represented the latest air-cooled aircraft engine developed by the company, incorporating many refine-ments and improvements, including:**
- **Increased cooling fin area of 2,800 square-inches (as opposed to 1,000 square-inches in other Cyclone models);**
- **Advancement in foundry techniques to cast cooling fins on the G cy-linder head as closely spaced as the teeth on a comb and nearly two in-ches in depth over the combustion chamber, and;**
- **Cylinder barrels made of of Nitralloy steel (nitrided to obtain a cylinder bore with a surface with three times the wear resistance of ordin-ary heat-treated cylinder barrels).**

1127

## A Proven Winner

1128

***"…While flying over scorched, monotonous deserts I learned that in 1934 the leaders of Dutch commercial aviation were following developments in America closely. KLM negotiated with TWA to purchase one of its ships. TWA had the Douglas production tied up with priority rights. The Dutch got their ship. Cyclone powered, it was used by two KLM pilots, Parmentier and Moll, in the McRobertson London-to-Australia air derby that involved 12,000 miles of flying. They took second place in the speed race and first place in the handicap division. By the time the race was over KLM had ordered a fleet of Douglas planes, all powered with Wright Cyclones…"***
***H.R. Ekins,*** **January 1937**

1129


**Caption: "Elkins, 4000 miles ahead of his racing rivals, shakes hands with the Dutch (K-L-M) Airline pilot who flew him from Athens, Greece, to Batavia, Java. Dutch airlines favor American airplanes and engines."**

1130

***"…The performances of Cyclones in Douglas airplanes used to establish records both in this country and abroad caused the Douglas Company to standardize on the Wright Cyclone engine for airliner installation. Of more than 150 Douglas airliners now in use only one, I believe, is powered with other than the standard engine…"***
***H.R. Ekins,*** **January 1937**
**RE: the *Wright R-1820 Cyclone* had become a topflight aircraft engine by the early 1930s thus, it was selected to power the *Douglas DC-2,* forerunner of the *DC-3***

1131

## Most Impressive

1132


***"…It was the dependability of airplane engines that impressed me most as I flew around the world. I was actually in the air 8 days, 10 hours and 26 minutes, and to a man anxious to get home swiftly, yet safely, the matter of dependability was of utmost importance…"***
***H.R. Ekins,***
**January 1937**
**Caption: "Completing a flight of almost 26,000 miles in 18-1/2 days Elkins steps from a TWA Douglas transport at Newark, N.J. with a world's record for fast travel, using American aircraft most of the way"**

1133

***"…The motors behind which I flew in my early days as a passenger in airplanes would run dependably for only about 250 hours before overhaul. Now they will run at least 400 hours. Dutch engineers, great enthusiasts for American airplane power plants, told me that operation of 700 hours without overhaul is possible…"***
***H.R. Ekins,*** **January 1937**

1134

## Mechanical Marvels

1135

*"…Several developments, I found as I flew, are responsible for the high efficiency of the mechanical facilities which enabled me to get around the world as fast as I did. They included the dynamic damper, a patented development removing all vibration from the engine. There were also improvements in cylinder head designs and better cooling which marked an important step towards increased power. In this connection we can look forward to further advances in supercharging which will allow greater power, especially at high altitudes…"*
***H.R. Ekins,*** **January 1937**

1136


The new Series F-50 Wright Cyclone develops 775 h.p. for take-off at sea level with correspondingly high power output at high altitudes. This outstanding performance reflects the following distinctive features of design:

1. *Dynamic Damper,* which promotes a smoothness of operation never before attained in a radial air-cooled engine and removes engine speed restrictions throughout the operating range.
2. *Controlled Pressure Lubrication of the Valve Gear* from the engine oil system, eliminating grease and oil fittings to be serviced periodically by hand.
3. *New Cylinder Heads* with deeper and more closely spaced fins, operating under higher brake mean effective pressures, but at lower operating temperatures.
4. *Specially Treated Cylinder Barrels* with hard inner surfaces which not only appreciably lengthen the life of these parts and that of the pistons, but also reduce piston ring wear.
5. *Improved Supercharger Unit* which markedly increases supercharger efficiency both at sea level and high altitudes.

These new developments, added to the Cyclone's basic design, produce in the Wright Series F-50 Cyclone an aircraft engine unequaled in its displacement class for performance, dependability and economy of operation.

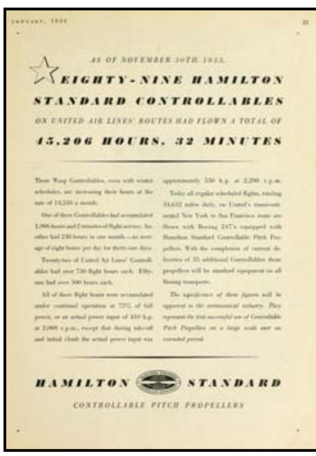
1137

*"…A remarkable development in aviation which was not available until a few years ago is the 'gear shift of the air' - the controllable pitch propeller operated from the engine oil pressure. And there are the new drives to operate vacuum pumps used to actuate retractable landing gear…"*
***H.R. Ekins,*** **January 1937**
**RE: *Frank W. Caldwell* (1889-1974) was an engineer who made landmark advances in the design of aircraft propellers in the 1920s and 1930s, having pioneered a new propeller design that used detachable blades. Caldwell's major breakthrough was perfecting the use of a hydraulic (rather than a mechanical) system to change the angle of the propeller blade. The blade allowed for pitch adjustments, a feature that made Charles Lindbergh's 1927 solo transatlantic flight possible. By minimizing or maximizing the pitch, not only did Caldwell-designed propellers improve aircraft take-offs and landings on short fields, they enabled pilots to "feather" the blades to reduce drag from a disabled engine on a two or four engine aircraft, thus saving valuable fuel and helping to control the aircraft.**

1138

**<u>Caption</u>: "American airplanes equipped with Hamilton controllable pitch propellers like these above were instrumental in enabling Elkins to set a world's air travel record. They permit short take-offs, maximum speed."**

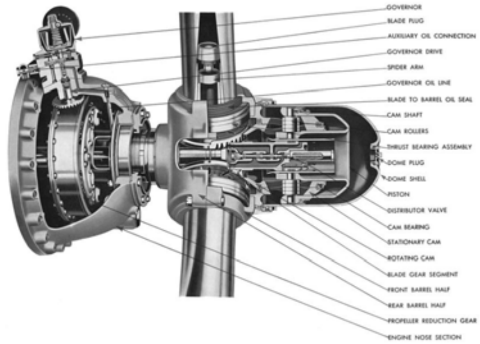
1139



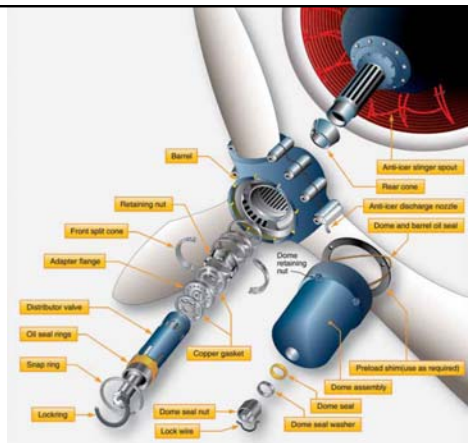

**The *Hamilton Standard S8460L* propeller, a two-position variable pitch device, replaced the ground adjustable fixed pitch propeller made by the *Standard Propeller Company,* which merged with Hamilton Standard. Later, constant-speed propellers were introduced that would maintain engine rpm across a range of propeller settings. Eventually, twin-engine aircraft were fitted with constant-speed propellers that could also be feathered, but many early twins didn't have this very useful feature.**

1140

A propeller is an "air screw" that generates forward thrust, or in the case of a reversible propeller, generates reverse thrust (to slow an aircraft rapidly for landing on short runways). The greater the pitch (angle of the blades) - the more pulling power at a specific spinning speed. Take-offs and/or landings require coarse pitch whereas steady speed requires fine pitch, in part to save fuel. The first propellers, carved from wood, were fixed pitch, thus they were a compromise between maximum thrust and fuel efficiency. Initially, variable-pitch propellers required pilots to have great physical strength to move the purely mechanical controls and overcome the so-called centrifugal - outward (Latin for "center fleeing") force of a rapidly spinning propeller. The pitch-changing mechanism of variable pitch propellers is a mechanical-hydraulic system in which hydraulic forces acting on a piston are transformed into mechanical twisting forces acting on the blades. Linear movement of the piston is converted to rotary motion by a cylindrical cam. 1141




1142




1143

A bevel gear on the base of the cam mates with bevel gear segments attached to the butt ends of the blades, thereby turning the blades. The centrifugal force acting on a rotating blade includes a component force that tends to move the blade toward low pitch. A second force, engine oil pressure, is supplied to the outboard side of the propeller piston to assist in moving the blade toward low pitch. Propeller governor oil, taken from the engine oil supply and boosted in pressure by the engine-driven propeller governor, is directed against the inboard side of the propeller piston. It acts as the counterforce, which can move the blades toward higher pitch. By metering this high-pressure oil to, or draining it from, the inboard side of the propeller piston by means of the constant-speed control unit, the force toward high pitch can balance and control the two forces toward low pitch. In this way, the propeller blade angle is regulated to maintain a selected rpm. 1144

<u>Caption</u>: **"Wright R-1820 Cyclone 9 and Hamilton Standard propeller of American Airlines Douglas DC-3"** 1145

In 1929, while working at the ***Hamilton Standard Propeller Corporation,*** Caldwell developed a hydraulic, two-position propeller that improved take-off and landing efficiency. In 1933, the ***Collier Trophy*** (awarded in recognition of significant achievements in the advancement of aviation) was awarded to Hamilton Standard, with particular credit to ***Frank Caldwell,*** for the development and demonstration of a controllable pitch propeller. Although work in Great Britain and Germany on the concept of a variable pitch propeller preceded Caldwell's efforts, he perfected a hydraulic rather than mechanical means to change the blade's angle.

1146


This new propeller design was incorporated into most planes used during WWII. Using Caldwell's design, Hamilton Standard produced 500K propellers during the war.

Caption: "More than 500,000 propellers bearing the Hamilton Standard emblem have been delivered to the armed services by the wartime team of Hamilton Standard Propellers and its American licensees – Frigidaire, Nash-Kelvinator, Remington Rand and Canadian Propellers. They comprise more than three-quarters of all propellers on American warplanes. In addition, two-thirds of all propellers on British-built warplanes are of Hamilton Standard design. These modern propellers are the result of intensive research, development, and grueling test in actual service. Always looking ahead, Hamilton Standard engineers have kept pace with the rapid increase of aircraft engine horsepower…" 1147

1148

Continuous Development

How improvement in engine and aircraft performance has been anticipated by Hamilton Standard developments.

1925 Hamilton Standard adjustable-pitch metal propellers come into general use, supplanting fixed-pitch propellers.

1930 First entirely practicable controllable-pitch propeller designed and flown by Hamilton Standard.

1933 The Hamilton Standard controllable-pitch propeller adopted as an essential item of equipment on high performance aircraft. Awarded the Collier Trophy as the greatest aeronautical achievement during 1933.

1934 "Constant-speed" control for Hamilton Standard controllable-pitch propellers developed and successfully applied to multi-motored ships.

1935 Hamilton Standard constant-speed propeller adopted as standard air line equipment - - is flown across the Pacific and back on the China Clipper - - is used on flight establishing new world's landplane speed record.

1936 "Continuous development"

HAMILTON STANDARD PROPELLERS
East Hartford, Connecticut
DIVISION OF UNITED AIRCRAFT MANUFACTURING CORPORATION

Caldwell also developed a "propeller whirl test" to test his designs for efficiency. The test process called for mounting a propeller to a stand with instruments that measured thrust, endurance, performance, and speed. He later designed whirl-testing facilities for the U.S. Government at *McCook Field* and *Wright Field,* in Dayton, Ohio. A true aviation pioneer, Caldwell's revolutionary propeller designs brought forth a new era of flight efficiency and safety. 1149

Caption: "Group poses standing behind the 1,000th Controllable Pitch Propeller produced by Hamilton Standard Propeller Company, Hartford, Connecticut, prior to delivery to the U. S. Navy; 1934. Frank W. Caldwell, Chief Engineer, at far right." 1150

## Marvels to Behold

1151

*"…I marveled as I sat in the control cabins of airplanes and as great areas of geography were left behind beneath us I learned of down-draft carburetors, wing de-icers, the complete shielding of the ignition wiring system to prevent interference with radio reception, and many other aviation achievements. The down-draft carburetor guarded against dirt getting into the engines by taking the carburetor intake air from the top of the motor instead of at the bottom where great clouds of dust were churned up when the plane taxied along the ground…"*
*H.R. Ekins,* January 1937

1152

## The Next Word

1153

*"…To attempt to look ahead in the aviation industry literally takes one's breath away. I thought, as I traveled, that I was flying in the last word in heavier-than-air planes. Now I am learning of engines of 1,000 horsepower. More than 600 Wright engines of 1,000 horsepower have been ordered by the United States Army Air Corps for the new Boeing and Douglas bombers now being built to increase the strength of American military aviation. These new power plants have a fuel consumption which closely approaches that of a Diesel engine. The Dutch have ordered new airliners to be equipped with 1,000 horsepower engines. American Airlines and TWA will use them in this country…"*
***H.R. Ekins*, January 1937**

1154

## Nitriding

1155

*"…Behind the scenes in all these development are advances in manufacturing. One of these revealed to me was the nitriding of the interior of cylinders in which the pistons move up and down. As the results of nitriding, the hardness of the cylinder interiors has been increased three times. They become so hard they will cut glass. This, of course, means that the cylinder walls have great wear resistance and will last materially longer…"*
***H.R. Ekins*, January 1937**

1156

## Magnafluxing

1157

*"…Then there is magnafluxing. Manufacturers, after machining and polishing each steel part for an airplane motor – magnetize it. Then they immerse it in an oil solution which has fine iron particles kept in suspension by an air agitator. If there is a surface crack or defect in the steel, the edges of the break form the two poles of a magnet and attract the iron particles. Hence, the break is shown by a thin black line. Defects which might not be discernible even under a microscope of 10 to 20 diameter enlargement strength are clearly shown up in magnafluxing."*
***H.R. Ekins*, January 1937**

1158

**Having Seen the Future**

1159

***"…Records accomplished during the last few months prove the phenomenal progress achieved by American air transport lines in the ten years since their inception. If we could look back some thirty-two years when the Wright Brothers climbed into a contraption which they called an airplane and went aloft, even though it was just for one minute and someone had the foresight to visualize the future of aviation and prophesied that by 1934 it would be an overnight flight to California from New York, or an eight hour hop to Miami, I am sure they would have been pronounced insane, but fortunately for us it is an actuality…"***
***Capt. Eddie Rickenbacker***
**RE: excerpt from an article the WWI ace authored for the February 1935 issue of *Modern Mechanix* magazine entitled: "Around the World on the New Airways of the Seas"**

1160


In 1939, Norman Bel Geddes designs Futurama, the General Motors pavilion at the New York World's Fair. Departing visitors are given a pin that reads, "I HAVE SEEN THE FUTURE."

1161

## Part 15

## Builder of Super Planes

1162

**The Talented Mr. Douglas**

1163

**His name is Donald Willis Douglas. Sixteen years ago he was working as an engineer for Glenn Martin, builder of the now famous Martin bombers. Today, as head of his own firm, he is rated one of the world's foremost designers and constructors. In July, 1936, President Roosevelt officially awarded him the Collier Trophy for 1935 in recognition of his outstanding work in the development of twin-engined commercial transport planes.**
***Modern Mechanix,* October 1937**
**RE: introduction to an article entitled: "Douglas – Builder of Super Planes"**

1164

## A Series of Fortunate Events

1165

***"DOUGLAS was born on April 6, 1892, in Brooklyn, N.Y., and as a youth attended the Trinity Chapel School in New York City. In 1909, having successfully passed the difficult entrance examinations in good style, he entered the United States Naval Academy at Annapolis…"***
***Modern Mechanix,*** **October 1937**

1166

***"…For three years everything went along quite well for young Douglas and it seemed certain that another year would see him commissioned in the U.S. Navy…"***
***Modern Mechanix,*** **October 1937**

1167

**Caption: "A young Donald Douglas as a cadet at the Naval Academy"**

***"…However, he was very much interested in aviation, even at that early-date, and spent all the time he could spare from study and training in building model airplanes. One day, he climbed to the second story of a barrack and launched a model into the air. Fate so ordained that the little craft swooped earthward, knocking off the hat of an admiral who was passing by at the time. Evidently, the old sea dog wasn't very air-minded, for within a short time Douglas resigned from the Naval Academy…"***
***Modern Mechanix,*** **October 1937**

1168

***"…The young man was determined, however, to secure a good engineering education, so he immediately entered the Massachusetts Institute of Technology, and was graduated in 1914 with a Bachelor of Science degree. The following year, he joined the engineering staff of the Glenn L. Martin Company and was made chief engineer of the little shop in Los Angeles, which was the only plant the Martin organization boasted of at that time…"***
***Modern Mechanix,*** **October 1937**

1169

***"…In 1916, Douglas resigned his position to become a civilian aeronautical engineer with the U.S. Army Signal Corps. In 1918, he rejoined the Martin organization, this time being made chief engineer of the large plant which Glenn Martin had developed at Cleveland, Ohio. During this time, he assisted in the designing and building of the first twin-motored Martin Bomber. This equal-span biplane was the first practical multi-motored bombing plane developed in this country. Powered with two 400 h.p. Liberty engines, this bomber was a standard service bombardment craft for many years…"***
***Modern Mechanix,*** **October 1937**

**RE: the *Martin MB-1* was a twin-engine bomber designed and built by the *Glenn L. Martin Company* for the *U.S. Army Air Service* (USAAS) in 1918. It was the first purpose-built bomber aircraft produced in the U.S. The MB-1 was a conventional biplane design with twin fins and rudders mounted above the tailplane and a fixed tailwheel landing gear with four-wheel main gear. Powered by two 400 hp *Liberty 12A* engines, it had room for a crew of three in open cockpits. Designated "Martin MB-1 GMB" (for *Glenn Martin Bomber*), initial delivery to the USAAS took place in October 1918.**

1170

1171

## DD & DD, Inc.

1172

*"…In 1920, Douglas again left Martin and after spending a short time in the East decided to go to the Pacific Coast in the hope of finding enough capital to enable him to establish his own aircraft factory. He arrived in Los Angeles with limited funds, but within a comparatively short time was able to interest a Mr. David Davis in his plans. Believing that the day of commercial aviation was dawning, Douglas was of the opinion that if the American public was stirred by a non-stop transcontinental flight, commercial air transportation would receive a more ready welcome…"*

***Modern Mechanix*, October 1937**

**RE: on July 10, 1920, The *Davis-Douglas Company* was formed in the back of a Los Angeles barber shop**

**Caption: "Donald Douglas and his partner David Davis"**

1173

## The Beginning of the Beginning

1174

*"…The Davis-Douglas Company was formed and a small shop was leased from the Goodyear concern. In this little plant, the first Douglas ship, the Cloudster, was built. Designed especially for the transcontinental hop, this Liberty powered craft was the first American-built airplane which could get off the ground with a useful load equal to its own weight…"*

***Modern Mechanix*, October 1937**

**Left: caption: "Beginnings: At upper left is the Los Angeles barber-shop office of Douglas and his early partner, David R. Davis. It was here that he designed his first plane."**

**Right: caption: "The Cloudster, as it took shape in a Los Angeles warehouse. Streamlined and instrument-equipped, it was a reconnaissance-type craft."**

1175

**Upper Left: caption: "The partially assembled Cloudster being towed by a truck. The engine is on the bed of the truck."**

**Upper Right: caption: "The Davis-Douglas crew pose with the Cloudster"**

**Left: caption: "The Cloudster has the distinction of being the first airplane in the world capable of carrying a useful load greater than its empty weight"**

1176

*Donald Douglas* was determined to design and build an aircraft capable of nonstop flight coast-to-coast across the continental U.S. The resulting aircraft was the *Cloudster,* a single-bay equal-span biplane of wooden construction. Except for the forward fuselage (which was covered with sheet metal), it was fabric-covered. Propulsive power was provided by a 400 hp ***Liberty V-12*** piston engine. Designed to make the first nonstop flight coast-to-coast across the U.S., it was the only product of the ***Davis-Douglas Company***. 1177

Caption: "Donald Douglas with some wing ribs"

1178


***"…On its attempted non-stop flight across the country, the Cloudster was forced down at El Paso, Texas, by engine failure. Mr. Davis withdrew from the concern and the Davis-Douglas Company passed out of existence…"***

***Modern Mechanix,*** **October 1937**

**RE: on February 24, 1921, the *Cloudster* made its first flight and in June 1921, the aircraft failed to make a nonstop transcontinental flight due to engine failure. Although it failed in its transcontinental flight attempt, it served as the basis for a USN torpedo plane. Following the failure of the flight, Davis lost interest in the company. Douglas went on to form the *Douglas Company* (later the *Douglas Aircraft Company*), in July 1921**

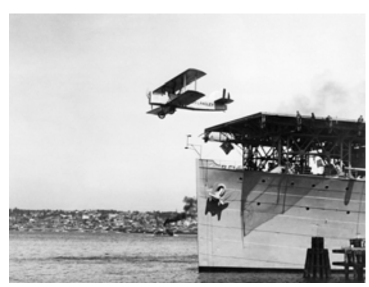
**Left: *Douglas Aircraft Company* stock certificate** 1179

***"…In the meantime, Douglas attracted the favorable attention of several influential men and in 1921, when the Navy announced an open competition for torpedo plane designs, he was able to raise some $15,000. With this sum he set to work, and designed and built the craft which won the competition. This marked the real beginning of the present Douglas organization, for the Navy immediately ordered two of the ships. The following year eighteen more were delivered to the U.S. Navy…"***

***Modern Mechanix,*** **October 1937**

**RE: *USN Contract No. 53305,* dated April 1, 1921, set out the specifications that resulted in the purchase of three DT (D for Douglas, T for torpedo) folding-wing aircraft that was the Douglas Aircraft Company's first military contract. The *Douglas DT* used a welded steel fuselage with aluminum covering the forward and center section/s while fabric covered the rear section. The DT could be fitted with either pontoons or wheeled landing gear and could carry a 1,800 lb. torpedo. The first flight was in November 1921 and production continued until 1929. The DT operated off the USN's first aircraft carrier, *USS Langley,* from land bases and from seaplane tenders.** 1180


1181



1182

*"…As a result of the success of the Douglas torpedo plane, the 'D.T.,' an improved model was brought out. This twin-float, Liberty-powered biplane was delivered to the Navy in quantity and many of them were also sold to the governments of Peru and Norway…"*
***Modern Mechanix*, October 1937**
**RE: Douglas built 46 DT-1 and DT-2 torpedo bombers for the USN, Norwegian and Peruvian Navy/s. Twenty DT-2 aircraft were built under license by the *Lowe, Willard & Fowler Engineering Co.*, six by the *Naval Aircraft Factory* and eleven by the *Dayton-Wright Co.* Another seven were built for Norway under license by *Marinens Flyvebåtfabrik.***
**<u>Caption</u>: "A Douglas DT of the U.S. Navy dropping a torpedo"**

1183

## Rivaling Magellan

1184

**Army fliers to cross twenty-two countries in journey that will cover thirty-nine thousand miles**
***Popular Mechanics*, May 1924**
**RE: introduction to an article entitled: "Perils Faced in Around-World Flight"**

1185

***"UNDER the imaginative pen of Jules Verne, Phineas Fogg went entirely around the world in eighty days, using boats, trains, elephants and even a sail-equipped sled. On the home stretch he burned the furnishings of his ship for fuel. But these difficulties pale into insignificance when compared with the hazards of the feat proposed by the United States Army - a round-the-world flight by a fleet of airplanes, American designed and built throughout…"***
***Popular Mechanics*, May 1924**

1186

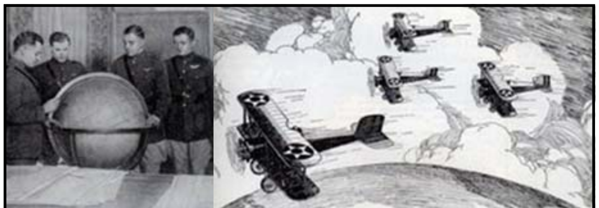
***"…'The United States,' said Maj. Gen. Mason E. Patrick, chief of the air service, 'has the distinction of holding every air record of value, including speed, altitude, endurance and distance, and now has conceived a project rivaling in importance the circumnavigation of the globe by Magellan. The four planes to make this flight will demonstrate the feasibility with which aerial communication may be established between continents. Much valuable information will also be obtained concerning the operation of the present type of aircraft in the various climates of the world'…"***
***Popular Mechanics*, May 1924**

1187


Map of Proposed Around-the-World Flight of Four Planes

***"…Starting from San Diego, Calif., the aviators will fly direct to Seattle, where they will hop off on the first leg of the approximately 39,000-mile voyage over the air lanes of twenty-two countries. Roaring northward along the coast of Canada and southern Alaska; across the Aleutian islands; down through Japan; across India; up the Persian Gulf; across Turkey and Europe to England; thence to Iceland and Greenland and southward to the Canadian border, it is hoped the planes will escape the rainy season in the United States and India and will complete the journey by August or September…"***
***Popular Mechanics*, May 1924**

1188



***"…The four American planes will be all metal, have a wing spread of fifty feet, a speed of 175 miles an hour and a radius of 2,500 miles. They will carry 800 gallons of gasoline, fifty gallons of oil and be able to stay aloft twenty hours. The longest continuous flight necessary on the voyage will be from Attu to the Kurile islands, a distance of 700 miles. Other long hops will be required over the Atlantic ocean between the Faroe islands and Iceland and Greenland, and between Greenland and northern Canada. It is expected that, before the journey is completed, each airplane will ha-ve changed motors three times…"***

***Popular Mechanics,* May 1924**

**Left: caption: "Army fliers at Langley Field, Va., studying route to be covered in Around-the-World flight"** 1189

***"…Deep canyons, mighty glaciers, timber-covered mountain ranges and snow-topped peaks form a terrain of marvelous beauty, but one which evokes no cry of admiration from a bewildered pilot looking down for some possible spot to set his 'crate.' A 'milk-bottle' atmosphere, however, is probably the greatest danger the fliers will face…"***

***Popular Mechanics,* May 1924** 1190

***"…Flying through snow is easier than flying through rain. Although safety always lies in height in the air, in flying over strange country every pilot strives to keep within sight of the ground, or under the cloud 'ceiling.' If he goes above the cl-ouds, he often loses all sense of direction. Also, having risen above the clouds, it is necessary to come down through th-em, and as the mist may be clinging to the ground or moun-tainside, a 'crash' results before the pilot realizes his posit-ion…"***

***Popular Mechanics,* May 1924**

1191

SLANG OF THE AIRWAYS

MIRRORING the romance, tragedy and adventure surrounding the conquest of the air, countless words and phrases, forming a strange language distinctive to aviation, have come into use among pilots. Some of these terms and their meanings follow:

CRATE OR SHIP—An airplane or hydro-airplane.

STICK—Control lever.

SIT DOWN—To make a landing.

CRACKED—Plane wrecked in landing.

BOTTLE OF MILK—Fog or snow-filled atmosphere.

BLINKERS — Intermittent guiding lights placed on the ground.

CEILING—Highest point under the clouds at which earth is visible or the maximum height to which the plane can ascend.

1192

***"…It was only a few years ago that the entire world was interested in the attempt of British aviators to fly across the Atlantic. Newspapers were filled with stories of the success-ful flight across the Atlantic of the United States Navy's NC-4, which was hailed as the acme of aviation achievement…"***

***Popular Mechanics,* May 1924**

**Caption: "In May of 1919, NC ("N" for Navy and "C" for Curtiss) Seaplane Division One set-off from Rockaway, New York on a history-making voy-age. Of the three flying boats that began the journey, only the NC-4 completed it."** 1193

# NC-4 Reaches Lisbon, And Wins for Navy Trans-Atlantic Palm

**Under Command of A. C. Read, American Biplane Completes Last Leg of Voyage in 9 Hours and 44 Minutes, Making a Total of 26 Hours and 41 Minutes' Actual Flying Time for Entire Trip.**

Washington, May 27.—Blazing the way of the first air trail from the western to the eastern hemisphere, the United States navy seaplane NC-4, under Lieutenant Commander Albert Cushing Read, swept into the harbor at Lisbon, Portugal, today, the first airship of any kind to have crossed the Atlantic ocean under its own power and through its natural element.

Taking the air at Ponta Delgada, Azores, at 6:18 a. m., Washington time, on the last leg of the transatlantic portion of the voyage from Rockaway Beach, Long Island, to Plymouth, England, the NC-4 covered the 800 miles in 9 hours and 43 minutes, maintaining an average speed of better than 80 knots an hour. The total elapsed flying time from Newfoundland to Lisbon was 26 hours and 41 minutes.

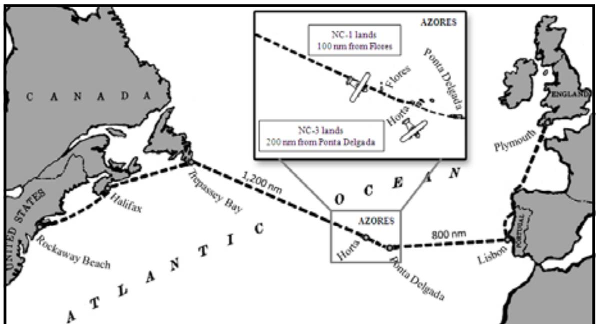
At the first opportunity the big plane will continue to Plymouth, 775 nautical miles to the north. Possibly Commander Read can start tomorrow. To the navy department, however, it makes little difference when he completes the journey. The great object of all the effort lavished on the undertaking, navigation of a seaplane across the Atlantic through the air, has been accomplished. Twentieth century transportation has reached a new pinnacle and the United States navy has led the way.

Ringing Welcome

DELAY DUE TO BAD WEATHER.

Navy officials emphasized that

1194




**<u>Caption</u>: "The transatlantic route of the flying boats from Rockaway, New York, to Plymouth, England." Only NC-4 was able to complete the entire flight. NC-1 was lost-at-sea while NC-3's crew made it safely to the Azores after a difficult and dangerous overnight 200 nm voyage."**

1195

***"…Ten years ago, almost to a day, the British channel was crossed by an airplane piloted by Louis Bleriot for the first time to win a coveted prize put up by a great newspaper. The barking challenge from Bleriot's tiny, twenty-two horsepower motor was taken up and the answer came a decade later in the spanning of the Atlantic, the non-stop record flight of Lieutenants Kelly and MacReady, of the United States Army, from New York to San Diego and the achievement of Lieut. Williams, U.S.N., in roaring through space at a rate of speed hitherto unknown in the checkered history of transportation. In 1915, a round-the-world flight was proposed as part of the Panama-Pacific Exposition, but scientists then deemed it 'impossible of accomplishment in this generation'…"***
***Popular Mechanics*, May 1924**

1196

***"…America, however, will not achieve the honor of being the first to circumnavigate the earth without a battle, for both Great Britain and Portugal have been preparing for months for similar attempts. The latter country will use Fokker monoplanes with a wingspread of about sixty-five feet and a capacity for carrying a useful load of 3,000 pounds at a speed of 110 miles-an-hour…"***
***Popular Mechanics*, May 1924**

1197

***"…Several previous attempts to encircle the earth have been made by the British and French, but without success. Supplies for the army fliers will be shipped from the United States to various points on the route and pathfinders will cover each section of the flight. For flights over the ocean, planes will use pontoons…"***
***Popular Mechanics*, May 1924**

1198

## A New Epoch

1199

***"…Regardless of the outcome of the attempt, it is bound to mark a new epoch in the conquest of the air by man."***
***Popular Mechanics*, May 1924**

1200

## First Around the World

1201

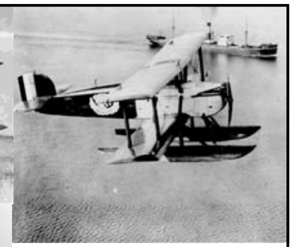
***"…Following this, the famous 'D.W.C's.' (Douglas World Cruisers) were designed and built for the U. S. Army's 'Round the World' flight. Designed to be used as either land or sea craft, two of the original flight of four machines completed the jaunt around the globe, making the trip in 175 days. This flight brought the first wide spread fame to Douglas ships, and rightly so, for they were the first airplanes to ever circle the globe…"***
***Modern Mechanix,*** **October 1937**

**RE: in response to a USAAS requirement for an aircraft suitable for an attempt at the first flight around the world, the *Douglas Aircraft Company* responded with a modified variant of their DT torpedo bomber; the *Douglas World Cruiser* (DWC). Five aircraft were ordered for the round-the-world flight (one for testing and training and four for the actual flight). The DWC was powered by a 420 hp *Liberty L-12* engine.**

1202

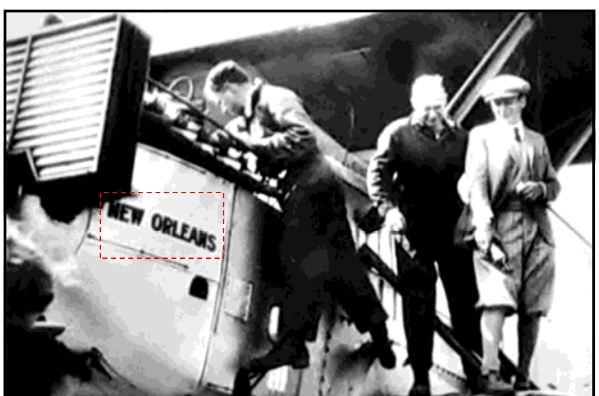
**The conversion from DT to DWC involved incorporating a total of six fuel tanks in wings and fuselage. For greater range, the total fuel capacity went from 115 to 644 gallons. Other modifications involved having increased cooling capacity as well as adding two separate tanks for oil and water. To ensure a more robust structure, a tubular steel fuselage, strengthened bracing, a modified wing of 49-feet wingspan and larger rudder were required. The dual cockpits for the pilot and copilot/crewman were also located closer together with a cutout in the upper wing to increase visibility.**

1203



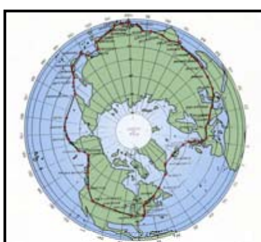
**Like the DT, the DWC could be fitted with either floats or a conventional landing gear for water or ground landings respectively.**
**Above: DWC float plane equipped with pontoons**
**Left T&B: DWC land plane equipped w/landing gear**

1204



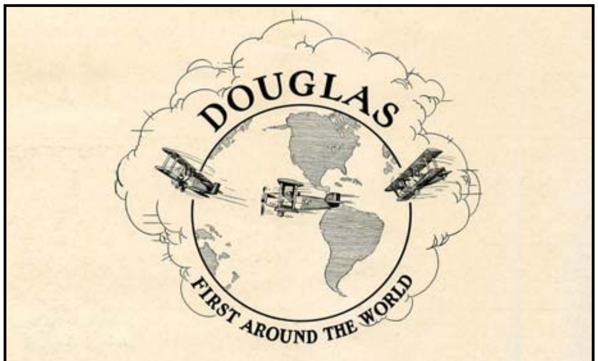

**Two different radiators were available, with a larger version for tropical climates. The four expedition aircraft were named *Boston, Chicago, New Orleans* and *Seattle***
**Caption: "Mechanics work on the Douglas World Cruiser 'New Orleans'"**

1205



**On April 6, 1924, the four expedition aircraft departed Sand Point, Washington. *Seattle*, the lead aircraft, crashed in Alaska on April 30, 1924. The other three aircraft continued west across Asia and Europe relying on a carefully planned logistics system, including prepositioned spare engines and fuel caches maintained by the USN and *Coast Guard. Boston* was forced down and damaged beyond repair in the Atlantic, off the *Faroe Islands*. The remaining two aircraft continued across the Atlantic to North America, where they were joined by the *Boston II* at Pictou, Nova Scotia (the re-christened prototype continued with the flight back to Washington and on the World Flight's ceremonial flypast across the U.S). The three surviving aircraft returned to Seattle on September 28, 1924. The flight covered 23,942 nm. Time-in-flight was 371 hours, 11 minutes and average speed, 70 mph.**
**Left: caption: "Polar map showing the originally proposed route for the 1924 flight"**
**Right: caption: "The six world fliers with adventurer and writer Lowell Thomas. From left-to-right: Arnold, Harding, Nelson, Wade, Smith, Lowell Thomas, Ogden and Mrs. Corliss Mosely, secretary to the pilots."**

1206




**Above: the success of the DWC established *Douglas Aircraft Company* as one of the major aircraft companies of the world and led it to adopt the motto: "First Around the World – First the World Around." The company also adopted a logo that showed aircraft circling a globe.** 1207

## Working for Uncle Sam

1208


***"…After this, the 0-2, forerunner of the modern Douglas observantion ships, was brought out. This craft differed from preceding Douglas designs in that radiator was streamlined into the fuselage lines instead of being left out in the air stream..."***
***Modern Mechanix,* October 1937**
**Caption: "U.S. Army Air Corp (USAAC) Douglas Aircraft Company O-2/O-2H Observation Biplane Marshall Islands stamp"** 1209

**After the successful *World Flight,* the USAAS ordered six aircraft similar in design to the DWCs to serve as observation aircraft, retaining the interchangeable wheel/float undercarriage but with much less fuel capacity and two machine guns in the rear cockpit. These aircraft were initially designated "DOS" (*Douglas Observation Seaplane*), but were re-designated "O-5" in May 1924.** 1210
**Caption: "Douglas O-2"**


***"…It is interesting to note at this point that Douglas has built more than 800 machines of the observation type. In addition to being standard service equipment with the U.S. Army Air Corps, they are standard with the Chinese National Air Force.***
***Modern Mechanix,* October 1937**
**Caption: "Before the beginning of WWII, the 15th Reconnaissance Air Squadron of the Chinese Air Force was armed with Douglas O-2MC bombers. Nanking, June 1937."** 1211


***"…While reviewing the various craft built by Douglas, mention should be made of the M-1. This Liberty-12-powered mail plane could carry 1000 pounds of mail, and was the standard plane of the Post Office Department. These machines replaced the veteran De Havillands and set a record of thousands of miles of flying over the various air mail routes of the nation before they were honorably retired from service…"***
***Modern Mechanix,* October 1937**
**RE: the USPS had been running an *Air Mail Service* since 1918, mainly using variants of the *de Havilland DH-4* biplane. In 1925, an order was placed with Douglas for a replacement aircraft based on the *Douglas O-2*. The company modified an O-2 by covering over the forward cockpit to make a mail compartment and moving the pilot into what had been the observer's cockpit. The aircraft was designated the "DAM-1" (for *Douglas Air-Mail*), but this was soon shortened to "M-1." The M-1 (above) used the same *Liberty* engine as the DH-4. In 1928, 3-engine aircraft took over the main routes of the Air Mail Service.** 1212

**Caption: "Postmaster General Nerr and Second Assistant Glover inspecting Douglas M-1; pilot Earl Ward"** 1213

***"…Among various military types and models brought out, the C-1, T2D, PD-1, BT, P2D-1, and B-7, were outstanding…"***
***Modern Mechanix,* October 1937** 1214


***"…The C-1 was an efficient Liberty-powered-bi-plane which was used as a military transport…"***
***Modern Mechanix,* October 1937**
**Caption: "C-1 Transport 1925; 435 hp Liberty V-1650-1; span: 56'7"; length: 35'4"; load: 2607 lbs.; range: 600 nm; ceiling: 14,850 ft.; Side-by-side open cockpit, eight-seat cabin convertible to 2500 lbs. freight load. Evolved from Army DWC World Cruiser. Although built primarily for the Air Service under this designation, a few were used in civilian roles; under $19,000."** 1215

***"…The T2D, built for the Navy, was fitted with air-cooled radial engines. It was available with either twin floats or wheels and carried a torpedo slung beneath the fuselage…"***
***Modern Mechanix,* October 1937**
**Caption: "T2D-1 1928 - Landplane and folding-wing seaplane versions; length: (land) 42'0"; (sea) 44'4"; load: 3975 lbs.; range: (land) 457 nm; (sea) 384 nm; ceiling: (land) 13,830' (sea) 11,400'; Cowled 575 hp Wright R-1820Es delivered as P2D-1 land and sea versions in mid-1930; length: 43'-11" load: 5167 lbs.; range: 1010 nm."** 1216

***"…The PD-1 was the first flying boat ever built by Douglas and was used as a patrol ship by the Navy. Like the T2D, it was equipped with air-cooled engines…"***
***Modern Mechanix,* October 1937**
**Caption: "PD 1929 - Coast patrol and trainer; two 525 hp Wright R-1750A, later 575 hp R-1820-64; span: 72'10"; length: 49'2" load: 6669 lbs.; range: 1309 nm; ceiling: 10,900'."** 1217


***"…The BT, a long nosed, equal span job, proved to be an outstanding basic training plane and was built in quantity for the Army…"***
***Modern Mechanix,* October 1937**
**Caption: "BT-2A 1936 - Production version; span: 40'0"; length: 31'2" load: 1038 lbs.; ceiling: 19,000'. "** 1218

*"…The T2D-1, an improved version of the T2D, was also available with either floats or wheels and featured a twin rudder tail group…"*
*Modern Mechanix,* October 1937
Caption: "T2D-1 1928 - Landplane and folding-wing seaplane versions; length: (land) 42'0"; (sea) 44'4"; load: 3975 lbs.; range: (land) 457 nm (sea); 384 nm; ceiling: (land) 13,830'; (sea) 11,400'; Cowled 575 hp Wright R-1820Es delivered as P2D-1 land and sea versions in mid-1930; length: 43'11" load: 5167 lbs. range: 1010 nm"
1219

*"…In 1930, Douglas entered the bombardment field with the production of the B-7. An unconventional, gull-wing monoplane, this craft was a distinct advance over the bombing craft then in service use. The machine was powered with two 600 h.p. Curtiss Conqueror liquid-cooled engines mounted on either side of the fuselage in well streamlined nacelles. The landing gear retracted into the rear of these nacelles. The original machines of this type had a high speed of some 158 m.p.h. The later models, however, showed speeds of well over 185 m.p.h…"*
*Modern Mechanix,* October 1937
RE: fearing that the advanced *Fokker XO-27* would challenge Douglas' role as the major supplier of observation aircraft to the U.S. *Army Air Corps* (USAAC), in 1929-1930, Douglas designed a new twin-engine monoplane observation aircraft.
1220

Douglas' design had gull wings mounted high on the aircraft's fuselage (the engines were suspended in streamlined nacelles under the wings via bracing struts). A retractable tailwheel undercarriage was fitted while the main wheels retracted into the engine nacelles. The fuselage was a semi-monocoque structure with corrugated duralumin covering, which housed the crew of four: a nose gunner/observer, a pilot (whose cockpit was situated ahead of the leading edge of the wing), an upper gunner (who sat in a cockpit aft of the wing) and a radio operator (housed within the fuselage). Armament was two 0.30-caliber machine guns.
1221

Seven "Y1B-7" bombers and five "Y1O-35" observation aircraft were ordered by the USAAC in August 1931. All twelve service test aircraft were completed by March 1933. Despite the plane's excellent performance, neither version entered mass production due to the fact that newer, more capable aircraft (i.e. *Martin B-10*) were under development while a change in USAAC policy meant that it was no longer interested in buying twin-engine observation aircraft.
1222
Caption: "Y1B-7 of the 31st Bombardment Squadron"

*"…Two later military developments were the 0-38 and the 0-43…"*
*Modern Mechanix,* October 1937
1223

*"…The 0-38 is an equal-span biplane powered with an air-cooled engine and has a speed of over 150 m.p.h. This craft is used by many of the National Guard observation squadrons…"*
*Modern Mechanix,* October 1937
Caption: "O-38 1931 - USAAC observation. Similar to O-29 and O-32, these were the last of the Douglas observations. 525 hp P&W R-1690; span: 40'0"; length: 32'0"; load: 1030 lbs.; range: 325 nm; ceiling: 19,750'. $12,000."
1224

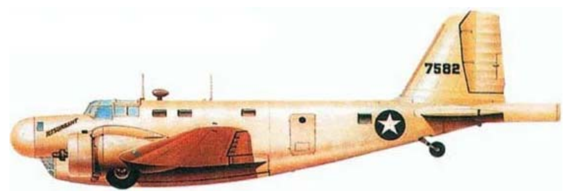

1225

***"…The 0-43 is a parasol monoplane type fitted with a liquid-cooled motor and is characterized by a rather long fuselage. Both of these types have been delivered in quantity to the Army and National Guard air squadrons…"***
***Modern Mechanix,*** **October 1937**
**<u>Caption</u>: "O-43 1934 - O-31 with new tail and parasol wing. 675 hp Curtiss V-1570-59; span: 45'8"; length: 33'11"; load: 1165 lbs. ceiling: 22,-400'; 1 prototype as Y1O-43, 24 production models as O-43A."**

1226


***"…The 0-46A, equipped with a radial air-cooled engine is the latest of the Douglas observation type planes…"***
***Modern Mechanix,*** **October 1937**
**<u>Caption</u>: "O-46A 1935"**

1227




***"…One of the most interesting of the many Douglas military planes is the Douglas bomber. This big, twin-engined monoplane resembles the Martin bomber to some extent. It is powered with 800 h.p. air-cooled engines and 100 have been ordered for the Air Service…"***
***Modern Mechanix,*** **October 1937**
**RE: in 1934, the USAAC sought a twin-engine bomber with twice the payload and twice the range of the *Martin B-10.* In 1935, a fly-off at *Wright Patterson Army Airfield* was conducted. Douglas used its DB-1 for the competition. It competed with the *Model 299* by *Boeing* (which was later developed into the *B-17 Flying Fortress*) and the *Model 146,* by Martin, which was an export version of the B-10. Boeing had the best design, but because of a crash, Boeing's prototype was first to be terminated. With a unit cost of $58,500, the DB-1 was cheaper than the B-17, which had a unit cost of $99,620. Re-designated the "Douglas B-18 Bolo" (above), in January 1936 production began. The B-18 was based on the *Douglas DC-2,* in most aspects, but with many modifications. In 1942, the B-18 was replaced by the B-17.**

1228

1229

## <u>Part 16</u>

## Douglas Commercial

1230

## Hat-in-the-Ring

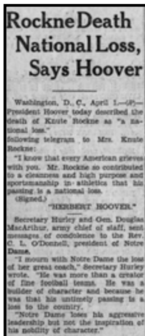
1231

***"…Although Douglas had made his name quite well known to the world of aeronautics, he did not enter the commercial field until 1932. The reason was that up until 1929 Ford, Fokker, Boeing and Curtiss had a monopoly on the air transport market and it was practically impossible for any other manufacturer to find a buyer for transport planes. However, the commercial transport market became saturated during the period from 1929 to 1931, because few of the air line operators were in a position to replace their flying equipment…"***

***Modern Mechanix,*** **October 1937**

**RE: in the early 1930s, primary passenger carrying aircraft included the *Fokker Trimotor* and *Boeing Trimotor,* both of which presented limitations and dangers. Commercial flying on these aircraft was unpleasant; often cold and drafty and smelling of oil and exhaust. Not only that, but they were noisy and uncomfortable, inducing motion sickness.** 1232

**<u>Caption</u>: "Employees of the Douglas Aircraft Co., Inc. – Sept. 11, 1929"**

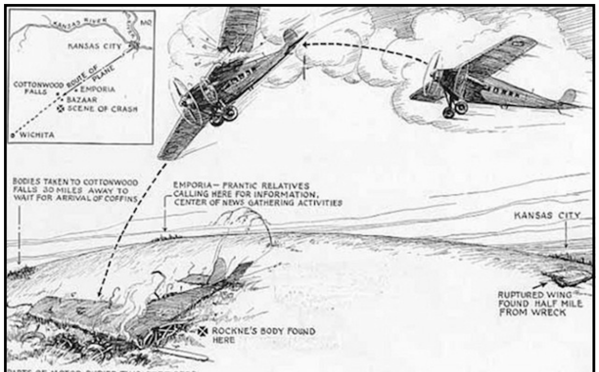


**Rockne Death National Loss, Says Hoover**

Washington, D. C., April 1.—(P)—President Hoover today described the death of Knute Rockne as "a national loss."
following telegram to Mrs. Knute Rockne:
"I know that every American grieves with you. Mr. Rockne so contributed to a cleanness and high purpose and sportsmanship in athletics that his passing is a national loss.
(Signed.)
"HERBERT HOOVER."

Secretary Hurley and Gen. Douglas MacArthur, army chief of staff, sent messages of condolence to the Rev. C. L. O'Donnell, president of Notre Dame.
"I mourn with Notre Dame the loss of her great coach," Secretary Hurley wrote. "He was more than a creator of fine football teams. He was a builder of character and because he was that his untimely passing is a loss to the country.
"Notre Dame loses his aggressive leadership but not the inspiration of his nobility of character."

**As well, flying, in general, was considered dangerous and unpredictable. Airplanes had to fly below all types of weather and would frequently run out of gas, resulting in crashes. This was highlighted by the crash, in bad weather, of a TWA *Ford Trimotor* in 1931, resulting in the death of *Notre Dame* football coach *Knute Rockne.*** 1233




**<u>Caption</u>: "Artist's Conception of Rockne's Fatal Crash"** 1234

## Aviation Oversight

1235

**Aviation industry leaders believed the airplane could not reach its full commercial potential without federal action to improve and maintain safety standards. At their urging, the *Air Commerce Act* was passed in 1926. This landmark legislation charged the Secretary of Commerce with fostering air commerce, including:**

- **Designate and establish airways;**
- **Establish, operate, and maintain aids to air navigation (but not airports);**
- **Arrange for R&D to improve such aids;**
- **License pilots;**
- **Issue airworthiness certificates for aircraft and major aircraft components, and;**
- **Investigate accidents.**

**A new "Aeronautics Branch" in the *<u>D</u>epartment <u>o</u>f <u>C</u>ommerce* (DOC) assumed primary responsibility for aviation oversight; *William P. MacCracken, Jr.,* became its first director.** 1236

Born in Chicago, Ill., ***William P. MacCracken, Jr.*** (left, 1888-1969) was a visionary and pioneer in aviation law. MacCracken earned his law degree from the ***University of Chicago*** in 1911. During WWI, MacCracken enlisted in the USAAS, where he received flight training; an experience that awakened a lifelong passion for aviation. In the mid-1920s, with pressure from those wanting to establish viable commercial aviation enterprises, President ***Calvin Coolidge*** needed someone to help establish the crucial foundation for U.S. aviation regulation as well as conceive long-term plans for fostering the aviation industry. Impressed by MacCracken's credentials, the POTUS selected him to help author the ***Air Commerce Act of 1926***. His skill and knowledge ultimately convinced Congress of the need for Federal oversight of aviation. Since so much of the industry was tied to commerce (mail delivery and commercial air travel), it made sense to locate the government's new ***Aeronautics Branch*** within the DOC. MacCracken became the first "Assistant Secretary of Commerce for Aeronautics," reporting directly to Coolidge administration Secretary of Commerce ***Herbert Hoover***.

1237

**In 1934, the DOC renamed the *Aeronautics Branch* the *Bureau of Air Commerce* (BAC) to reflect the growing importance of aviation to the nation. In one of its first acts, the BAC encouraged a group of airlines to establish the first air traffic control centers (Newark, NJ; Cleveland, OH and Chicago, Ill) to provide en route *Air Traffic Control* (ATC). In 1936, the BAC took over these centers. Early en route controllers tracked the position of planes using maps and blackboards and little boat-shaped weights (a/k/a "shrimp boats"). They had no direct radio link with aircraft, but used telephones to stay in-touch with airline dispatchers, airway radio operators and airport traffic controllers. Although en route ATC became a federal responsibility, local government authorities continued to operate airport towers.**

1238

1239


**While the DOC worked to improve aviation safety, a number of high profile accidents called the department's oversight responsibilities into question. A 1931 crash that killed all on board, including *Knute Rockne,* elicited public calls for greater federal oversight of aviation safety. On May 6, 1935, *TWA Flight 6,* travelling from Los Angeles to Newark crashed. Of thirteen passenger and crew, five died in the accident, including U.S. Senator *Bronson Cutting* (R-NM).**

**<u>Caption</u>: "A TWA Douglas DC-2, like the one that crashed in 1935 (left). Senator Bronson Cutting in 1928 (right)."**

1240

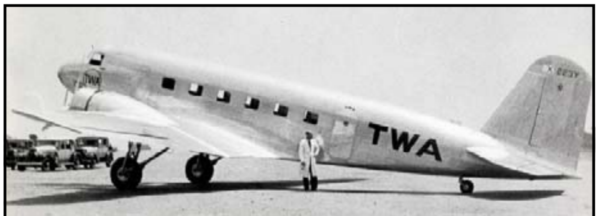
## Invitation to Bid

1241


***"…Early in 1932, Transcontinental and Western Air Express decided to purchase some new transports and invitations for bids were extended to various aircraft builders…"***

**<u>Caption</u>: "Boeing B-247 introduced with United Airlines. This revolutionary aircraft influenced TWA to build an even more revolutionary aircraft of their own."**

1242




*"… At once, there was a turmoil in the commercial field, with practically all of the major aircraft manufacturers striving to win the contract. At this point, Donald Douglas stepped into the picture with his DC-1. This ship readily won the TWA contract and Douglas was well launched in the commercial field…"*

***Modern Mechanix,*** **October 1937**

**RE: the *Douglas DC-1,* created by a team led by *Arthur E. Raymond*, may be considered to be the first scientifically U.S.-designed airplane. It blended the research and experience of industry, federal research laboratories (i.e. NACA) and academic centers, specifically the *Guggenheim Aeronautical Laboratory* of the *California Institute of Technology,* where its shape was refined by extensive wind tunnel testing.**

1243

***"…The DC-1's were the result of careful experimentation and sound engineering. Low-wing, twin-engined monoplanes of all metal construction, these transports with their retracting landing gear were soon a familiar sight at all of the larger airports…"***

***Modern Mechanix,*** **October 1937**

**RE: the DC-1 utilized the all-metal, multi-cell structure *John Knudsen Northrop* had previously developed. The 12-passenger, twin-engine DC-1 blended advanced aerodynamics (typified by turbulence-reducing wing-fuselage fillets), payload-enhancing wing flaps and refined engine cowling placement, higher-strength aluminum alloys, a retractable landing gear, controllable pitch propellers and a lightweight monocoque fuselage structure. Its superiority over the rival *Boeing 247* was evident from the outset. The DC-1 spawned the DC-2 and DC-3 and an entire "DC" generation.**

1244


1245


***"…The DC-1 was soon improved and appeared as the DC-2. This model is one of the most efficient and popular transports ever built and it is quite probable that no other commercial airplane ever sold so quickly and so well…"***

***Modern Mechanix,*** **Oct. 1937**

**<u>Above</u>: caption: "The DC-2 was a 14-seat, twin-engine airliner produced by the Douglas Aircraft Corp. starting in 1934. It competed with the Boeing 247."**

**<u>Left</u>: *Delta Air Lines* DC-2 ad**

1246

TRANSCONTINENTAL & WESTERN AIR INC.

KANSAS CITY, MISSOURI

August 2nd,
1932

Douglas Aircraft Corporation,
Clover Field,
Santa Monica, California.

Attention: <u>Mr. Donald Douglas</u>

Dear Mr. Douglas:

Transcontinental & Western Air is interested in purchasing ten or more trimotored transport planes. I am attaching our general performance specifications, covering this equipment and would appreciate your advising whether your Company is interested in this manufacturing job.

If so, approximately how long would it take to turn out the first plane for service tests?

Very truly yours,

Jack Frye

Jack Frye
Vice President
In Charge of Operations

JF/GS
Encl.

N.B. Please consider this information confidential and return specifications if you are not interested.

**In the early 1930s, fears concerning the safety of wooden airframes compelled the U.S. aviation industry to develop all-metal types. With UAL having a monopoly on the *Boeing 247,* rival *<u>T</u>ranscontinental and <u>W</u>estern <u>A</u>ir* (TWA) issued a request for an all-metal trimotor (left). Douglas' response was more radical. When it flew on July 1, 1933, the prototype DC-1 had a highly robust tapered wing, a retractable undercarriage and only two 690 hp Wright radial engines driving variable-pitch propellers. TWA accepted the basic design and ordered twenty (as the "DC-2") with more powerful engines and seating for fourteen passengers.**

1247

**The design impressed a number of American and European airlines and additional orders followed. Those for European customers *KLM, LOT, Swissair, CLS* and *LAPE* were assembled by *Fokker* in the Netherlands. A total of 156 DC-2s were built. Although over-shadowed by its successor, the DC-3, it was the DC-2 which first demonstrated that passenger air travel could be comfortable, safe and reliable.**

1248



*"…In addition to the fifty-eight which were sold to TWA, American Airlines, Eastern Air Transport, and Pan American Airways, thirty-four were delivered to Royal Dutch Air Mail Lines, Swissair, China National, Japan Air Transport, Spanish Air Mail, and Avio Linee Italiane S.A…"*
***Modern Mechanix,* October 1937**
**Above: TWA DC-2**
**Left: caption: "Advertising poster for KLM Royal Dutch Air Lines, ca. 1938, showing a cross-section of a Fokker-assembled Douglas DC-2"**

1249

**The DC-2 proved its worth and KLM immediately ordered fourteen more and, later, another three. Initially, the DC-2s were deployed on the long-haul route between the Netherlands and its East Indian colonies. Later, the DC-2s were increasingly used on European routes.**
**Caption: "The DC-2 was KLM's first all-metal airplane"**

1250

**By Day, By Night**

1251

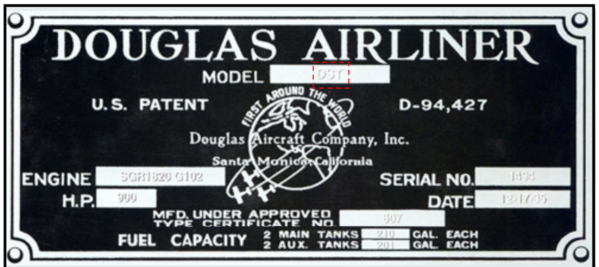
*"…In 1936, the DC-2 was developed into the DST, 14 passenger sleeper plane, and the DC-3, a day plane with reclineable seats for 24 passengers…"*
***Modern Mechanix,* October 1937**
**RE: the *Douglas DST* was a low-wing, twin-engine airliner designed to accommodate 24 day passengers or 16 in Pullman-style berths on night flights. The most popular version had 21 seats and was called the "DC-3." The DC-3 "sleeper planes" became the most common on U.S. airlines. However, it was realized that, as a day-plane, three rows of seats could be fitted into the DST. As such, the DC-3 could carry 21 passengers (later as many as 28), thus earning more income for the airlines.**

1252


1253

***American Airlines* decided it needed a sleeper plane on its southern route across the U.S. and presented the problem to Douglas. *Fred Hermann,* the project engineer and his team contacted inventors and went to the *Pullman Company* for ideas. Try as they might, they could not squeeze a comfortable berth into the narrow fuselage of the DC-2.**
**Caption: "Passenger cabin of a Royal Dutch Airlines DC-2"**

1254




***"WITH a capacity of twenty-four passengers by day and sixteen by night, a giant transport will be placed in operation by American Airlines, Inc. The new ship, a Douglas with a top speed of 215 miles an hour, is an all-metal low-wing monoplane powered by two engines of 1,000 horsepower each…"***
***Popular Mechanics,*** **January 1936**
**RE: designed over a two year period by Douglas' Chief Engineer *Arthur E. Raymond* and built for *American Airlines,* the DST was the original variant of the DC-3 commercial airliner**

1255

1256


**Thus, the wider, circular fuselage of the DST was designed to hold seven upper and seven lower berths. It had 14 sleeping berths for passengers on overnight transcontinental flights and could fly across the U.S. with three refueling stops. There were no prototypes built.**
**<u>Caption</u>: "This was American Airlines Flagship Texas. It was the first DST off the assembly line (NC14988). It was sold to the War Department on July 21, 1942. Its CAA registration was cancelled and it was given a USAAF serial number. It crashed at Knobnoster, MO October 15, 1942."**

1257

***"…Lower berths will be formed by folding the backs and bases of the seats together in the eight sections, while the upper berths will be dropped into position from the ceiling. Each berth will be six feet five inches long and nearly three feet wide, complete with reading lights, clothes nets, electric call buttons and baggage racks…"***
***Popular Mechanics,*** **January 1936**
**RE: luxury came to air travel with the *Douglas DST,* which had seven upper and seven lower sleeping berths, with full down mattresses. Two seats in each section folded down to form a thick, soft foundation for a mattress. The upper berths folded into the ceiling when not in use.**

1258

1259

***"…The new transport will have separate dressing rooms for men and women passengers and these will be complete with running water, mirrors and linens…"***
***Popular Mechanics,*** **January 1936**

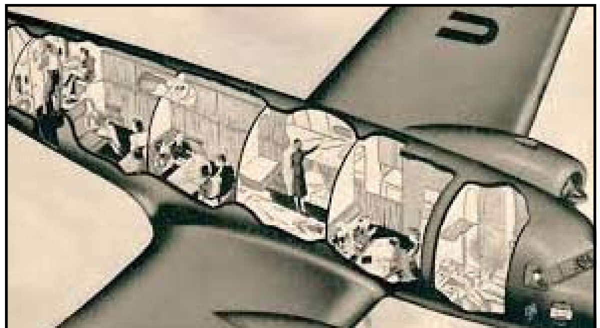
1260

1261

*"The twelve-ton ship, a low-wing twin-engined monoplane built on the lines of previous Douglas transports but more roomy, has a cabin seven feet eight inches wide and six feet six inches high, accommodating four spacious passenger compartments on each side of a center aisle. For day travel each compartment has facing seats; as a sleeper, the back and bases of the seats form eight lower berths that are six feet five inches long and thirty-five inches wide. Upper berths are twenty-nine inches wide. Dropping down from the roof of the cabin, the 'uppers' are accessible by steps and are provided with air by an extra slot above the cabin window. Separate dressing rooms for men and women are located at the rear of the ship…"*
***American Airlines***

1262

1263



***"…In front of the cabin is a complete commissary equipped to serve more elaborate meals than formerly, and to keep food and beverages hot or cold indefinitely. The ship's length is sixty-five feet, its wing span ninety-five feet. Besides baggage racks in the compartments, there is luggage and mail space at the rear of the fuselage and opposite the commissary."***
***American Airlines***

1264

***"…The pilot's cockpit will have every known aid to navigation, including automatic pilot and latest radio equipment. Power will be sufficient for either engine to take the ship off the ground and fly with full load. Automatic constant-pitch propellers, which adjust their pitch to maintain maximum efficiency under varying conditions, will be used. Wheels will be completely retractable and a new type landing gear construction will provide unusual strength and smoothness of landing."***
***Popular Mechanics*, January 1936**
**<u>Caption</u>: "DST 1935 - two 850hp Wright SGR-1820-G2 Cyclones; span: 95'0'; length: 64'6"; load: 8250 lbs.; range: 1250 nm"**

1265

**Heir Apparent**

1266

***"…The DC-4, a four-engined transport is scheduled for production during 1937…"***
***Modern Mechanix,*** **October 1937**
**RE: heralding the coming-of-the-age of the large, four-engine commercial airliner, the *Douglas DC-4* was nearly 3x the size of other giants of the airways then in service**
**<u>Caption</u>: "Douglas 'DC-4' has nose wheel for safe landing. It retracts when the ship is in the air."**

1267

***"…The 'DC-4' was built to the order of United Air Lines, Transcontinental and Western Air, American Airlines, Pan American Airways and Eastern Air Lines. All production models will have super-charged cabins for stratosphere travel…"***
***Popular Mechanics,*** **March 1939**
**<u>Caption</u>: "The Douglas 'DC-4' whose four motors develop 5,600 horsepower"**

1268


***"…Truly a hotel on wings with accommodations for forty-two guests by day or thirty by night, it has a top speed of four miles-per-minute. A crew of five operates the huge ship…Two auxiliary engines, working independently of four giant motors generating a total of 5,600 horsepower, supply electricity to light the ship, cook food or operate hair cutters and electric shavers. The DC-4 has a comfortable ladies lounge and men's dressing room and even a private compartment which may be used as a bridal suite. There are telephones for the crew and a dictaphone for business men who want to work while traveling…"***
***Popular Mechanics,*** **March 1939**
**<u>Caption</u>: "Cross-section of the Douglas DC-4"**

1269


1270


1271

**When Boats Had Wings**

1272

***"…One of the most interesting of the many Douglas developments is the Dolphin. This eight-place monoplane amphibian, powered with two 450 h. p. air-cooled engines, has a high speed of 160 m.p.h. Designed primarily for the commercial market, this machine found but few sales and for a time it looked as though the plane would be a washout, as far as sales were concerned…"***

***Modern Mechanix,* October 1937**

**RE: the Dolphin's design, which was adapted from the *Douglas PD-1* (above), was introduced at a time when the Gre*at Depression* was causing failures and production cutbacks throughout the aviation industry**

1273

***"…However, the Army, in searching for a small amphibian transport, bought one and gave it a series of extremely hard tests. Entirely satisfied with the Dolphin's performance, the Army ordered twenty-eight. In addition to this, the Navy took delivery on eight and the Coast Guard purchased thirteen. These government sales, together with numerous sales to private individuals, made the Dolphin a very profitable model to build…"***

***Modern Mechanix,* October 1937**

**Caption: "Dolphin 1931 all-metal, semi-monocoque fuselage had five water-tight bays; wood-framed wing was covered with plywood; metal-clad empennage had fabric movable surfaces"**

1274


Fostered by the United States Army and Navy through rigid requirements, American aviation today is recognized for its dependability and safety , , The years that Douglas has been associated in building to these inflexible standards for the service of the Government now finds reflection in the new Amphibian…a craft that carries on the name which has been gained by Douglas…that dependability must be permanent , , The Amphibian, custom-built by Douglas is now available. Speed 150 M.P.H. 600-800 H.P. Twin motors, each capable of carrying the entire load. Passengers and crew 8 , , You are invited to write for specifications.

1275

***"…One of the latest Douglas achievements is a giant DF twin-engine flying boat. Designed for trans-oceanic flying, this ship can fly non-stop with thirty-two passengers for 1500 miles. With twelve passengers, it has a non-stop range of 3300 miles. Fitted with two 1000 h. p. engines, the boat has a high speed of 185 m.p.h. and a cruising speed of 167 m.p.h. Among the interesting features of the craft are the retractable wing floats. These hydraulically operated floats retract inward and upward into the under side of the wing…"***

***Modern Mechanix,* October 1937**

**RE: the *Douglas DF* flying boat was originally designed with *Pan American Airways* (PAA) in mind, but when they showed no interest, two were sold to *Japan Air Lines* (JAL) in 1936**

**Caption: "DF 1936 - two 1000hp Wright SGR-1820; span: 95'0"; length: 24'6"; load: 11,185 lbs.; range: 2700 nm"**

1276

## A Most Careful Experimenter

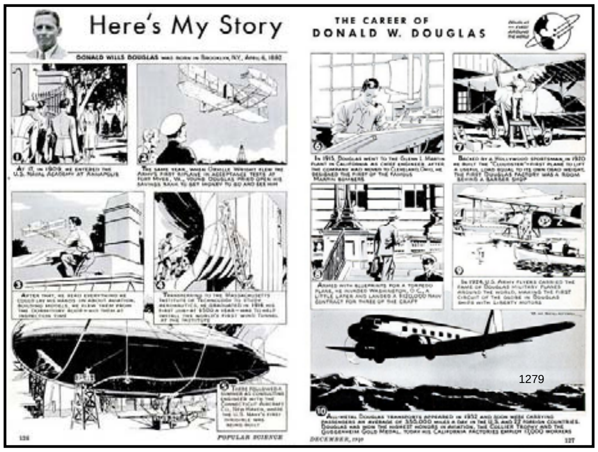
1277


***"…Douglas, throughout his career as an airplane designer and builder, has been a most careful experimenter. Although he has produced several hundred planes, representing in all more than a hundred different stages of development, he has kept his designs within a few well defined types…"***

***Modern Mechanix,* October 1937**

1278

**Caption: "DC-3 Mainliner and M-2 mail plane in Santa Monica,1941"**




1279


***"…Since 1921, when he first started in the airplane manufacturing business, Douglas has built around 1,500 planes. The majority of these have been built for the Army, Navy, and Coast Guard (Douglas early recognized the fact that Uncle Sam was about the only reliable customer who could buy airplanes in large quantities and pay for them)…"***

***Modern Mechanix,*** **October 1937**

**<u>Caption</u>: "WWII Douglas Aircraft Company SBD Dauntless dive bomber magazine advertisement"**

1280

1281

***"…Douglas has ample reason to be proud of his planes. Beginning with his first plane, which won the Navy's competition, his craft have steadily progressed in popularity and today, they are part of the standard equipment of the Army, Navy, and major American airlines…"***

***Modern Mechanix,***
**October 1937**

**<u>Caption</u>: "Donald Douglas standing in front of an early Douglas Aircraft"**

1282

***"…From the little shop in Los Angeles where the Cloudster was built, his plant organization has grown until it occupies a factory at Santa Monica covering 390,000 square feet of floor space and employing some 2,000 persons…"***

***Modern Mechanix,*** **October 1937**

**<u>Caption</u>: "Douglas Aircraft Plant, Clover Field, Santa Monica, Calif., March 1939"** 1283

**<u>Caption</u>: "Donald Douglas, President of the Douglas Aircraft Company gets onboard a five-place Douglas 'Cloudster,' 1945"** 1284

DOUGLAS

1285

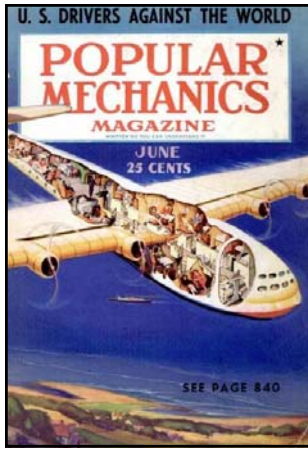
## Part 17

## A Tough Act to Follow

1286

**This is the Year!**

1287




**For years aviation engineers have been discussing giant airplanes of the future. This year they have caught up with their prophecies and the day of the aerial monsters is here.**

***Popular Mechanics,*** **June 1938**

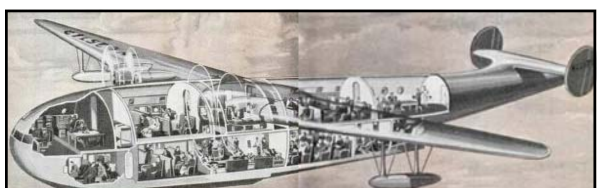
**RE: introduction to an article entitled: "AGE of the AERIAL MONSTERS"**

**<u>Caption</u>: "Cutaway drawing showing interior of Consolidated's version of a transoceanic airliner on the cover of this month's issue of PM. Note the double-deck arrangement and luxurious accommodations, very similar to those on ocean liners."**

1288

**A Dream Come True**

1289



***"ONE thing that has helped make the dream come true is the perfection of aviation engines far more powerful than any of the past. One engine of a 1938 four-motored airplane develops more power than the total horsepower of a tri-motored transport of ten years ago. Four such engines provide as much as 6,000 horsepower for take-offs, more power than is required by a streamline engine to pull twelve railroad coaches…"***

***Popular Mechanics,*** **June 1938**

**<u>Caption</u>: "Martin's concept of a transatlantic air liner shows nose and interior of plane"**

1290

**Very Hush, Hush**

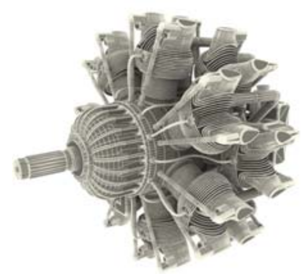
1291

*"…These tremendous air-cooled motors, the latest developments of the engine manufacturing companies, are on the 'military secret' list and are not available to everyone, nor may they be exported abroad…"*
***Popular Mechanics,*** **June 1938**

1292

*"…They are twin-row radials of improved design, consisting essentially of two radial engines, one placed right behind the other, and attached to a common crankshaft. They develop one horsepower for every pound-and-a-quarter of weight…"*
***Popular Mechanics,*** **June 1938**
**Caption: "Pratt & Whitney developed twin row radial engines which gave the power needed for new heavier aircraft"**

1293



1294

**Super Transport**

1295

*"…The new airplanes made possible by these engines actually dwarf the present giants of the airways. The new DC-4, to be launched soon by the Douglas Airplane Company, was assembled like a ship, in a sort of dry dock…"*
***Popular Mechanics,*** **June 1938**
**Caption: "View of workmen busy on giant fuselage and wings of Douglas transport, DC-4. The scaffolding forms a sort of dry dock in which the plane was assembled like a ship."**

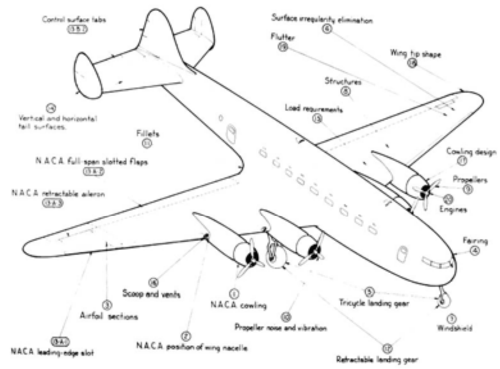
1296

***"…Engines for this giant craft are being supplied by Pratt & Whitney. They are twin-row Hornets - 14-cylider radial air-cooled types with a displacement of 2,180 cubic-inches. They have a take-off rating of 1,400 horsepower at 2,500 revolutions a minute using 95 octane fuel and 1,200 horsepower using 87 octane fuel. Normal rating is 1,150 horsepower at 2,350 r.p.m. with 95 octane fuel. Two of these engines are installed in the leading edges of the wings on each side of the cabin…"***

***The Chicago Tribune,*** **October 3, 1937**

**RE: *Fred B. Rentschler, c*hief at P&W, had been itching to get his new and powerful *Hornet* engines into a four-engine airliner; the DC-4 would provide that opportunity. The DC-4's four, 14-cylinder, twin-row, air-cooled radial engines totaled more than 5,600 hp - equal to the output of two diesel locomotives. It was the beginning of a new era in aircraft engine development; the triple-tailed prototype DC-4 (a/k/a "DC-4E") would serve as a flying testbed.**

1297




**<u>Caption</u>: "The design formula for propeller-driven aircraft recommended by the NACA in 1939 looked very much like the later configuration of the Douglas DC-4E"**

1298

## Trends in Engine Design

1299

***"The P&W gang at Hartford Connecticut had made tremendous strides in engine improvement without which we probably wouldn't have had the power available to get the 32-ton airplane off the ground. Higher compression ratios, supercharging, tougher alloys permitting faster crankshaft speeds, redesigned fins for cooling, did the trick."***

***Ivar Shogran,*** **Douglas' Chief of Power-Plants**

1300

***"…The power of aviation engines has been climbing upward for years. In 1930 the Pratt & Whitney Wasp was rated at 420 horsepower but today the same engine delivers 600 horsepower with hardly any change in size. The increased output is due to improvements that include refinement of cylinder design and higher compression ratios and supercharging. These last two improvements are possible because of the better fuels that are available today and in turn permit a higher number of engine revolutions-per-minute, which results in greater horsepower…"***

***Popular Mechanics,*** **June 1938**

1301

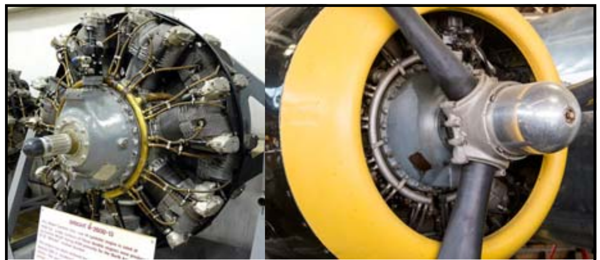
***"…Other engine improvements include hollow valves filled with sodium to promote cooling, tougher alloys that are better able to withstand the higher crank speeds, and redesigned fins on the air-cooled cylinders which together with pressure baffles that force the air to circulate between the fins result in better control of engine temperatures…"***

***Popular Mechanics,*** **June 1938**

1302

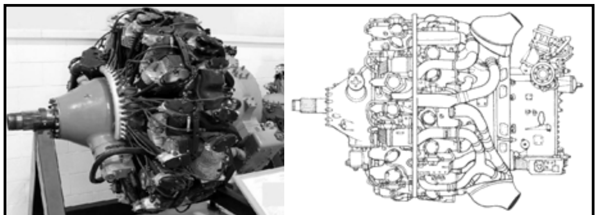
***"…The trend in engine design seems to be toward more and smaller cylinders, providing a smoother flow of power with less vibration. The two-row radial engines are a development of this trend, as well as an answer to the cry for greater horsepower. The new R-2180 Twin Hornet, made by Pratt & Whitney, is a fourteen-cylinder twin-row radial with a displacement of 2,180 cubic inches…"***
***Popular Mechanics,*** **June 1938**

1303



***"…Even more powerful than the Twin Hornets are the new 1,500-horsepower Wright Cyclones of similar radial type that are being used to power the new four-engined flying boats that carry seventy-two passengers…"***
***Popular Mechanics,*** **June 1938**
**Above L&R: the *R-2600 Wright Cyclone* series engine was introduced in 1939, initially rated at 1,500 hp. With improvements, it later reached a rating of 1,800 hp. In military use, it was used on USAAF A-20s, A-24s and B-25s as well as some USN torpedo and patrol bombers. It gained fame powering the *Boeing Model 314* "Clipper" flying boats. It held fourteen cylinders in two rows in an air-cooled radial configuration. Maximum horsepower and rpm was 1,700 and 2,600 respectively. It weighed 1,980 lbs. and cost $16,500. After the end of WWII, the R-2600 was superseded by larger radial engines.**

1304



***"…Today the engine manufacturers are working on engines of even larger horsepower. The day of the 2,500-horsepower aircraft engine is almost in sight and when such power plants are available larger aircraft than ever will be possible."***
***Popular Mechanics,*** **June 1938**
**Above L&R: the *Wright R-3350 Duplex-Cyclone* was one of the most powerful radial aircraft engines produced in the U.S. It was a twin-row, super-charged, air-cooled, radial engine with eighteen cylinders. Power ranged from 2,200 to over 3,700 hp, depending on the model. Developed before WWII, the R-3350's design required a long time to mature before finally being used to power the *Boeing B-29 Superfortress*. After the war, the engine had matured sufficiently to become a major civilian airliner design, most notably in its "Turbo-Compound" incarnation.**

1305

1306

***"…The DC-4 has nearly three times the gross weight of the big Douglas transports now in service. The four-motored plane has a wing spread of 139 feet. Its fuselage is ninety-seven feet long and it stands twenty-four feet high. It will carry forty-two passengers and a crew of five, as well as three-and-a-half tons of mail and express. The plane will have a top speed of around 237 miles-per-hour at 8,000 feet, a cruising radius of 2,200 miles, and a service ceiling of around 23,000 feet. The plane weighs 65,000 pounds fully loaded and will be able to cross the continent with only one stop…"***
***Popular Mechanics,*** **June 1938**

1307

**In 1935, in response to a requirement from UAL, Douglas began work on a four-engine airliner to follow the company's successful twin-engine DC-3. The new airliner (designated sequentially as the "DC-4") was to have twice the passenger capacity of the DC-3, with 42 passenger seats, or 30 seats as a sleeper transport, along with cabin pressurization and climate control. It was a low-wing aircraft, made mostly of aircraft aluminum alloy, with a triple-fin tail; power-boosted controls; four radial engines and tricycle landing gear (an innovation, at the time). Length was 97-feet 7-inches; wingspan 138-feet 3-inches and empty weight was 42,565 pounds. Power was provided by four *Pratt & Whitney Twin Hornet* 14-cylinder two-row air-cooled radial engines. The engines were toed-out slightly to improve engine-out handling. Three tailfins were used to ensure that the aircraft could keep flying more or less straight if both engines on one wing were not operating.**
**The prototype performed its first flight on June 9, 1938.**
**Caption: "The original three-tail DC-4E"**

1308

*"ACCURATE details of the 60,000-pound Douglas DC-4 transport plane, which will have four engines and carry forty passengers, now are available. The giant ship is being assembled at the Douglas plant in Santa Monica, Cal., and the corps of engineers, who have been living with it for nearly eighteen months, now believe it will be flying by the early days of next year. Interior and exterior lines and arrangements of the first ship, which is definitely an experimental plane, will follow those of the model shown above…"*

***The Chicago Tribune,*** **October 3, 1937**

**Caption: "Exact scale model of the DC-4E as it will appear when finished"**

1309

*"…The wing span on this first machine will be 138 feet 3 inches. The fuselage, which already has been completed save for the interior furnishings, will be 97 feet 7 inches long. These are stupendous dimensions for an airplane. The largest commercial airliner flying in the United States today has a wing spread of only 95 feet…"*

***The Chicago Tribune,*** **October 3, 1937**

1310

1311

*"…On its tricycle landing gear the giant ship will stand 24 feet 6-1/2 inches above the ground. The two main landing wheels will be 65 inches, or 5 feet 6 inches, in diameter, and the nose wheel will be 3 feet 8 inches in diameter. The entrance to the cabin will be 9 feet 6 inches off the ground when the ship is at rest…"*

***The Chicago Tribune,*** **October 3, 1937**

**Left: caption: "Douglas DC-4E on tarmac, Santa Monica, Calif., ca. 1938"**

**Right: caption: "Passengers boarding Douglas DC-4E on February 13, 1939, Santa Monica, Calif."**

1312

## Sharing the Risk

1313

**Early in 1936, *William A*. "Pat" *Patterson*, President of UAL, called a meeting of operations and traffic personnel. The pioneer transcontinental carrier had a problem; UAL's fleet of 10-passenger *Boeing 247* transports was being outclassed by the newer, larger, faster *Douglas* DC-3 used by *American Airlines* and TWA. Something had to be done. As an interim measure, Patterson had ordered DC-3 airliners and spent +$1 million to "soup-up" the Boeing 247. But Patterson knew that UAL needed something better. "What do we want in an airplane?" Patterson asked the perplexed group. The result was a composite "Dream Plane" - a four-engine luxury transport capable of carrying 40 or more passengers; performance that would enable it to cross the continental U.S. with only one stop and speeds better than three-miles-a-minute.**

1314

Patterson took the broad concept to ***Jerome C. Hunsaker,*** aerodynamic expert at MIT, for a basic airframe design and to P&W, for power-plant potentialities. Before long, he had detailed "specs" for the new four-engine plane. With specs, in hand, Patterson made the rounds of the various aircraft manufacturers. Boeing was too busy building big flying boats. Consolidated complained airline people didn't know how to design airplanes. Sikorsky submitted a bid so low that Patterson's own directors ignored it. However, at Douglas it was a very different story. When ***Donald Douglas*** heard about the proposal and learned his former mentor at MIT, Jerry Hunsaker, was in on the project, he expressed a keen interest. Douglas called in his Chief Engineer, ***Arthur Raymond,*** and they began to put ideas down on paper.

1315

When Douglas, Raymond and Patterson met, Raymond put the $64K question to Patterson: "Engineering such a plane will take a lot of time and a lot of money . . . are you just looking or buying?" Patterson responded: "We'll put up $300K for the engineering cost, if you'll foot the bill for the rest." Douglas remembered all too well his experience with the DC-1. The initial $125K TWA put up was just seed money. Douglas had lost money until they were well into the production stages with the DC-2. Even then, it was the foreign business and additional airline orders that finally put the company in the black. Tackling such a large project as Patterson was proposing was risky unless Patterson could guarantee enough orders to minimize the risk.

1316

***"…Research, engineering, and construction costs on this first giant amount to one-and-a-half million dollars. The plane was built at the joint order of the five leading domestic air lines. The idea of this united action is to develop a standard type of super-transport…"***
***Popular Mechanics,*** **June 1938**
**RE: Patterson's response was that other airlines, including: TWA, AA, EAL and PAA had heard about the proposed airliner. They wanted in and all had agreed to split the engineering cost with UAL. Thus, the "Big Five" had signed a pact that none would spend any money with any other company in the design and development of a plane in this weight category until they had first evaluated the Douglas design. If the big ship lived-up to expectations, orders would follow. *Donald Douglas* accepted the share-the-risk arrangement and the challenge posed. Practically every improvement and innovation then available to the aircraft builder was incorporated into the DC-4; auto pilots, de-icers, controllable-pitch propellers, navigational aids etc. There were also features which the DC-4 would pioneer.**

1317

## State-of-the-Art

1318

***"…Instead of settling down on a tail wheel in landing, the DC-4 will land level with the ground with its tail remaining in the air. The plane uses a retractable tricycle type of landing gear that employs a nose wheel instead of a tail wheel. The two huge main landing wheels are twenty-six feet apart…"***
***Popular Mechanics,*** **June 1938**
**Caption: "Douglas DC-4E fuselage showing nose wheel installed"**

1319

***"…It will be a low-wing monoplane with a nose wheel instead of a tail wheel and with the two main landing wheels placed well behind the center of gravity. This innovation follows a number of experiments which proved this feature has many advantages…"***
***The Chicago Tribune,*** **October 3, 1937**

1320

***"…While no radically new features are incorporated in this ship, the engineers have overlooked no known formula to improve its speed, control, and safety. One of the features regarded most favorably is the nose wheel and the placing of the main wheels behind the center of gravity…"***
***The Chicago Tribune,*** **October 3, 1937**

1321

***"…Tests with smaller ships have proved that the tricycle gear virtually will eliminate all tendency to ground loop. This is true because the center of load, which is at the CG, or center of gravity, leads the main landing wheels rather than pushing forward from behind them. Thus when the ship lands in a cross wind or with considerable drift the load tends to straighten the ship into the track of its motion in the air rather than attempting to swing the tail around to get ahead of the landing gear, as in the case of planes with landing wheels ahead of the CG…"***
***The Chicago Tribune,*** **October 3, 1937**

1322

***"…With a nose wheel also, extremely fast landings will be possible without danger. Once on the ground, brakes can be applied without hazard of a nose-over. The ship always is in flying position. This means that passengers in berths will not be cocked at a crazy angle when the ship is on the ground. Furthermore, the initial push needed to get it rolling for take-off should be less…"***
***The Chicago Tribune,*** **October 3, 1937**
**RE: tricycle landing gear greatly improved the DC-4's take-off and landing characteristics. The DC-4, in normal level flight attitude on the ground, presented the control and lift surfaces to the airstream right from the beginning of its taxi run, cutting-out the need to "lift the tail high." On landing, the tricycle arrangement enabled pilots to literally "fly" the ship in, rather than let it settle with loss of lift at the last minute. "Positive control right to touchdown," pilots exclaimed. On the ground, the DC-4's taxiing capabilities far exceeded the maneuverability of smaller planes because of the "kiddi-car" type undercarriage; the large airplane could be turned on the proverbial dime.**

1323

***"…All the landing wheels retract into the main shell of the ship, special fairings being provided which will entirely close the wells into which they will sink. The nose wheel is hinged directly under the seats of the two pilots. It retracts straight backward into a well beneath the floor of the galley…"***
***The Chicago Tribune,***
**October 3, 1937**
**<u>Caption</u>: "Douglas DC-4E with nose wheel in retracted position"**

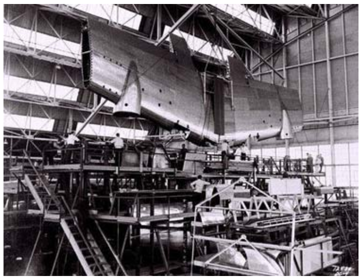
1324

***"…The main landing wheels are set well behind the engine nacelles, and these retract sideways and toward each other to fold into compartments in the wing between the fuselage and the inboard engines. In the air, with landing gear retracted, no portion of the wheels is exposed, as has been the practice on transport machines up to this time…"***
***The Chicago Tribune,*** **October 3, 1937**

1325

***"…The wings of this plane are attached nearly midway in the length of the fuselage. It is a definite step in the direction of the flying wing which engineers predict will be the ship of the future. The root of the wing is 25 feet in width, but the gleaming metal airfoils taper sharply to a pointed tip. The sweepback, typically Douglas in outline, is along the leading edge. The trailing edge is nearly straight…"***
***The Chicago Tribune,*** **October 3, 1937**

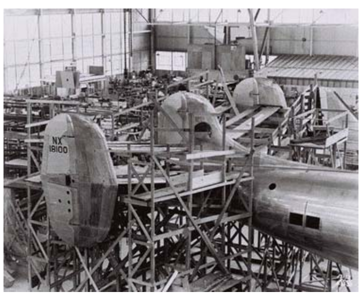
1326



1327

***"…Instead of a conventional tail the plane has triple vertical tail surfaces. The new arrangement allows better control with half the power plants not operating. The horizontal airfoil surface of the tail group is about the size of the wing of a small bomber…"***
***Popular Mechanics,*** **June 1938**
**Caption: "Douglas DC-4E with rear view of tail and right wing"**

1328




1329

***"…The machine also will have a triple tail. That is, there will be but one horizontal stabilizer and one set of elevators, but there will be three vertical fins and three rudders. This was a compromise arrangement adopted in order to provide exceptional control at slow speeds and to avoid the construction of one enormous vertical fin which would have towered more than 35 feet into the air…"***
***The Chicago Tribune,***
**October 3, 1937**
**Caption: "Two men working on the outboard rudder of a Douglas DC-4E"**

1330

***"It got to a point where we had blown up the DC-3 rudder to almost five times its normal size and still we had instability. The normal rudder configuration simply was no good. Then somebody, I don't know who it was, suggested we try three smaller rudders and vertical stabilizers instead of one. The result gave the ship remarkable stability especially during two-engine operation. And this was a must requirement . . . that the plane be able to fly on any two engines."***
***Bailey*** **"Doc"** ***Oswald*****, Douglas' Chief Aerodynamicist**
**Caption: "Douglas Aircraft Company Santa Monica Inspection Department group photo with the Douglas DC-4E"**

1331


1332

***"…Control surfaces are so large that manual control by the pilot is augmented by hydraulic booster pumps. Some of the control cables are nearly one-half inch in diameter…"***
***Popular Mechanics,* June 1938**
**RE: the DC-4's ailerons, rudder and elevators were bigger than the wings on training planes Douglas was building, at the time. Thus, super-human strength would have been required to move these huge "planes" in the man-made hurricanes whipped-up by the plane's powerful propellers. The solution was control "boosters" whereby standard control cables were replaced with small diameter hydraulic lines. Small electric motors, driving pumps, used the principle of the hydraulic automobile brake to operate ailerons, rudder and elevators, giving the pilot "finger-tip control," akin to power steering in an automobile.**

1333

***"…Cruising speed will be about 200 miles-an-hour, with a top speed of about 225 miles-an-hour. It must be able to land with full load at sea level at a speed not greater than 65 miles-an-hour…"***
***The Chicago Tribune,* October 3, 1937** 1334
**Caption: "Douglas DC-4E in flight"**

1335

***"…To provide for this, flaps have been installed extending from inner margins of ailerons beneath the fuselage."***
***The Chicago Tribune,* October 3, 1937** 1336
**Caption: "Douglas DC-4E inside hangar, showing wing flaps down"**


***"…The whole ship, of course, is constructed entirely of metal - duralumin spars being used throughout…For the first time in a large airplane, flat flush-type rivets are used in fastening the outer metal skin, materially reducing resistance…"*** 1337
***The Chicago Tribune,* October 3, 1937**


1338

***"…The lighting and other secondary power requirements are so heavy that auxiliary engines instead of batteries are used for the circuits. These air-cooled auxiliary engines drive alternators furnishing enough 800-cycle 110-volt current to light a huge office building. They also operate vacuum pumps for instrument-operating vacuum, provide pressure for the de-icers, run a hydraulic pump for the autopilot, and furnish pressure for the main hydraulic system that operates the air flaps, landing gear, and the minor hydraulic units…"***
***Popular Mechanics,*** **June 1938**

1339

***"…For the first time in a commercial transport these four engines will bear only the loads of flying the airplane. Special Eclipse engines of four cylinders each are installed behind the inboard engines in each wing to carry all other loads, including those of supplying power for a 110-volt electric light system, radio, vacuum pumps for the numerous gyro instruments in the cockpit, and heat for the galley…"***
***The Chicago Tribune,*** **October 3, 1937**
**RE: retracting the nose wheel and main gear into the fuselage presented a major mechanical problem. However, the DC-4 had "muscles" new to aircraft operation. Douglas' engineers took advantage of two auxiliary engines working independently of the DC-4's four P&W engines. The auxiliary engines drove generators to provide electricity and actuated pumps for the hydraulic controls that ran the unique "booster" system, auto pilot, landing gear, wing flaps and de-icers. They also drove the compressors for cabin air conditioning and heating.**

1340

***"…As much as 250 horsepower has been taken away from the effective power transmitted to the propellers of engines in other commercial ships, where such accessories as will be operated by the Eclipse engines were actuated off the main engines. It was decided that in the DC-4 the motors would turn their own magnetos and pump their own fuel but perform no other functions. The Eclipse engines are buried in the wings but cooled by air led through special ducts for this purpose…"***
***The Chicago Tribune,*** **October 3, 1937**

1341

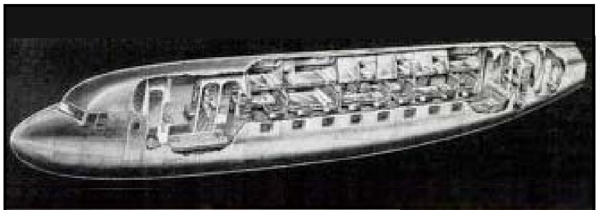
1342

***"…The exhaust systems of these engines pass into the exhaust pipes of the propelling engines, being located so as to pass through steam boilers for cabin heating, making heat for the boilers available even when the plane is standing on the ground with the main propelling engines not operating…"***
***Popular Mechanics,*** **June 1938**

1343

***"…Inside the huge cabin various arrangements of comfortable lounge chairs, reclining chairs, or sleeping berths are to be installed according to the desires of the different air lines…"***
***Popular Mechanics,*** **June 1938**
**Caption: "Model of the DC-4E"**

1344



*"…The different plans all include dressing rooms and a large galley under the care of a steward and stewardess…"*
***Popular Mechanics,***
**June 1938**
**<u>Above</u>: caption: Interior arrangement of DC-4E, showing deep, comfortable berths for traveling at night"**
**<u>Left</u>: caption: "Mock-up of DC-4E passenger compartment"**

1345

1346

***"…The cabin alone will be 7-1/2 feet high, 9 feet 9-7/8 inches wide, and more than 66 feet in length. There will be a double row of lounge chairs down each side of an 18-inch aisle in the main cabin. The chairs nearest the windows on each side will be 28 inches wide; those nearest the aisle will be 25 inches wide. They will be so constructed that when arranged for night flights, 24 persons can rest in comfortable beds in the main cabin and two others in the private compartment on the right side at the tail of the fuselage…"***
***The Chicago Tribune,* October 3, 1937**

1347

1348

***"…Each lower berth will be 28 inches wide and 6-1/4 feet long. These berths also will have beside them a lounging chair in what is virtually a tiny sleeping compartment. The upper berths will be as long and somewhat wider - 32 inches - but there will be no lounging chair. This arrangement is reached by staggering the lowers…"***
***The Chicago Tribune,***
**October 3, 1937**
**<u>Caption</u>: "Stewardess and passengers aboard a Pan Am Douglas DC-4"**

1349

1350

***"…The rear compartment can be entirely cut-off from the rest of the airplane and has its private lavatory, and upper and lower berths much like those in Pullman car compartments. The cabin floor hides vast storage compartments for mail and express…"***
***The Chicago Tribune,* October 3, 1937**

1351

***"…There are thirty-two windows in the main cabin space, sixteen upper skylights, and two portholes. Space beneath the cabin floor is used for baggage and express, providing more room than is available in many large sized trucks…"***
***Popular Mechanics,* June 1938**
**RE: the DC-4 could accommodate 42 guests by day and 30 by night. There was a Ladies' Lounge, a Men's Dressing Room, a private compartment up front (a/k/a "Bridal Suite"), comfortable seats arranged two abreast (twenty along each side) which could be made up into sleeping berths.**
**<u>Caption</u>: "Douglas DC-4E - the father of modern airliners"**

1352

Douglas DC-4
*America Leads*

World's largest land transport, designed to carry 42 passengers and a crew of five. Equipped with pressure cabin for sub-stratosphere operation, and tricycle landing gear.

SPECIFICATIONS—Wing span 117' 6". Length 92' 3". Height 27' 10". Weight empty 34,546 lbs. Useful load 12,454 lbs. Fuel 1700 gals. Oil 88 gals.

PERFORMANCE — Powered with four Pratt & Whitney twin-row "Hornet" engines developing 1100 h.p. each, the DC-4 has a maximum speed of 257 m.p.h., a cruising speed of 235 m.p.h. and a cruising range of 2600 miles. Rate of climb 1200 ft./min. Service ceiling 22,900 ft. Manufactured by Douglas Aircraft Corporation, Santa Monica, California.

***"…Provisions are to be made for installing air-compressing gear and for sealing the cabin and cockpit for sub-stratosphere flying…"***
***Popular Mechanics,* June 1938**

1353

***"…Because the airplane is so large, it is being equipped with a separate pair of motors for generation of electricity, with a new type of heating and ventilating unit, with valves which will enable the operators to supercharge the cabin at will for high altitude operation…"***
***The Chicago Tribune,* March 6, 1938**

1354

***"…The cabin will be more completely soundproofed than any previous commercial ship, and for once the soundproofing will be extended into the pilots' cabin, hitherto a neglected spot…"***
***Popular Mechanics,* June 1938**

1355

***"…Pilots from Pan American Airways, United Airlines, American Airlines, Transcontinental and Western Air, and Eastern Airlines went out to the Douglas factory and sat in the giant mock-up of the DC-4. These men arranged and rearranged the instruments until they were exactly as they wished them to be. The final result, to the mind of the writer at least, is ideal…"***
***The Chicago Tribune,* October 3, 1937**

1356

*"…At the maximum forward point in the fuselage nose is the roomy, comfortable pilots' and captain's office. There the controls, switches, dials, and Instruments necessary in the flying of the giant plane are placed. Without a doubt the cabin of the DC-4 will be the best from the flying standpoint of any in an airplane manufactured in the United States…"*
***The Chicago Tribune,*** **October 3, 1937**

1357

*"…In the cockpit the pilot and co-pilot sit farther apart than in present transports, the space between them being taken up by a wide control stand upon which are mounted all engine operating levers. Throttles are duplicated on each side of this pedestal so that it is not necessary for either man to reach across it. A third seat behind the pilots is provided for a flight engineer, who also has access to all engine controls and who thus can relieve the flying crew of all engine operating problems…"*
***Popular Mechanics,*** **June 1938**

1358

1359

*"…The flight instruments are duplicated for first and second pilots. These groups are placed exactly in front of the two seats. From the ceiling down the instrument panel to the floor run the numerous engine instruments in quadruple series, since the same indicators are provided for each of the four engines…"*
***The Chicago Tribune,*** **October 3, 1937**
**Caption: "Douglas DC-4 cockpit"**

1360

*"…The flight and engine groups are separated. The throttles, mixture controls, propeller controls, etc., are on a mount between the two seats. There also is a master control for the gyro-pilot which probably will fly the big airplane most of the time it is in the air. This master control is a knob which can be actuated like the stick in small airplanes but in addition can be twisted to the right or left to control the rudder pick-offs of the gyro-pilot as well. In other words, the pilot with one hand can instantly make any adjustment he desires in the gyro-pilot. Radio switches for the eight separate units are on the ceiling, and the units themselves are placed in a cabinet on the right side of the cockpit behind the second pilot's seat…"*
***The Chicago Tribune,*** **October 3, 1937**

1361

1362

***"…A third seat which may be occupied by a commander, who will give orders but never touch a control, a special radio navigator, or an engine specialist, is included. This sliding seat moves through an arc of about 140 degrees from a small table, upon which charts may be spread, to a position exactly between the two pilots' chairs…"***

***The Chicago Tribune,*** **October 3, 1937**

1363

***"…Directly behind the cockpit is a lavatory for men and a dressing room. Then comes the galley, which will be completely equipped to turn out hot meals. Behind this the main cabin begins. At the rear of the main cabin is a cloak closet and an aisle leading to the women's dressing room on the left and the compartment on the right…"***

***The Chicago Tribune,*** **October 3, 1937**

1364

***"…There are no gasoline tanks in the fuselage, as in the Douglas DC-2s and DC-3s now flying the air lines. All the tanks for the DC-4 will be in the wings, between the inboard and outboard engines on each side…This giant plane will carry enough gasoline to enable it to fly for 1,500 miles, with a reserve supply enough for another 500 miles. Thus transport operators will be able to cross the continent with one stop should this be desirable…"***

***The Chicago Tribune,*** **October 3, 1937**

**<u>Caption</u>: "The DC-3, largest air liner now flying over land. It is 65-feet-long, carries 21 passengers, and is a refinement of the DC-2, which was 60-feet-long."**

1365

***"…Four single engine fuel systems are provided, each engine having its own 100-gallon tank of high octane take-off fuel and its own 500-gallon tank of cruising fuel. One main selector switch on the engine pedestal changes over all the tanks in one motion. In addition, supplemental by-pass levers make it possible to route fuel from any of the tanks to any of the engines. Engine-driven fuel pumps are supplemented by hand pumps in the cockpit…"***

***Popular Mechanics,*** **June 1938**

1366

***"…To make certain that this large fuel-delivery system is foolproof in every respect, the engineers conducted comprehensive tests with a full-scale mock-up. They even had to make allowances for such conditions as the rearward acceleration of fluid in the fore and aft fuel lines during take-off, which in some systems results in a temporary drop in fuel pressure at the carburetors…"***

***Popular Mechanics,*** **June 1938**

1367

***"…One problem magnified by the size of the plane had to do with the engine control system arrangement. Each of the outboard engines is seventy feet away from the cockpit, yet it must respond to control adjustments as rapidly and easily as if it were only a few feet away. A combination of push-pull rods at each end, connected by cables stretching through the wing, was found to be the answer. In cases where automatic controls are used in the engines, manual over-ride controls are attached for possible use from the cockpit in emergencies. …"***

***Popular Mechanics,*** **June 1938**

**RE: the size of the DC-4 posed new problems with every progressive step; the engine control system is a good example. Each of the two outboard engines was 70-feet from the cockpit. Thus, the same positive, sensitive response possible when power controls were only a few feet away from the engines (as in the DC-3) had to be included in the DC-4's design.**

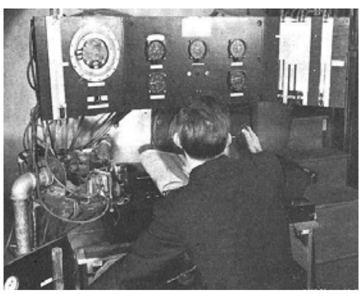
1368

***"We had to start from scratch. It meant designing a whole new controls system. But finally, we whipped it with a combination of push-pull rods and cables that ran through the internal structure of the thick wing. It was rather ingenious. . . and it worked. Each engine had a 100-gallon tank of special take-off fuel and another 300-gallon tank of cruise fuel. You could switch from one tank to another with the flip of the wrist. It gave the pilot extra power for take-off, the critical moment of any flight. Yet, once the ship was airborne and set for cruise speeds she was ready to start an economy run."***
***Ivar Shogran,*** **Douglas' Chief of Power-Plants**

1369

***"We felt from the very beginning that an airplane of this size was just too much for one man to handle. It seemed we were asking that a pilot or co-pilot have four hands. So we built duplicate engine and hydraulic system controls and installed a second control board just behind the pilots' station. It meant putting a third flight crew member up front, but it took a great load off the pilots during critical flight moments."***
***Donald Douglas***
**RE: the DC-4's engine control system and the new fuel-feed technique brought about a major innovation in aircraft design: the flight engineer's station**

1370



1371

## Making Progress

1372

***"THE Douglas Aircraft Company of Santa Monica, Cal., announced not a great while ago that fully 90 per cent of the engineering and construction work on the new Douglas DC-4 had been completed. By the time this article appears in print the assembly of this new commercial airliner, the largest to be built in America up to this time, should be virtually completed. The plane is expected to make its first test flight some time during the latter days of this month…"***
***The Chicago Tribune,*** **March 6, 1938**
**<u>Top</u>: caption: "the enormous whale-like fuselage of the DC-4E in its jig at the Douglas plant awaits wing attachment"**
**<u>Bottom</u>: caption: "The new four-engined Douglas DC-4E prepares for test flight"**

1373

## The Latest Information

1374

*"…The latest information concerning the DC-4 revises somewhat earlier stories regarding this great ship which have been printed in this department. For instance, instead of having a gross weight of 60,000 pounds the machine will gross at 65,000 pounds, or 32.5 tons. With a 20,000 pound payload the range, instead of being 1,900 miles, will be 2,200 miles. The top speed will be 240 miles-an-hour at the most efficient altitude instead of 225 miles-an-hour, and the plane is expected to cruise at 210 m.p.h…"*
***The Chicago Tribune,*** **March 6, 1938**

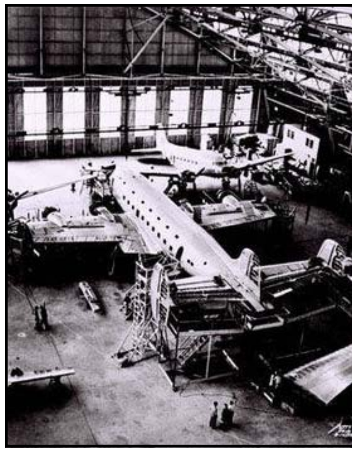
1375

*"…The designated sea-level landing speed is 68.5 miles-an-hour, but the Federal Bureau of Air Commerce regulations now permit landing speeds as high as 70 miles-an-hour for airplanes the size and weight of the new Douglas. Tests with smaller craft have shown that speeds as high as 80 to 90 miles-am-hour will not be excessive for large craft fitted with the new safety nose wheel landing gear which the Douglas Company is pioneering in its DC-4 design…"*
***The Chicago Tribune,*** **March 6, 1938**

1376

*"…Harry H. Wetzel, vice president and general manager at the Douglas plant, says that a total of 500,000 engineering hours will have gone into the construction of the first DC-4 when the prototype is finished. The time consumed in developing this giant airliner from the drawing board to the finished product, according to Wetzel, represents not so much the difficulties and problems of constructing large-size planes as it does the careful research and testing of parts and new features the DC-4 incorporates…"*
***The Chicago Tribune,*** **March 6, 1938**

1377



*"More than 500,000 hours in engineering and design, another 100,000 hours of ground and laboratory tests, eighteen months to build. Some 20,000 different pieces of metal framed to different shapes, 1,300,000 rivets. Total cost - $992,808 for labor and engineering, $641,804 in materials and overhead."*
**RE: excerpt from a *Douglas Airplane Company* press release discussing the magnitude of the DC-4 project. *Donald Douglas* confided to Chief Engineer Raymond: "I knew we could design planes as big as this and bigger; but I frankly didn't know how we would ever build them!"**

1378

1379

**The Great Outdoors**

1380

***"…In building the new ship it was necessary to find and test a number of new materials as well. Separate, independent systems for supplying electricity, cooling, heating, and control operations had to be designed and created. It was necessary, for instance, to design and build special locks for all the control surfaces of the DC-4, inasmuch as it will be too large for any hangar now in existence and consequently must be left outdoors…"***
***The Chicago Tribune,*** **March 6, 1938**

1381

***"…This was a greater problem than at first may appear. The need for the lock was great. So large are the control surfaces – ailerons rudders, and elevators – that they might be seriously damaged if banged around by gusty winds. The locks had to be strong enough to resist the wind forces, yet weak enough to be overridden by the pilot should a take-off be made with the controls locked…"***
***The Chicago Tribune,*** **March 6, 1938**

1382

***"…The Douglas engineers wanted no repetition of the disaster that overtook the Boeing company's first 299 flying fortress bomber when it crashed at Wright Field, Dayton, as two army pilots took it off with the controls locked. This problem finally was licked, but it involved more hours of engineering work…"***
***The Chicago Tribune,*** **March 6, 1938**
**RE: the *Board of Officers* convened at *Wright Field*, Dayton, Ohio, to investigate the cause of the crash of the *Boeing Model 299* "Flying Fortress" prototype on October 30, 1935, found that the accident was not due to structural failure or to the malfunctioning/failure of any of the four engines, control surfaces or the automatic pilot but, rather, to the locked condition of the rudder and elevator surface controls (primarily the latter), which made it impossible for the pilot to control the airplane. These findings were based on the locked condition of the controls found after the crash; the testimony of *Donald Putt*, co-pilot and *Leslie R. Tower*, pilot, as to the behavior of the airplane in the air and the testimony of eyewitnesses as to the behavior of the airplane on take-off and flight.**
**Caption: "Side view of the Boeing XB-17 (Model 299) after it crashed and burned on October 30, 1935 and the fire was extinguished"**

1383

1384

**Ship No. 1**

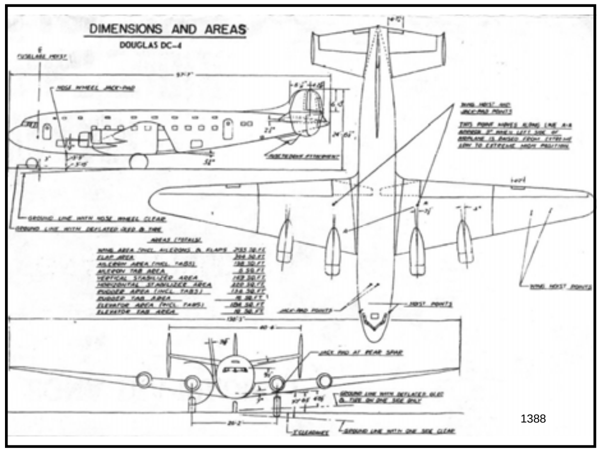
1385

***"…All told the DC-4 will have cost $1,500,000 by the time the No. 1 ship is completed. This cost is jointly borne by the Douglas Company, United Air Lines, Transcontinental and Western Air, American Airlines, Pan American Aviation Supply Corporation – a subsidiary of Pan American Airways Systems – and North American Aviation, Inc…"***
***The Chicago Tribune,*** **March 6, 1938**

1386

*"…The dimensions of the ship may well be repeated here: Wings will span 138 feet 3 inches; the fuselage will be 97 feet 7 inches long. On the tricycle landing gear, which will keep the ship in a level attitude even on the ground. Entrance door to the cabin will be 9 feet 6 inches off the ground when the ship is at rest…"*
***The Chicago Tribune,*** **March 6, 1938**

1387




1388

***"…It may well be said, however, that the DC-4 will be approximately three times as large as the DC-3. Visitors to the International Air Show at Chicago last month will remember the size of the DC-4 – largest plane on exhibit there."***
***The Chicago Tribune,*** **March 6, 1938**
**RE: when the DC-4 made its public debut in early 1938, a newspaper man commented: "It looks like somebody put a magnifying glass on the DC-3 and made it three or four times its normal size"**
**Caption: "The Douglas DC-4E: the biggest land transportation plane ever built in the United States"**

1389

1390

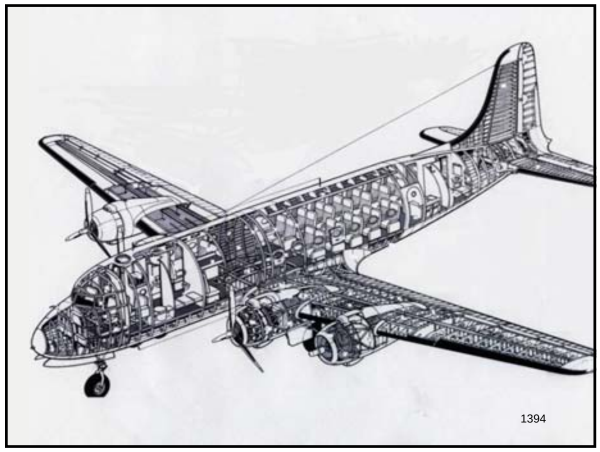
## War and Remembrance

1391

**While design work on the DC-4 proceeded, WWII broke out. Subsequently, American aircraft manufacturers switched to military production. The USAAF liked the DC-4 design and decided to bring it into service as the "C-54 Skymaster" (USN designation "R5D") The first C-54 performed its initial flight on February 14, 1942, retaining the same general configuration as the DC-4, but it was, in general, a new design. The C-54 was somewhat scaled-down, with shorter span and length, empty weight reduced by 10% and it had a single tailfin instead of the triple-fin tail. Pressurization was also eliminated.**

1392

1393



1394

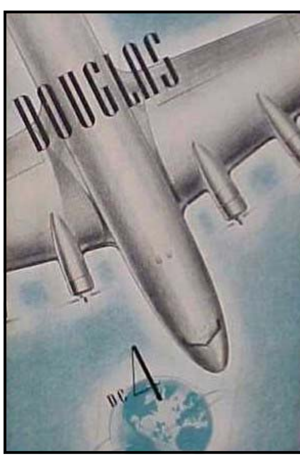
**While not as successful as the DC-3, the DC-4 was built in significant numbers and led to the improved DC-6 and DC-7 derivatives, which were also built in significant numbers.**

**<u>Caption</u>: "Douglas prop-driven commercial airliners (bottom-to-top): DC-7, DC-6, DC-4 and DC-3." The aerodynamic shape of the DC-4 wing and fuselage is identical to the later DC-6 and DC-7. Note the use of a single tailfin on all production DC-3 thru DC-7 models)**

1395

**A New Milestone**

1396




***"The DC-4 in no way replaces the famous twenty-one passenger DC-3. Rather, it is an independent development anticipating future needs for greater load capacity in trunk-line operations for long distances. It represents the Douglas Company's contribution to the science of aeronautics - a new and significant milestone in aviation's progress."***

***Donald Douglas***

**RE: an official Douglas company announcement declared that the new Douglas Commercial's "design and construction follows closely that of the DC-3." Others referred to the DC-4 as: "A Grand Hotel with wings," given amenities such as air-conditioning, hot and cold water, an electrically operated galley, curling irons for ladies, electric shavers for men and telephone service while the plane was in port or airborne (within radio contact range).**

1397

## <u>Part 18</u>

## On the Ground and in the Air

1398

## On the Safe Side

1399

***"…A testing laboratory in charge of outstanding engineers was kept busy for more than two years hunting information on materials and designs. Most of the important parts of the plane were built and then deliberately and scientifically destroyed in the testing laboratory to prove the calculations of engineers and designers. Special machinery and fittings were designed and built at the Douglas plant to carry out these tests. In all more than 100 major structural tests were conducted, requiring 21,000 engineering and shop hours, to prove and check engineering designs and stress calculations…"***
***The Chicago Tribune,*** **March 6, 1938**

1400

***"…To make sure their calculations provide the needed safety factors Douglas engineers performed more than 300 major physical tests and approximately 1,000 minor tests before construction really started. Hundreds of thousands of dollars were spent on building up vital parts of the plane and then testing them to destruction. The special anti-frost laminated glass for the cockpit windows was subjected to temperatures of forty degrees below zero to make certain that it remain transparent under extreme conditions…"***
***Popular Mechanics,*** **June 1938**

1401

## Going Nowhere

1402

**Indoor test of mammoth skyliner equals three trips around the world**
***Popular Science,*** **August 1938**
**RE: introduction to an article entitled: "63,875 Miles in a Shed"**

1403

## Indoor Flying

1404

***"WITHOUT leaving its hangar, a new 65,000-pound transcontinental airliner, designed to carry twice as many passengers as present-day transport planes, was subjected recently to all the strains of taking-off, zooming, diving, landing, and flying nearly three times around the world…"***
***Popular Science,* August 1938**

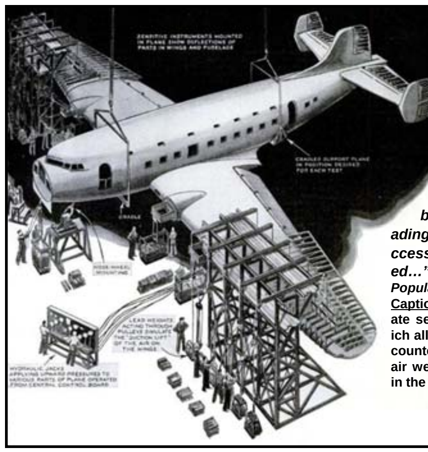
1405

## The New Method

1406

***"…Engineers at the Douglas plant, Santa Monica, Calif., inaugurated the new method of putting costly planes through grueling tests without running the risk of trials in the air. Such 'standstill flights' promise to become standard practice in the future…"***
***Popular Science,* August 1938**

1407




***"…One million pounds of lead, giant hydraulic jacks, block-and-tackle chains, and steel frame-works that looked like parts of a skyscraper skeleton were employed in the tests. As many as 200 sensitive instruments had to be checked and their readings recorded as each successive strain was applied…"***
***Popular Science,* August 1938**
**<u>Caption</u>: "Details of the elaborate set-up for the tests, in which all load conditions to be encountered by the plane in the air were accurately reproduced in the shed"**

1408

## Flightless Trials

1409

***"…To be sure that every man was letter-perfect in his share of the work, elaborate rehearsals were held before each part of the tests began. All told, more than 100,000 hours of shop and engineering labor were expended in making the flightless trials…"***
***Popular Science,* August 1938**

1410

***"…One of the most important dealt with the attachment of the outer wing sections to the broad center section. The original built-up section was destroyed half-a-dozen times before the strength was approved by the engineers…"***
***The Chicago Tribune,*** **March 6, 1938**

1411

***"…In one of the tests, cables hooked to the leading edges and top surfaces of the wings pulled upward to duplicate the 'suction' lift of flight. In another huge hydraulic pistons drove downward on the engine mountings with a force equal to 180,000 pounds, straining the 139-foot metal wings to reveal their strength. The combined force of pistons and lead-bar weights, in some instances, equaled three-and-a-half times the entire weight of the plane…"***
***Popular Science,*** **August 1938**

Workers operating the pulleys that applied loads of 180,000 pounds to the wings. Right, twenty tons of pig lead, in fifty-five-pound bars, to be piled inside the fuselage.

1412

**Not So the DC-4**

1413

***"…Also a part of the engineering tests on the wing involved the building of strips of metal for the de-icing shoe or boot. The wing on the prototype machine will be so constructed that the curve of the leading edge will be virtually the same with the de-icer boot attached or off. All present machines have a substantial portion of their efficiency when the boot is attached for winter operations, because the pure wing curve is changed. Not so the DC-4…"***
***The Chicago Tribune,*** **March 6, 1938**

1414

**Above: caption: "Douglas DC-4E outer wing showing test plates, March 19, 1938"**
**Left: caption: "Douglas DC-4E, right outer wing being prepared for tests, March 26, 1938"**

1415

1416

**Special Attention**

1417

*"…The new-type, three-wheel landing gear employed on the big ship received special attention. More than fifty times, the wheels, tires, and struts were smashed down with impacts up to 120,000 pounds. Each time they struck, the deflection of tires and struts was filmed by automatic, high-speed motion picture cameras. Miniature seismographs also recorded on revolving drums the force and character of the vibrations set up by the impact…"*
***Popular Science,*** **August 1938**

1418

**Hitherto Not Encountered**

1419

*"…Many special problems were met which have not hitherto been encountered. One of the most difficult involved a study of vibration of the various parts for all the different speeds and conditions which might be met in operation…"*
***The Chicago Tribune,*** **March 6, 1938**

1420

*"…Vibration of metal wings, spars, skin, etc. causes fatigue. Fatigue weakens structure and has caused accidents. The crash of Northwest Airlines Lockheed 14 in Montana last January was most probably the direct result of a structural failure caused by vibration…"*
***The Chicago Tribune,*** **March 6, 1938**
**RE: on January 10, 1938, *Northwest Airlines Flight 2,* an L14H, crashed into the *Bridger Mountains,* about twelve miles northeast of Bozeman, Montana. It was the first fatal crash of a *Northwest Airlines* aircraft and/or a *Lockheed Super Electra.* All ten passengers and crew on board were killed.**
**Caption: Lockheed Super Electra Model 14 cross-section"**

1421

**"BOZEMAN, Mont., Jan. 10 - *A Northwest Airlines transport plane crashed on a snow-covered peak high in the Bridger Mountains fourteen miles northeast of here late today, carrying to their deaths ten persons listed as being aboard. Sheriff Lovitt I. Westlake of Bozeman, who led a party on bobsleds to the crash scene, said he counted nine bodies. He said they were charred beyond recognition. Northwest Airlines officials reported eight passengers and a crew of two were aboard. The fuselage of the plane was burned into a twisted mass of steel. Sheriff Westlake said that the plane appeared to have plunged nose first into the mountainside in a small clearing. Two ranchers, cutting wood on the rugged mountain slope, said they saw the plane burst into flames as it hit the ground."***
***The New York Times,*** **January 11, 1938**

1422

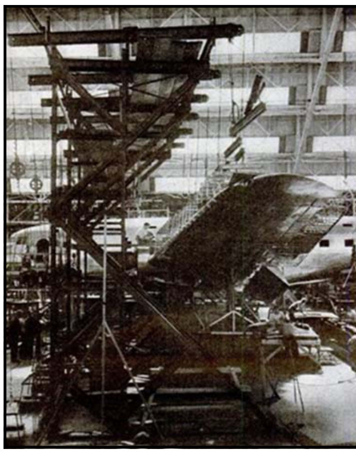

Investigators with the ***C**ivil **A**eronautics **A**uthority* (CAA) determined that both vertical fins and both rudders were missing from the twin-tailed aircraft. They determined that the empennage had failed due to flutter. Weather reports from surrounding communities as well as the existence of a dust storm in ***Bozeman Pass*** led investigators to believe that the aircraft likely encountered severe to extreme turbulence which may have initiated the flutter, resulting in structural failure.

**Caption: "A Lockheed 14H similar to the accident aircraft. Howard Hughes used the same aircraft in his July 1938 'round-the-world flight."**

1423

## According to Calculations

1424



***"…A test that took days to complete reproduced all the strains the plane would undergo if it were pulled up into a 2,000-feet-a-minute zoom while traveling 240 miles-an-hour. This is the top speed of the forty-two-passenger plane, which was designed at the order of five major air lines. According to the calculations of the engineers, the load-applications and vibration tests piled up a strain equal to that encountered by a plane flying 63,875 miles…"***

***Popular Science,* August 1938**

**Caption: "The Douglas DC-4 undergoing load tests that duplicated all the stresses in normal flight"**

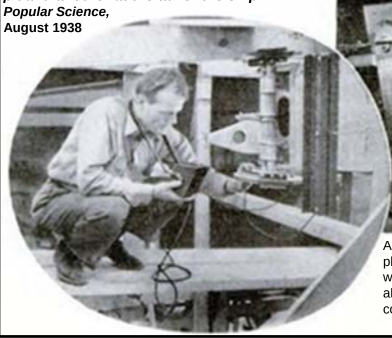
1425

## Indicated by the Fact

1426

***"…The gigantic size of the new plane is indicated by the fact that when mechanics tackled the job of adjusting the controls, a portable telephone system had to be used for communication between a worker in the cockpit and another at the tail of the ship."***

***Popular Science,* August 1938**



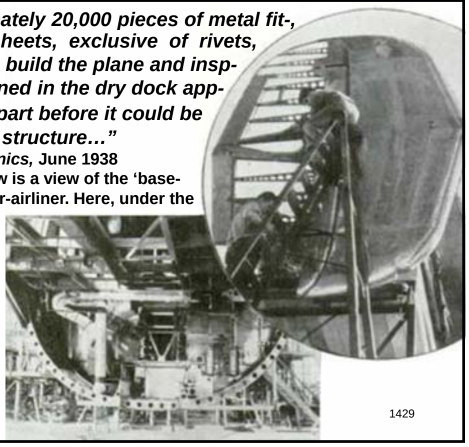
A mechanic in the cockpit of the plane communicating with another worker in the tail, at left, by portable telephone while adjusting the controls

1427

## The Sum of All of its Parts

1428

*"…Approximately 20,000 pieces of metal fit-, tings, and sheets, exclusive of rivets, were used to build the plane and insp-ectors stationed in the dry dock app-roved every part before it could be added to the structure…"*
*Popular Mechanics,* June 1938
Caption: "Below is a view of the 'base-ment' of a super-airliner. Here, under the floor, may be seen in pro-cess of comp-letion the maze of controls, he-ating, electric and ventilating systems. Abo-ve is the rud-der."



1429

*"…Parts of the tests on the wing involved the use of flush-type rivets, which are more expensive in production than the ordinary rivets with small protruding heads. Wind tunnel tests, however, disclosed that the flush head added considerably to the performance of the big plane, so this type of rivet was adopted and a number of tests were made to check its strength and to perfect tools which will enable it to be used with al-most as much speed as the older type…"*
*The Chicago Tribune,* March 6, 1938
Above: standard-type rivets on the underside of the wing of a DC-3

1430

**100% Wrong**

1431

A test pilot, most people seem to think, is a foolhardy fellow destined to live a short but exciting life, a reckless chap who whisks an unproved plane into the sky and zips, zooms, rolls, dives, slips, spins and stalls in an earnest effort to dislodge an engine or snap a wing. If he succeeds, according to pop-ular belief, he abandons ship, parachutes blithely down and then loafs until someone builds another airplane for him to murder. This conception of a test pilot's job, I am happy to re-port, is just about 100 per cent wrong.
*Popular Mechanics,* February 1939
RE: introduction to an article written by *Benny Howard,* UAL's research test pilot, entitled: "CHECK and DOUBLE-CHECK"

1432

**Strictly Business**

1433

*"UNITED Air Lines, which I represent in the tests of the lar-gest land plane ever built on this continent, was not looking for a stunt man. If I went up in the Douglas DC-4, which rep-resents an investment to-date of almost two million dollars and the combined engineering of Douglas, United, TWA, Am-erican, Eastern and Pan American Air Lines, and started any impromptu aerial acrobatics, another pilot with no flying cir-cus leanings soon would sit at the controls of the forty-two passenger, 65,000-pound sky liner…"*
*Popular Mechanics,* February 1939

1434

***"…There is nothing spectacular, dashing or heroic about test-flying a new airplane, at least there isn't if the test crew knows its business. In fact, truth compels the blushing admission that the average test flight in the DC-4 is almost as exciting as a game of solitaire. That's the whole idea of testing – to make it a prosaic business, to put the ship through its paces safely, to go the limit without taking chances…"***
***Popular Mechanics,*** **February 1939**

1435

## Doing the Proving

1436

***"…Someone once described an engineer as a highly trained man who has to have everything proved to him. The test pilot does the proving. But if the engineer wants to determine the stalling characteristics of a new plane, the test pilot doesn't take the ship aloft, point her nose up and await developments. He finds out in advance what will happen by sneaking up on the stall…"***
***Popular Mechanics,*** **February 1939**

1437

***"…He bides his time. He waits until weather conditions are right. He finds out what the ship will do under each condition leading up to a stall. He is patient, slow, cautious, methodical, perhaps to the engineer he seems just a bit stupid. But when he finally stalls the ship, he knows exactly what it is going to do. He has crept up on his objective by taking a step at a time and testing his footing with each cautious step…"***
***Popular Mechanics,*** **February 1939**

1438

***"…Thus, he executes a potentially dangerous maneuver without taking chances. That's test flying – a patient, methodical approach to each problem, taking nothing for granted, never accepting the obvious until it's proved…"***
***Popular Mechanics,*** **February 1939**

1439

## A Winged Technical Institute

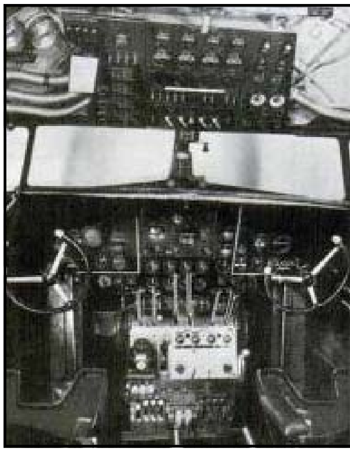
1440

*"…Few realize the tremendous amount of data which must be obtained, the hundreds of performance figures which must be checked and correlated in testing a new plane such as the DC-4. While in the test stage, this sky liner is actually a huge flying laboratory, its cabin filled with more than 2,000 pounds of test instruments and 6,000 pounds of wooden framework, seats and boxes for housing the crew, the scores of instruments and the ballast. The instruments in this winged technical institute record everything from the fuel required to take-off to the temperature of the brake linings during a landing…"*
***Popular Mechanics,*** **February 1939**

1441

## Proving Ground in the Sky

1442



*"…Let's make a typical test flight, our destination the proving ground in the sky. There are a score of engineers and observers aboard. With me in the cockpit is a flight engineer, a pilot for the Douglas company and another representing the Civil Aeronautics Authority…"*
***Popular Mechanics,*** **February 1939**
**Caption: "Pilot's compartment of DC-4 filled with flight and test instruments"**

1443

*"…In the cabin engineers and observers sit on comfortable benches in front of large desks containing amazing arrays of instruments. An engineering chart has been prepared outlining every test for the flight, and even the position of each observer. All of us are equipped with parachutes…"*
***Popular Mechanics,*** **February 1939**

1444

**Caption: "Engineers at their stations in the cabin during a test flight"**

1445

*"…As we thunder down the runway to the hum of 5,600 horsepower developed by the four engines, the flight engineer speaks rapidly into a dictating machine, recording his impression of the take-off as he watches the dials and gauges. The ship's interphone system also connects the flight engineer with the pilots and with the engineers and observers in the cabin so data can be correlated as rapidly as it is gathered…"*
***Popular Mechanics,*** **February 1939**

1446

*"…During the progress of the flight, this engineer at my elbow continues to dictate so that when the trip is finished we have a complete record of everything which has occurred. This is important because everything that occurs on a test flight may be significant and nothing must be forgotten or we may have to do the entire test again…"*
***Popular Mechanics,*** **February 1939**

1447

## Never Before Possible

1448

*"…Back in the cabin engineers and observers watch tons of instruments as they blink and whirl their thrilling story. Engine performance, the electrical system – big enough to illuminate an office building – the hydraulic system, vibrations and deflections in structural members – all are being checked and double-checked…"*
***Popular Mechanics,*** **February 1939**
**Left: caption: "Adjusting mechanism which produced artificial 'airquakes' on tail surfaces of DC-4"**
**Right: caption: "Engineers reading instruments and recording data in cabin during flight tests"**

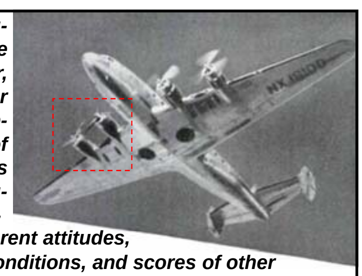
1449

*"…On blueprint blanks, the engineers make detailed notes as the ship speeds high above the clouds. Engine pressures and temperatures, for example, require blanks with 110 lines, each of which must be filled out carefully during a flight. If just one person slips up and fails to get his share of the data, we may have to do the whole thing over…"*
***Popular Mechanics,*** **February 1939**

1450

*"…After such a flight, all the results are checked and transcribed. Eventually, thick volumes of reports thus are accumulated, adding valuable information to the science of aeronautics…"*
***Popular Mechanics,*** **February 1939**

1451



*"…In this manner engine temperatures, on the ground and in the air, fuel consumption under varying conditions, vibrations in single parts of the ship and in groups of parts, load distributions, air-flow character- over the airplane in different attitudes, speeds and operating conditions, and scores of other equally important matters are checked with an accuracy never before possible in actual flight…"*
***Popular Mechanics,*** **February 1939**
**RE: before the first DC-3 had made its first flight, Douglas and UAL were discussing a four-engine aircraft with double the capacity of the DC-3, which led to the DC-4; first of the Douglas family of four-engine airliners**
**Caption: "Douglas DC-4 climbing on only two engines. Note that two propellers are idle."**

1452

***"…Among the instruments carried for recording test data are an air-speed trailing bomb, differential pressure gauges, hydraulic pressure gauges, accelerometers, propeller stress-measuring apparatus, photographic equipment for recording flying characteristics, and boundary layer and wake measuring instruments…"***
***Popular Mechanics,* February 1939**

1453

***"…A pitot static tube on an airplane is used normally to measure air speed, and the air-speed trailing bomb is simply a ballasted and finned pitot static tube on the end of a long cable. By trailing the bomb in a region unaffected by the airplane and its wake, the total and static pressure at the pitot on the bomb may be compared with the pressures from the pitot static tube on the ship…"***
***Popular Mechanics,* February 1939**

1454

***"…Until recently, the actual power developed by an airplane engine in flight was unknown, although an approximation was made by extending the test stand performance of an engine to altitude by theoretical means…"***
***Popular Mechanics,* February 1939**

1455

***"…On the DC-4 we have a device which indicates the actual crankshaft torque developed by any of the four engines at any time. The external stationary gear of the planetary gear reduction is balanced by means of hydraulic pressure within two cylinders. This hydraulic pressure is easily recorded in flight and is translated into actual engine torque. This, with the tachometer which gives engine speed, yields an accurate measurement of brake-horsepower developed…"***
***Popular Mechanics,* February 1939**

1456

***"…Potentiometers measure the temperature of every cylinder, oil temperatures throughout the entire oil system, the temperatures of various accessories and of two thirty-horse-power auxiliary power plants, and brake-drum temperatures during taxiing and landings…"***
***Popular Mechanics,* February 1939**

1457

***"…A survey of the pressure distribution of the fuselage is also being made to determine the best design for the sealed cabin. Long rubber tubes to various points, a bank of type-writer-like selector valves and a differential pressure gauge are used for this purpose and enable an operator to take readings as rapidly as he can press the buttons…"***
***Popular Mechanics,* February 1939**

1458

***"…Propeller blades are exposed to centrifugal and thrust loads and vibrational loads. Because of their fatiguing effect, the last two are very important and the magnitudes of these loads are measured at several points on the propeller blades with the aid of carbon elements cemented to the blades, the resistance of which varies with the deformation. By means of wires run along the blades to brushes and from rings on the nose case of the engine to an oscillograph, a photographic recording of stress variations is obtained…"***
***Popular Mechanics,* February 1939**

1459

***"…A movie camera also makes a record of the force applied on all the controls and the direction, the movement of the controls in degrees, the accelerations of the plane and the attitude of the plane in every dimension. The camera is trained on a set of normal flight instruments, including turn-and-bank indicator, artificial horizon, directional gyro and airspeed indicator to record the attitude and flight condition. At the same time, the camera makes a record of the readings of separate instruments which indicate the force applied to the controls and the movement of these controls…"***
***Popular Mechanics,* February 1939**

Above, engineer in cabin watching 'movies' of propeller vibration during flight. Right, disk on propeller hub for measuring propeller vibrations during test flight.

1460

***"…There are instruments on this ship which measure the energy lost when forcing the wing through the viscous medium, air, and there are others which show the force the pilot applies to the elevator control which is equipped with a hydraulic booster. There is even a carbon-monoxide indicator and a complete system for oxygen distribution to members of the test crew, since the cabin is not yet pressurized…"***
***Popular Mechanics,* February 1939**

1461

***"…All this may seem a bit complicated – and it is. It's so complicated that it may take twenty engineers and observers to glean all the information which all these test instruments deliver on a single flight. If I so much as bat an eye in the cockpit, an instrument somewhere on the ship will record the fact for posterity – and probably measure the energy I required to do it…"***
***Popular Mechanics,* February 1939**

1462

***"…After a few months at the controls of the DC-4, I no longer need speculate on my flying skill. It has been analyzed for me by scores of sensitive instruments which faithfully record everything I do and every move I make from the time I climb into the cockpit in the morning until I climb out at night…"***
***Popular Mechanics,* February 1939**

1463

## Doping it Out

1464

***"…The real 'miracle men' of aviation today are not the test crews who, with the aid of a truckload of instruments, test the performance of a new plane after it is built. The wonder boys are the fellows who doped out all the performance characteristics before the ship was built. These wizards of the slide rule and power curve set down the performance specifications for the DC-4 some three years ago while the raw materials for the plane were still in the earth. They doped out top speed, rate-of-climb, take-off and landing speeds and hundreds of other factors. And their dope was correct…"***
***Popular Mechanics,*** **February 1939**

1465

**The Gauntlet**

1466

***"…The test flying in which we now are engaged in this 'proof of the pudding' but it is only one phase of the tests to which the DC-4 has been subjected. This ship was tested for months before it left its hangar…"***
***Popular Mechanics,*** **February 1939**

1467

***"…Every critical condition of taxiing, flying and landing was reproduced in ground experiments while the plane was being built. Reduced to mileage, the 'indoor flights' of the ship, as recorded in load applications and vibration tests, were sufficient in force and duration to have taken the DC-4 nearly three times around the world before it left the ground…"***
***Popular Mechanics,*** **February 1939**

1468

***"…To accomplish these things without taking the ship outside its construction hangar required 100,000 hours of shop and engineering labor, 175,000 pounds of structural steel and scores of tons of equipment such as hydraulic jacks, blocks and tackles, chains and special rigging. More than 200 points on the ship were subjected to deflection readings as successive loads were applied and some tests were made to load factors three and one-third times the gross weight of the plane…"***
***Popular Mechanics,*** **February 1939**

1469

**A Pretty Soft Snap**

1470

***"…Small wonder, after such accurate planning and such rigid preliminary testing, that the pilot who puts this leviathan of the skyways through its preliminary paces has a pretty soft snap – even if his ego is deflated once in a while by a few tons of snooping instruments which jot down every wobble he makes…"***

***Popular Mechanics,*** **February 1939**

**<u>Caption</u>: "The author in DC-4's cockpit"**

1471

## Tomorrow's Sky Liner

1472

***"…Soon the testing will be finished. Then the heavy timbers which hold the pig-lead bars in place during flights will come out. Out also will come a truckload of test equipment. In will go luxurious fittings, curtains, berths, reading lamps, carpeting. Then the Douglas DC-4 will become not only the largest land plane ever built in this country, but probably the safest ship ever constructed – safe because it will have been more thoroughly tested than any other airplane. In this task of checking and double-checking tomorrow's sky liner, I am proud to have had a humble part."***

***Popular Mechanics,*** **February 1939**

**RE: evaluation by UAL revealed that the *DC-4* was underpowered and overly complex, making it expensive to maintain. In response to requests from UAL and EAL, Douglas decided to simplify and downsize the design, but retained the designation "DC-4." The prototype DC-4 was retroactively designated "DC-4E" ("E" for "<u>E</u>xperimental"). The DC-4E was sold to *Imperial Japanese Airways* and subsequently reverse-engineered, to be used as the basis for the *Nakajima G5N* heavy bomber, which never entered production.**

1473

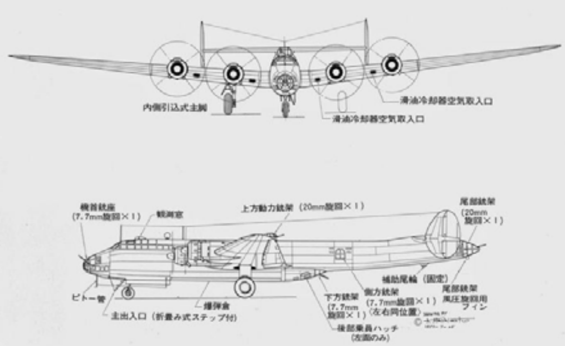
***"We sold the original DC-4 prototype to Japan and it later crashed with some high ranking military officers aboard into Tokyo Bay. We like to think that helped hasten the conclusion of the war. We then called it the DC-4E for 'Extinct.'"***

***Arthur E. Raymond,*** **Chief Engineer - *Douglas Aircraft Company***

**RE: the Japanese did use the DC-4E prototype to fashion their own version of a four-engine bomber and transport; the *G5N-2* and the *G5N-L* respectively, which the Allies designated "Liz." Modifications included changes in the wing spar and a slight extension in the nose. Both aircraft were equally unsuccessful.**

**<u>Caption</u>: "The Nakajima G5N Shinzan kai ("Deep Mountain") was a four-engined long-range heavy bomber designed and built for the Imperial Japanese Navy prior to WWII"**

1474



1475

## Design by Committee

1476

*"We designed the first DC-4 by committee. Before this, we worked with one airline, like American or TWA. Five airlines were in on the DC-4 design, and everyone wanted something special on their version. The crowning blow came when they all said it had to fit in the DC-3 hangar. This meant we had to put five tails on it. We had to take the control surface area under engine out conditions, and spread it over the five tails (three above and two below) to squeeze it in the DC-3 hangar. That was its downfall. We had a terrible time working out the stability and getting it licensed…"*
***Arthur E. Raymond,*** **Chief Engineer -** ***Douglas Aircraft Company*** 1477
**Caption: "Rear view of the three-tail DC-4"**

*"…When we got it to the point of flying, it had gained so much weight (65,000 pounds) and was so ungainly that Doug junked the whole thing. He knew it was a lemon. Then we redesigned it the way we wanted it, with a single tail, not so heavy, and it was a success."*
***Arthur E. Raymond,*** **Chief Engineer -** ***Douglas Aircraft Company***
**RE: in May 1939, following its first flight and a year of factory testing, UAL took tentative delivery of the experimental DC-4. For three weeks they tested it and found it met some, but not all, of their specifications. They decided not to purchase it. The other airlines followed suit and as previously agreed, each paid $91,250 to cover a portion of Douglas' engineering and development costs.** 1478
**Caption: "The original 3-tail DC-4"**

## DC-4 v2.0

1479

**Douglas began the second version of the DC-4 in 1940. UAL was still interested in a redesigned DC-4, so Douglas modified and trimmed the original design down to 48K pounds. WWII interrupted the new DC-4's civilian destiny. On the production line, the 40 DC-4s ordered by the airlines and already in airline livery became the C-54 military transport – they were never delivered to the airlines.** 1480
**Caption: "Douglas C-54 Skymaster"**


EQUALLY EPOCH MAKING: United Air Lines' order last month for six four-engined Douglas DC-4's promises a new standard of luxury in domestic air travel. Above, is an air shot of part of a crowd of 300,000 which turned out to see the ship in Chicago. 1481

*"The original design of the DC-4 was to have included a pressurized cabin but we delayed that until we grew the fuselage into the DC-6"*
***Malcolm Oleson,*** **Chief Engineer -** ***Douglas Aircraft Company***
**RE: the *C-54 Skymaster* became the USAAF's long-range transport during WWII and proved transoceanic air service was practical by land-based airplanes. Between 1941 and 1945, C-54s successfully completed 79,642 transoceanic flights. Douglas manufactured 1,162 DC-4s and one, dubbed "The Sacred Cow," won fame as the first airplane designated for the service of the POTUS. Although FDR flew in it on only two occasions, it flew many important diplomatic missions.**
**Caption: "The Sacred Cow transported President Roosevelt to the Yalta Conference in February 1945"** 1482

**Caption: "'Sacred Cow' elevator on display in the Presidential Gallery at the National Museum of the United States Air Force. This elevator enabled President Franklin D. Roosevelt to enter the aircraft easily. A victim of polio and unable to walk, President Roosevelt could remain in his wheelchair and be lifted into his airplane comfortably, rather than being carried up the stairs."**

1483

PRESIDENTIAL AIRCRAFT

DOUGLAS C–54C "SKYMASTER"

This aircraft, named the *Sacred Cow*, was built in 1944 for use by President Franklin D. Roosevelt. It is a Douglas C-54 transport aircraft with extensive interior modifications. One special feature is an elevator behind the passenger cabin to lift the president in his wheelchair in and out of the plane. The passenger compartment includes a conference room with a large desk and bullet-proof picture window. President Roosevelt made his first and only flight in this aircraft, traveling to Yalta in the USSR in February 1945 for a major international wartime conference with the leaders of Great Britain and the USSR. After Roosevelt's death in April 1945, President Truman signed the National Security Act of 1947 while on board the *Sacred Cow*. This act established the Air Force as an independent service, making the *Sacred Cow* the "birthplace" of the U.S. Air Force. In 1983 the Sacred Cow was shipped to the National Museum of the United States Air Force. Restoration began in 1985. After ten years and more than 34,000 hours of work, the restoration was completed. The aircraft now appears as it did during President Roosevelt's trip to Yalta.

SPECIFICATIONS
**Span:** 117 ft. 6 in.
**Length:** 93 ft. 5 in.
**Height:** 27 ft. 7 in
**Weight:** 80,000 lbs. loaded
**Engines:** Four Pratt & Whitney R-2000 Engines of 1,450 hp each
**Crew:** 7 (plus 15 passengers)

PERFORMANCE
**Maximum speed:** 300 mph
**Cruising speed:** 245 mph
**Range:** 3,900 statute miles
**Service ceiling:** 30,000 ft.

1484

1485


**Caption: "Douglas DC-4 Mainliner – 1946 – 230 m.p.h.** The Douglas DC-4 Mainliner was the first 4-mile-a-minute commercial plane and brought new luxury and speed to air transportation**.** The plane carried upwards of 44 passengers and a crew of 3 or 4, consisting of 2 pilots and 1 or 2 stewardesses, plus 5,000 pounds of cargo."

1486


1487

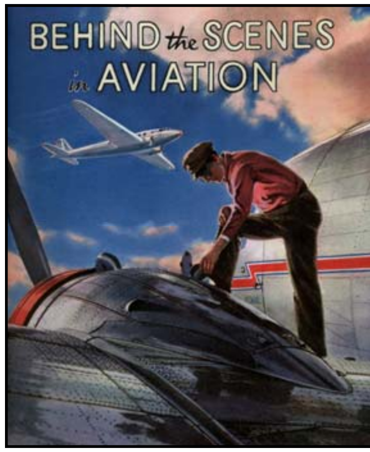
## Part 19

## Behind the Scenes

1488

**Little-by-Little**

1489




**Little by little, aviation engineers are revolutionizing the art of flying. Today's big transports are vastly improved over those of only a year or two ago although an untrained eye can hardly spot the differences.**
***Popular Mechanics,*** **December 1938**
**RE: introduction to an article entitled: "BEHIND the SCENES in AVIATION"**
**Caption: "Mechanic checking the oil supply of one of the big engines of a modern transport plane before a flight"**

1490

**Improving the Baseline**

1491

***"SCORES of slight improvements in power plants, instruments and construction have materially increased efficiency. Behind the scenes the engineers are working on other improvements. 'Within five years we will be wondering how we ever got along without the many improvements in radio alone which are now being developed,' one of them remarks. 'Within that time passenger transports will be landing on schedule in zero-zero weather'…"***
***Popular Mechanics,*** **December 1938**
**Caption: Loading passengers at the start of a night flight"**

1492

***"…'Among other new instruments in the control room, the pilot probably will have a height indicator to tell him the exact distance down to the ground. Planes will be carrying heavier loads farther and faster due simply to numerous small improvements which are constantly being made'…"***
***Popular Mechanics,*** **December 1938**

1493

**Thinking Out Loud**

1494

***"…Among the things looming for the near future are opposite-turning propellers for two- and four-engined airplanes. Gearing all outboard propellers to rotate inwardly at the top suggests higher speeds and greater stability. Another idea under development is to divert the flow of air used for engine cooling into the exhaust pipes, with the thought that the flow of air will have an extractor effect on the exhaust gases, contributing to engine efficiency. Various ways of putting the exhaust gases and radiator cooling air to work by making them contribute a rearward thrust are also being studied. Greater engine efficiency is being sought in a solid fuel injection system that would eliminate the present types of carburetors…"***
***Popular Mechanics,* December 1938**

1495

***"…New ways of controlling airplanes in flight are also receiving attention. Two controls instead of three, provided by coupling aileron and rudder action, seem to have possibilities. A British invention dispenses with the present ailerons completely…"***
***Popular Mechanics,* December 1938**
**Left: caption: "Triple tail surfaces and passenger loading door of a four-engine Douglas DC-4"**
**Right: caption: "Landing flaps on Lockheed transport"**

1496

***"…In this system a hollow tube crisscrosses from each leading edge of the wing to the opposite trailing edge, permitting the pilot to obtain aileron control by opening or closing the tubes to make use of the difference in pressure existing between the two edges of the wing. Localized boundary layer control at the wing tips is another suggestion for providing aileron action. If present ailerons continue to be used, they may be made more effective by arranging some means of sealing the gap between the wing and the aileron surface to prevent leakage of air at that point…"***
***Popular Mechanics,* December 1938**

1497

## Air Brakes

1498

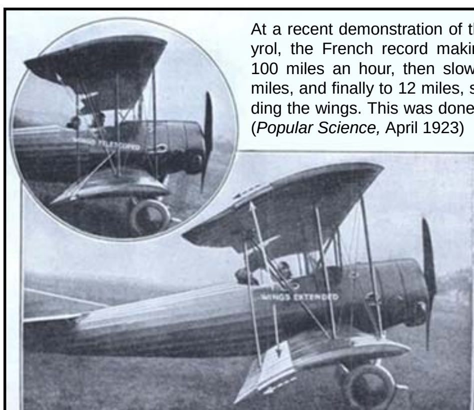
**Telescoping Wings "Brake" Airplane**

ONE of the most difficult problems of flying - that of reducing the speed of a high powered airplane to a minimum without slowing down the engine - has been solved to some extent by a Frenchman, M. Bille, who has invented an airplane in which the wing surface can be mechanically increased, thus cutting down the speed of the machine.

Early inventions for varying the size of wings in flight lacked wing rigidity necessary to safe flying. Bille's invention overcomes this handicap by means of two pairs of extension wings that telescope snugly into the main wings of the plane, so that they can be extended or taken in at will during flight…(*Popular Science,* April 1923)

1499

At a recent demonstration of the plane Maneyrol, the French record making aviator, flew 100 miles an hour, then slowed down to 35 miles, and finally to 12 miles, simply by extending the wings. This was done in six seconds. (*Popular Science,* April 1923)




To reduce speed in flight, the telescoping wings are extended, as shown above, increasing wind resistance. Inset shows the Bille plane with wings telescoped

1500

## Streamline Moderne

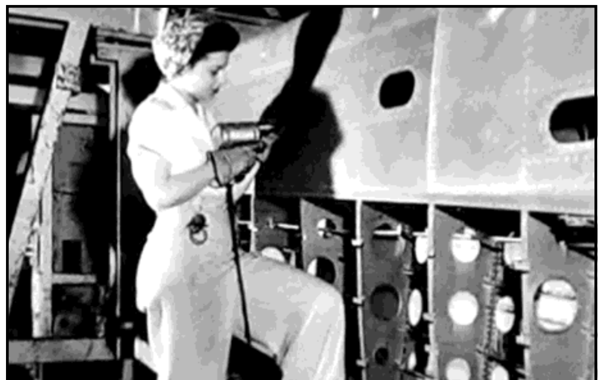
1501

***"…Completely smooth wing and fuselage surfaces would add 273 extra horsepower to present transports, the National Advisory Committee for Aeronautics has determined. Rivet heads, overlapping joints and surface roughness resulting from working tolerances and factory workmanship offer as much as forty-two per cent more drag than perfectly smooth airfoil shapes…"***
***Popular Mechanics,*** **December 1938**

1502

***"…Manufacturers are beginning their 'cleanup' campaign by using flush-type rivets but high manufacturing costs may prevent them from ever achieving perfect wings in metal construction…"***
***Popular Mechanics,*** **December 1938**

1503



**The use of flush-type rivets in the DC-4's aluminum skin was a first in large aircraft production**
**Caption: "Outer-wing riveter"**

1504

***"…Every detail counts. Even the drag of ordinary rubber boot de-icers along the leading edges of wings has been studied, and de-icer drag has been reduced from an original sixteen per cent to nine by mounting the boot in a flush position instead of lapping it over the leading edge…"***
***Popular Mechanics,*** **December 1938**
**Caption: "Attaching a 'rubber boot' de-icer to leading edge of wing"**

1505

***"…Engineers are studying the phenol-formaldehyde resin type of plastics as a possible new material for airplane surfaces that can be molded into smooth and efficient airfoil shapes…"***
***Popular Mechanics,*** **December 1938**

1506

## Flying Blind

1507

***"…Blind landings made by instruments alone will be normal procedure within a year or two. Thousands of such landings have already been made safely, with short-wave radio signals orienting the pilot toward the field and other signals telling him when to start the 'let down' glide in a safe landing attitude with flaps and landing gear extended. The new tricycle landing gear makes instrument landings easier, reducing the bounce of a hard landing, allowing more immediate braking and permitting planes to land across the wind…"***

***Popular Mechanics,* December 1938**

1508

## Panoramic Reception

1509

***"…Many radio possibilities are being explored. One patent provides 'panoramic reception' of several radio compass signals visually and simultaneously on a cathode-ray tube indicator…"***

***Popular Mechanics,* December 1938**

1510

## Images on the Ether

1511

***"TWO remarkable developments recently revived public interest in television, and brought the dream of practical transmission and reception of 'images on the air' a step nearer realization. In a dramatic demonstration at Schenectady, N.Y., a few weeks ago, Dr. E.F.W. Alexanderson, consulting engineer of the General Electric Company, projected six-foot images bright enough to be seen by a large gathering. Before that, the best television image had been only a few inches square and had been produced by the feeble flickering of a neon tube…"***

***Popular Science,* August 1930**

1512

***"…On the heels of Alexanderson's exhibition came an announcement from the Gloucester, Mass., laboratory of John Hays Hammond, Jr., known for his radio research work, to the effect that he had adapted the principles developed by Alexanderson to a system of television for use in aviation. This may make landing in a thick fog, now the most difficult and dangerous feat in aerial navigation, a simple and safe procedure…"***
***Popular Science,*** **August 1930**

1513

***"…Alexanderson's improvement involves the light source and the method of controlling the light in projecting the television image. Instead of the pinkly glowing neon tube, Doctor Alexanderson used a powerful arc lamp, which supplied a steady and very strong light. He was enabled to do this by the use of a remarkble new light valve, or light shutter device, operating at enormous speed. This valve, known as the 'Karolus cell,' was developed by Doctor Alexanderson from an invention by Dr. August Karolus, of Leipzig, Germany…"***
***Popular Science,*** **August 1930**

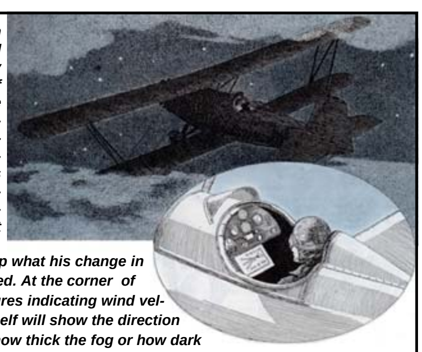
1514

***"…By means of the Karolus valve, Doctor Alexanderson interrupted the flow of light from the arc through the holes in the scanning disk in the receiving set on the stage. The light valve was, in turn, controlled by the received television impulses. The Karolus cell, which contains nitrobenzol, was placed between two prisms, which polarized the light so that it vibrated in one plane only. This was necessary because the new light valve works only on polarized light. The original Karolus cell was delicate and extremely short lived. Just how Doctor Alexanderson has succeeded in perfecting the valve to the point where it will stand continuous operation under the strain of a high intensity light such as the arc produces, remains his secret…"***
***Popular Science,*** **August 1930**

1515

***"…The new Hammond invention, which is of great interest to aviators, also makes use of the Alexanderson development of the Karolus light valve. With this development, he has combined a method used in the Navy to duplicate, at a distance, the position of the loop used to take radio compass bearings. When Hammond's invention is perfected, the aviator landing in fog or darkness will see before him, just below his regular instrument board, a screen on which will appear a bright image showing every detail of the landing field. Hangars, runway, and the obstructions to aerial navigation at the edges of the field will appear. A round black spot also will show on the screen and this spot will represent the exact position of the airplane over the field…"***
***Popular Science,*** **August 1930**

1516



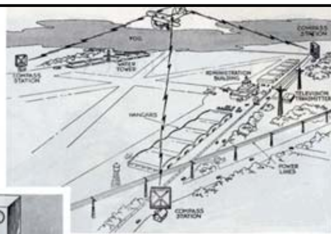
***"…As he sails through the air the spot will move across the tiny map in duplication of his own motion. If he sees the spot representing his airplane heading for some obstruction on the field, he has only to correct his controls, change his course, and the black spot will immediately show by its motion on the map what his change in course has accomplished. At the corner of the map will appear figures indicating wind vel- velocity and the map itself will show the direction of the wind. No matter how thick the fog or how dark the night, the aviator's map will be as brightly lighted as the filed itself would be on a clear sunny day…"***
***Popular Science, August 1930***
**Caption: "Flying blindly through a fog, the pilot of an airplane will see on a screen before him images of the airport field and the outline of all obstructions that may be in his path"**

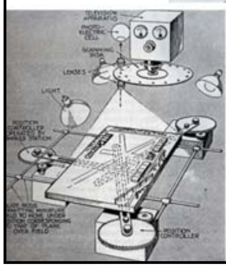
1517

***"…The method by which this startling result is accomplished is, when analyzed, relatively simple. On the plane there will be a small radio transmitter which will send out a continuous stream of radio waves. These radio waves will be picked up by three radio compass stations equally spaced around the outside edge of the field. At one side of the field, out of the way, will be a television transmitting station, and in this station will be located the unique apparatus which makes the whole invention possible. A conventional type of television transmitter will be set with the lenses pointed straight down. Under this television scanning unit will be a miniature reproduction of the entire field. Every detail of the field and surrounding obstructions will be reproduced in small size to exact scale. Strong lights will be centered on this miniature flying field. The model field will be mounted in such a way that it can be moved in any direction under the 'eye' of the television transmitter by means of three position controllers, each one automatically operated by the corresponding compass station…"***
***Popular Science,*** **August 1930**

1518

**Right**: caption: "Here is the real airport, with the three compass stations designed to pick up the continuous stream of radio waves sent out by plane"
**Below**: caption: "Diagram of miniature field, a television image of which is sent to the plane in fog and is seen by pilot on screen to guide his landing"





*"…The exact means by which this will be accomplished has not yet been revealed by the inventor, but some such scheme as that shown in the accompanying illustration probably will be used. Slotted arms duplicating the actual radio bearing will move the model flying field. Three arms will be necessary because that number of bearings are needed to locate a point. The spot representing the plane in the television image of the flying field probably will be a tiny disk set at the focal point of the lens system used in the scanning equipment. Its shadow would then appear on the image of any object scanned by the television transmitter…"*
***Popular Science*, August 1930**

1519

*"…Although Hammond has said that he uses the Alexanderson system of television - which means, of course, the Alexanderson type of Karolus cell - it is hardly probable that he intends to install an arc light in the plane's television receiver. However, the new light cell could be used with any source of illumination and in an airplane, where space and weight are limited, a concentrated filament nitrogen-filled electric bulb would give adequate light for a screen of the size contemplated…"*
***Popular Science*, August 1930**

1520

## Fine Tuned

1521

**TRAILING** wires, left, on United Air Lines plane used to discharge static as soon as it gathers on ship

*"…Static is slowly being wiped out although a moving airplane is an almost perfect static-generating machine. Shielded loop antennas have eliminated some of the static. United Air Lines is experimenting with wires with sharpened ends trailed from the tail of the plane to provide leakage paths along which static charges may be dissipated…"*
***Popular Mechanics*, December 1938**

1522

**<u>Caption</u>: "Enclosed loop antenna on underside of fuselage"**

1523

*"…Ultrashort radio waves in which static conditions are less acute are to be adapted to air line use. Beginning next year, much lower wave lengths will be used for plane-to-airport communication over short distances…"*
***Popular Mechanics*, December 1938**

1524

## Radio Telephony

1525

**Thanks to the radio telephone developed for use by airplanes in experiments conducted by Herbert Hoover, Jr., pilots on all modern air lines can now learn every fifteen minutes the exact condition of the weather along their routes**
***Modern Mechanics and Inventions,* June 1931**
**RE: introduction to an article written by *John Edwin Hogg* entitled: "Radiophone Increases Safety"**

1526

## Is the Coast Clear?

1527

***"IF YOU lived within range of the radio station at the Alhambra airport, the plane terminal for Los Angeles, you might tune down to 100 meters on your radio receiver and hear something like this: 'Alhambra calling ship 55. Answer please.' A voice that sounds considerably farther away, but easily audible and distinct, would next be heard. 'This is ship 55 answering Alhambra. Pilot Carson speaking'…"***
***Modern Mechanics and Inventions,* June 1931**

1528

***"…The conversation that follows is like a confab between spooks. 'What is your position, Carson?' asks the dispatcher. A dim droning of an airplane's engines comes through the air with the pilot's voice, but above the noise we hear clearly: 'My altitude is 8,000 feet. My position is L 9. I'm five miles north of beacon 27. Visibility over the desert is perfect, but from the Sierra Madre mountains to the ocean I can't see anything but fog.' 'There's five hundred feet of good visibility under the fog here in the San Gabriel Valley,' replies the dispatcher. 'Come on in. Keep above the clouds and we'll listen for you'…"***
***Modern Mechanics and Inventions,* June 1931**

1529

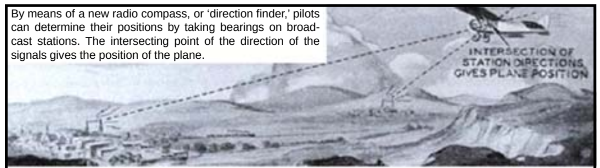
***"…There is some twenty minutes of silence, and then the drone of the airplane can be heard in the air above the dispatcher's office, which is situated in the tower overlooking the million dollar airport of the Western Air Express. 'All right, Carson, you're right over the middle of the field now,' says the dispatcher. 'Come on down. The coast is clear. No other planes are in the vicinity. Alhambra signing off with ship 55'…"***
***Modern Mechanics and Inventions,* June 1931**
**Caption: "April 1930: New Western Air Express terminal at Alhambra Field. This photo was published in the April 14, 1930 edition of the Los Angeles Times."**

1530

*"…In a few minutes an airplane roars down out of the fog, sailing over house tops and trees towards the airport. Its lights dip gracefully, and it is down - safely on the aviation field. The radio telephone has removed the danger from an airplane landing that would have been extremely hazardous a year ago. Similar conversations between pilots in the air and the various Western Air Express fields are to be heard during almost any hour of the day or night. The ships may be moving between Alhambra and Kansas City, to and from Salt Lake City, Agua Caliente, Mexico, San Francisco, El Paso, Dallas, or over any of the air lines that radiate from Alhambra like the spokes of a half wheel…"*
**_Modern Mechanics and Inventions,_ June 1931**
**Caption: "Dedication ceremonies of the new Western Air Express terminal at Alhambra Field on April 17, 1930"**

1531

By means of a new radio compass, or 'direction finder,' pilots can determine their positions by taking bearings on broadcast stations. The intersecting point of the direction of the signals gives the position of the plane.




*"…Radio compass and radio beacon experiments are now also going forward at the Alhambra airport. A radio beacon is already in operation to inform pilots when they're over the field, even during conditions of obscured visibility. Aviators approaching the field come within its sphere of influence twenty miles away. The beacon impulses are recorded by an instrument with an oscillating pendulum. These impulses become stronger as the field is approached, and turn on a colored light on the pilot's instrument board when the plane gets over the field. A radio compass has now been developed with which the pilot can take bearings on any station transmitting any kind of signals, either broadcast or code. By determining the directions of two or more broadcast stations, the pilot can chart out his own position, which will be at the point of intersection of the directions from which the signals come…"*
**_Modern Mechanics,_ June 1931**

1532

## Making History

1533

**Right: caption: "A 32-passenger air liner of the Western Air Express in front of the Alhambra Station. Note aerial strung from the wings to the fuselage mast."**
**Lower Right: caption: "Dr. Lee DeForest and Herbert Hoover, Jr., who are literally father and son of the present system of radio telephony used in commercial aviation"**

*"…Herbert Hoover, Jr., son of the nation's chief executive, is chief engineer of the Western Air Express radio service, and is directly in charge of communications. For the past year he and his staff of radio-trained assistants have been at work conducting a series of experiments that have made radio and aviation history…"*
**_Modern Mechanics and Inventions,_ June 1931**

1534

## Speaking Distance

1535

*"…As a result of his labors every plane of the Western Air Express is now equipped with two-way radio telephones. The whereabouts of every airplane in the company's vast network of western air lines is known during every minute of their flights. Every pilot of the various lines, while in the air, is constantly within 'speaking distance' of his home airport, of weather stations, and of terminals, and intermediate fields…"*
**_Modern Mechanics and Inventions,_ June 1931**
**Caption: "Air-mail pilots are equipped with the specially devised radio helmet shown. Both microphone and ear phones are designed to shut-out motor noises, and are connected by a special plug."**

1536

## Gone Are the Days

1537

*"…If another plane of the Western Air Express is ever forced down, every office of the entire system would know about it almost instantly. They would know almost the exact spot at which such a ship makes contact with the ground. Gone are the days of the 'needle-in-the-hay-stack-hunts' for aviators 'down in the rough,' as in the case of Maurice Graham, famous mail pilot…"*
***Modern Mechanics and Inventions,*** **June 1931**
**Caption: "Maurice Graham, a veteran pilot, whose death in a crash stimulated radiophone experiments"**

1538

***"…Finding and rendering assistance to the radio telephone-equipped airplane is placed in the class with answering the 'S.0.S.' call of an ocean ship, with her latitude and longitude known to the rescue ships. Radio telephony gives aviation an entirely new set of values for weather science. The danger of collision between airplanes in the air is virtually eliminated. Pilots are no longer forced to rely wholly upon their own judgment, and aerial passengers are given a new sense of security in the safety and reliability of modern air line service…"***
***Modern Mechanics and Inventions,*** **June 1931**

1539

**Right: caption: "This photo, showing the Indian-Pueblo town of Ancoma, N.M., gives an idea of some of the territory covered by air routes. The town now has a radio station for receiving plane positions and transmitting the necessary weather data."**

**Lower Right: caption: "Co-pilot Gil D. Clark using typical plane equipment to talk with Alhambra station from a 32-passenger Western Express plane in flight"**

1540


1541

## The Simplest Possible Terms

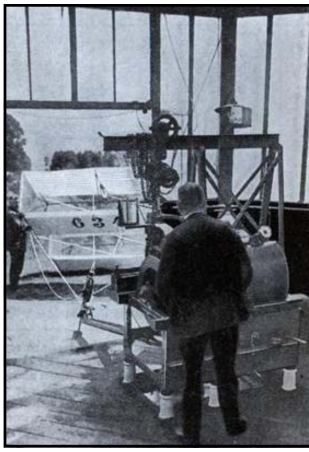
1542

*"…A transport pilot has plenty to occupy his time and attention when in the air. Thus, out of necessity, conversations with the dispatcher are rendered in the simplest possible terms. The pilot, in reporting his position as 'L 9,' is using a code language developed for the purpose. The maps of the air routes are all divided up into squares, and these squares are designated in the manner of a city map. Alphabetic letters indicate distances on the map north and south, and the numbers represent distances east and west. Thus, when a pilot reports his position as 'K 4,' 'G 2,' 'B 14,' or whatever the designation may be, the location is as definite to the dispatcher as if the pilot were present, and pointing out a location on a map on the wall. The beacon lights are all designated by number, and flash their own identifications to pilots in the air. This gives a very definite location when a pilot reports in to say that he is five miles north of beacon 27…"*
***Modern Mechanics and Inventions*, June 1931**

1543

## Aerography

1544



*"…Tremendously increased value to the science of aerography is given to aviation by the development of two-way radio telephony. All pilots of the Western Air Express receive their weather reports every fifteen minutes. Every detail of every weather condition along their routes of flight is revealed to pilots in the air almost as fast as such weather conditions are known to the aerographers at the various ground stations. It is no longer possible for a pilot to fly blindly into adverse weather conditions. He is warned of dangerous storms, and if the circumstances warrant it, he sets his ship down to avoid disaster…"*
***Modern Mechanics and Inventions*, June 1931**

**Caption: "Meteorologists are now using mammoth kites for determining the velocity of the wind at high altitudes. The force of the pull on the string is recorded on the graph, above."**

1545

## One Alone

1546

*"…While radio telephony would now make it possible for Western Air Express pilots to be at all times subject to the orders of officials of the company, no such orders are ever given to a pilot in the air. The company employs only such pilots as are capable of taking complete command of a ship. Each pilot is considered to have the same authority that a captain has on a ship at sea. The company may advise him, warn him of dangerous weather, or talk to him at all times, as the traffic manager might talk to him in the home office. But all decisions concerning 'set downs' for bad weather, emergency landings and similar things, are left exclusively to the pilot's judgment after he is advised of conditions by radiophone. He alone is the man responsible…"*
***Modern Mechanics and Inventions*, June 1931**

1547

*"…Innumerable incidents might be cited to prove the incalculable boon that radio telephony has been to pilots of the Western Air Express. Not long ago, Pilot Klotz, coming into Alhambra from Salt Lake City with the night air mail, was warned of a fog condition that temporarily rendered a safe landing virtually impossible at the local field. A neighboring airport was free from fog at the time, and Klotz was directed to it by radio phone. The mail truck was sent to the field in advance of his landing at the other field. Thus the radio telephone not only made it possible for the pilot to land without danger, but also avoided delay in the mails…"*
***Modern Mechanics and Inventions*, June 1931**

1548

***"…Again, very recently, Pilot Bert Cox, coming into Los Angeles with a load of passengers from San Francisco, encountered a storm condition that he regarded as dangerous. Without radio communication he'd have had no alternative but to set his ship down at the nearest emergency airport. But by calling the Alhambra dispatcher on the radio telephone he was promptly given instructions for flying around the storm. He arrived on schedule with perfect safety, and to the company's credit for maintaining dependable service…"***
***Modern Mechanics and Inventions*, June 1931**

1549

**In Real Time**

1550

***"…The radio telephone is a tremendous convenience to the relatives and friends of passengers traveling by air. Persons who desire to meet passengers at the various air terminals have only to call the terminal by telephone to receive detailed information concerning the location of the plane and the time at which it will arrive…"***
***Modern Mechanics and Inventions*, June 1931**

1551

**Flag Stops**

1552

***"…Along its various air lines the Western Air Express maintains a number of so-called flag stops. These are points at which air liners do not regularly stop, but where stops will be made to pick up passengers or to set them down. Smoke signals and flares were formerly employed to bring a pilot out of the sky, but radio telephone now eliminates such primitive methods. Pilots receive instructions by radio whenever there are passengers waiting to be picked up at intermediate ports…"***
***Modern Mechanics and Inventions*, June 1931**

1553

**Advice and Consent**

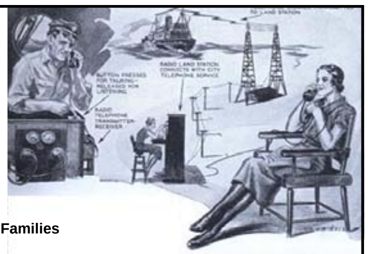
1554

*"…In the traffic tower at the Alhambra airport, the handling of aerial traffic is now in the hands of a former railroad dispatcher, Mr. A.C. Hall. The mechanics of air line dispatching are precisely the same as those long in use in railroading, with certain modifications made for different demands. The former railroad dispatcher is employed for his technical knowledge of the subject, but he is advised in his actions and duties by a qualified transport pilot always on duty in the traffic tower. The pilot is there because of his expert knowledge of aerial conditions, and to advise the dispatcher concerning conditions upon which only a pilot would be qualified to advise other pilots in the air…"*
***Modern Mechanics and Inventions,* June 1931**

1555


**Above: caption: "The dispatcher's desk in the tower of the Alhambra airport terminal. The radiophone keeps him in direct contact with various planes at all times."**
**Left: caption: "Sitting at a desk before a microphone, the operator can warn passenger or mail plane pilot of severe storms or direct landing operations. The above drawing shows the hookup with which signals are transmitted to and received from the pilot."**

1556



**Fishermen Now Radiophone to Families**

DEEP sea fishermen spend a large portion of their lives isolated on the ocean, out of touch with land for days and days on end. A new two way radio telephone, especially designed, for installation in fishing boats has now broken down this barrier of space, permitting the sailors to speak to their friends and families ashore.

How the combined receiver and transmitter operates is illustrated in the artist's drawing above. No trained radio man is necessary to put through a call. The fisherman simply presses a button and connects up with a land station, which hooks him up to the city telephone system. Engineers are planning on installing many of these instruments on American fishing boats cruising the East coast areas. (*Modern Mechanix and Inventions,* February 1933)
Caption: Fishermen are no longer isolated from the world, thanks to the development of this new fishing boat radio, which connects with land through the circuits shown here"

1557

## Flying the Beam

1558

***"…The landing field must be of sufficient area and of an all-way plan to permit the departure of large planes every few minutes of the day and night. As the air mail is the backbone of commercial aviation in this country, and mail pilots at this writing are flying 40,000 miles each twenty-four hours, the problem of providing for the expeditious handling of this mail either now or in the future is a vital one in the case of all airports in communities that want air-mail service…"***
***Popular Mechanics,* December 1929**
**RE: in 1903, the *Wright brothers* made the first heavier-than-air powered flight at Kitty Hawk, NC, and it wouldn't be long before pilots adopted air transport for mail delivery. In 1911, *Fred Wiseman* conducted an unofficial air-mail flight carrying three letters from Petaluma to Santa Rosa, California. The following day, a large exhibition orchestrated by *Sir Walter George Windham,* in British India, made the first official air-mail flight. Windham used the event to generate publicity and raise money for charity. His pilot, *Henri Pequet,* would fly just over eight miles from Allahabad to Naini to deliver 6,500 letters. In July 1914, French pilot *Maurice Guillaux* carried Australian mail 584 miles from Melbourne to Sydney; at the time the longest such flight in the world. By 1918 the east coast of the U.S. had limited air-mail service. Two years later, on August 20, 1920, a North American transcontinental air-mail route was established. Pilots used ground-based landmarks for guidance during daytime flights, but at night they were grounded due to an inability to safely navigate.**

1559


**However, aircraft of the era lacked the technology necessary for navigation during night flights and/or inclement weather. Long before the advent of radio guidance and/or *Instrument Flight Rules* (IFR), pilots were limited to visual guidance, using landmarks to chart the route. Flying at night was out of the question; bad weather and limited flight times meant air-mail delivery was limited and unreliable. Indeed, the service was faster, but it lacked flexibility and reliability of operations. By 1924, the USPS developed an effective solution. A system of ground-based navigation beacons, extending from New York to San Francisco, would help pilots fly across the country at night and, ultimately be the world's first beacon system.**

1560

The early versions of the system used approximately 1,500 air-mail beacons, each constructed roughly between three and five-miles apart. The beacons featured a 50-foot tower with rotating lights placed on top of concrete foundations in the shape of giant arrows measuring between 50 and 70 feet long. To increase visibility of the concrete arrows, they were painted bright yellow.

Caption: "The Newark-Heath Airport in Ohio has a well-preserved example of Beacon 2 of the Columbus-Philadelphia route, ca. 1933

1561

**The first towers contained acetylene-gas powered lights which were fed by fuel stored in a shed at the base. At the top of the towers, a rotating beacon with 5K-candlepower and would flash every ten seconds. In clear weather, the beacon lights could be seen for ten miles. Below the main white beacon, a secondary set of red and green lights would flash a *Morse Code* letter to identify the beacon to pilots. To accommodate emergencies, intermediate landing fields were established every twenty-five miles along the route. The fields were constructed with rotating incandescent electric lights mounted on 50-foot towers set to sweep six times per minute. These less-common emergency field beacons were visible up to seventy-five miles distant. The program was an immediate success and continued to expand throughout its operational life.**

1562

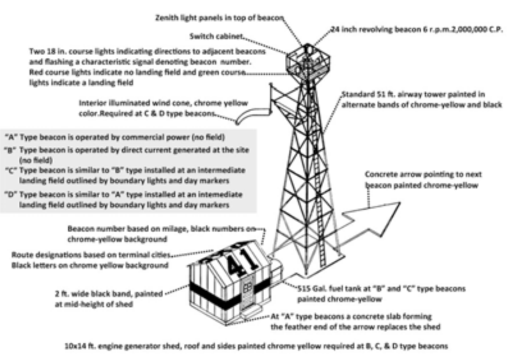



Fig. 301. Standard installation airways beacon.

1563

STATUS OF AIRWAY MARKING AND LIGHTING

| Route | June 30, 1927 Rotating Beacons | Acetylene Beacons | Arrow Markers | Intermediate Fields | Dec. 31, 1927 Rotating Beacons | Acetylene Beacons | Arrow Markers | Intermediate Fields | June 30, 1928 (Estimated) Rotating Beacons | Acetylene Beacons | Arrow Markers | Intermediate Fields |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Transcontl. .... | 185 | 427 | 0 | 92 | 185 | 427 | 0 | 92 | 247 | 460 | 62 | 112 |
| N. Y.-Boston.. | 19 | 4 | 19 | 3 | 19 | 4 | 19 | 3 | 19 | 4 | 19 | 3 |
| St. Louis-Chi.. | 24 | 0 | 24 | 9 | 24 | 0 | 24 | 9 | 24 | 0 | 24 | 9 |
| Dallas-Chi. ... | 74 | 8 | 74 | 20 | 74 | 8 | 74 | 20 | 74 | 38 | 74 | 20 |
| Pueblo-Chey. . | 16 | 9 | 16 | 6 | 16 | 9 | 16 | 6 | 16 | 9 | 16 | 6 |
| S. Lake-Pasco. | 1 | 20 | 0 | 0 | 1 | 20 | 0 | 0 | 41 | 20 | 41 | 13 |
| L. A.-S. Lake. | 21 | 2 | 21 | 7 | 21 | 2 | 21 | 7 | 41 | 10 | 41 | 17 |
| Los. A.-Seattle | 0 | 0 | 0 | 0 | 35 | 3 | 35 | 8 | 52 | 10 | 52 | 13 |
| Atlanta-N. Y.. | 0 | 0 | 0 | 0 | 59 | 2 | 59 | 13 | 78 | 2 | 78 | 19 |
| L'ville-Clev. .. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 3 | 33 | 11 |
| Chi.-T. Cities.. | 0 | 0 | 0 | 0 | 29 | 2 | 29 | 9 | 29 | 2 | 29 | 9 |
| Total ...... | 340 | 470 | 154 | 137 | 463 | 477 | 277 | 167 | 654 | 558 | 469 | 232 |

| | June 30, 1927 | Dec. 31, 1927 | June 30, 1928 |
|---|---|---|---|
| Marked and lighted airways, miles..... | 4,121 | 5,500 | 7,512 |
| Marked airways, miles................ | 0 | 125[1] | 725[2] |

1564

# Airway Bulletin

No. 35, May 1, 1927. Published by Information Division, Aeronautics Branch, Department of Commerce, Washington, D. C.

NEW YORK-BOSTON AIRWAY (NY-B)—220 MILES

The New York-Boston Airway is lighted by the Department of Commerce with 19 electric 24" beacons of 2,000,000 c. p., rotating at 6 r. p. m.; and 4 acetylene gas "blinkers." There have also been provided lighted intermediate fields at 3 of the beacon sites. Along the route are 4 municipal or commercial airports.

The electric beacons are mounted on 50' steel towers. Preparations are being made to install arrows at the base of the towers, pointing along the course to the northerly terminal. These will be placed by July 1, 1927.

Department of Commerce lights burn from dark to dawn, nightly.

*Site numbering.*—Lights are spaced at intervals of approximately 10 miles. The number corresponding with the approximate mileage from the southern terminal of the route will be marked on each arrow, visible from the air. The site numbers based on this mileage system are obtained by omitting the unit zero, i. e., beacon No. 18 is approximately 180 miles from the southern terminal. At Type B and C sites the beacon and route designations will be marked on the roof of the power house placed at the butt end of the arrow. Blinkers are not spaced in accordance with this system.

*Intermediate fields.*—Standard equipment of Department of Commerce intermediate fields on this route include the 24" rotating electric beacon, internally lighted wind indicator (cone), tower, and flood-lighted 54' concrete arrow; 50' circle marker at intersection of landing strips, white boundary lights, green approach lights, and red obstruction lights.

White boundary lights on 3' conduits outline the intermediate field and show its shape.

Red lights, flashing 80-120 times per minute, are mounted on all obstructions or at equivalent heights.

Fixed red lights on 3' conduits within the line of boundary lights indicate poor or dangerous approach.

Fixed green lights on 3' conduits within the boundary lights or at the end of landing strips indicate the best approach.

*Types of lighting.*—

Type A: 24" rotating electric beacon, operated by commercial power; sun relay control.

Type B: 24" rotating electric beacon, operated by generating set at base of tower. Caretaker in charge.

Type C: Intermediate field, with 24" rotating electric beacon, boundary lights, obstruction lights, etc., operated by generating set at base of tower. Caretaker in charge.

Type D: Intermediate field as above, operated by commercial power; sun relay control.

Type E: Acetylene-gas flashing light ("blinkers"); sun valve control.

45682—27

NEW YORK-BOSTON AIRWAY (NY-B)—220 MILES

BOSTON. Municipal airport. See special Airway Bulletin.

21: Needham, Mass. Lat. 42° 19' 0", long. 71° 15' 21". Type A.

20: *Framingham, Mass.* Intermediate field. Lat. 42° 17' 40", long. 71° 26' 0". Type D. See special Airway Bulletin. Beacon is 300 yds. E. of field.

19: About 10 miles N. of Milford, Mass. Lat. 42° 13' 50", long. 71° 32' 45". Type A.

18: At Blackstone River, Mass. Lat. 42° 10' 15", long. 71° 34' 57". Type A.

—: Gas blinker. (Indicated by cross in circle.)

17: *Dudley, Mass.* Intermediate field. Lat. 42° 3' 0", long. 71° 55' 0". Type D. See special Airway Bulletin.

—: Gas blinker. (Indicated by cross in circle.)

15: Near Westford, Conn. Lat. 41° 57' 30", long. 72° 11' 10". Type B.

14: Tolland, Conn. Lat. 41° 52' 48", long. 72° 22' 15". Type A.

13: Manchester, Conn. Lat. 41° 48' 30", long. 72° 30' 5". Type A.

HARTFORD, CONN. Municipal airport, Brainard Field. See special Airway Bulletin.

11: New Britain, Conn. Lat. 41° 39' 40", long. 72° 45' 10". Type A.

—: Gas blinker. (Indicated by cross in circle.)

10: Cheshire, Conn. Lat. 41° 31' 40", long. 72° 54' 3". Type A.

9: *Bethany, Conn.* Intermediate field. Lat. 41° 26' 40", long. 72° 59' 45". Type D. See special Airway Bulletin.

8: Monroe, Conn. Lat. 41° 20' 48", long. 73° 10' 0". Type A.

7: Easton, Conn. Lat. 41° 14' 57", long. 73° 16' 57". Type A.

—: Gas blinker. (Indicated by cross in circle.)

6: New Canaan, Conn. Lat. 41° 7' 42", long. 73° 30' 45". Type A.

5: White Plains, N. Y. Lat. 41° 2' 20", long. 73° 43' 57". Type A.

4: Yonkers, N. Y. Lat. 40° 56' 45", long. 73° 52' 20". Type A.

3: HASBROUCK HTS., N. J. Teterboro Airport, commercial. See special Airway Bulletin. Type A. Light is about ¼ mile from field, on a hill. Lat. 40° 50' 54", long. 74° 4' 54".

2: Newark, N. J. Lat. 40° 48' 6", long. 74° 9' 30". Type A.

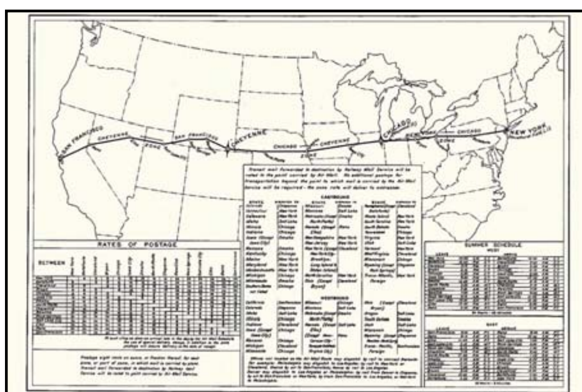
1: Elizabeth, N. J. Lat. 40° 39' 45", long. 74° 17' 24". Type A.

NEW BRUNSWICK, N. J., Hadley Field, commercial airport. See special Airway Bulletin.

2

U. S. GOVERNMENT PRINTING OFFICE: 1927

1565



By the end of the first year, the air-mail service had eighteen terminal airfields, eighty-nine emergency airfields and more than five-hundred beacon lights in operation.

Caption: "Early Airmail Beacon Route Map, ca. 1924"

1566


1567

*"…A prominent postal official is quoted as predicting that all first-class mail will go by air within three years. But at present, on short flights, the transport of air mail between airport and terminal may often take longer than the actual time the plane has been in the air. To overcome this handicap, prominent architects, aviators, engineers and postal officials have recommended the installation of pneumatic tubes between airports and post offices…"*
***Popular Mechanics,*** **December 1929**

1568

**In 1926, management of the beacon system was turned over to the *Department of Commerce,* which continued expansion or the air-mail beacon system until 1929. However, as technology improved, so did the towers. Later versions on spur routes were built ten-miles apart and were equipped with stronger beacon lights; up to one-million candlepower, making them visible up to forty miles away in clear weather. By the 1930s, navigation and radio technology had improved to allow flight without land-based visual guidance. The *Low Frequency Radio Range* (LF-RR) system began to replace older visual-based systems. The air-mail beacon program operated until 1933, when technology advancements and the high cost-of-operation during the *Great Depression* rendered it obsolete. After the beacon program was de-funded, various beacons continued to operate in limited capacities well into the 1940s. During WWII, the DOC decommissioned and disassembled the towers for their steel, in order to support the war effort. The last airway beacon was officially shut-down in 1973.**

**Caption: "Airmail beacon in Omaha, Nebraska, ca. 1920s"**

1569


1570

***"…Supplementing the super-sonic altimeter, will eventually be two systems of radio beacons, one, nine stations of which have already been installed by the Department of Commerce, covering routes between airports and the other, a purely local beacon, broadcasting down the best runway of the flying field. Whenever fog or storm conditions will make landing difficult, the latter beacon will be on…"***
***Popular Mechanics,*** **February 1930**

1571

***"…An incoming plane, arriving over the airport on the long-range beacon, will tune to the wavelength of the local beacon and locate the direction and length of the runway from it, flying back and forth in the radio lane as he descends. The super-sonic altimeter will guard his descent down to a point where the ground below will be visible, even in the thickest fog…"***
***Popular Mechanics,*** **February 1930**

1572

## The Barber-Pole Effect

1573

*"…Experiments, carried out by the London office of the Sperry company during England's famous 'peasoup' fogs, proved that a moving object below was visible from as high as fourth-story windows, while one standing still could not be seen from the second floor. As everything below is moving, in relation to the plane, the pilot gets what Mr. Sperry describes as a 'barber-pole effect,' the ground flashing by in alternate stripes of darker and lighter colors, as the terrain varies…"*
***Popular Mechanics,*** **February 1930**

1574

*"…In the London experiments, a white sheet was tied to the top of an automobile, and the car driven past the Sperry offices, and then parked, thereby determining the altitudes at which moving and stationary objects could be seen in a dense fog…"*
***Popular Mechanics,*** **February 1930**

1575

## The Network

1576

*"…The radio division of the lighthouse service, under which air wave beacons, either radio or lights, come, has completed the installation of radio beacons from Boston to Des Moines, with intermediate plants at Hadley Field, N.J., Bellefonte, Pa., Cleveland, Goshen, Ind., Chicago, and Sterling, Ill., while a ninth has been installed at Key West, for the Havana route. These are in addition to the army-controlled beacons at San Francisco and Hawaii…"*
***Popular Mechanics,*** **February 1930**

1577

*"…Installation of fifty more radio beacons by the lighthouse service has been approved, and within two years it is expected that every important air route in the country will be fully protected by radio…"*
***Popular Mechanics,*** **February 1930**
**Caption: "First radio beacon station, with the operating shack and antenna system at College Park, Maryland. Airplane used the radio signals for navigation. 1928."**

1578

***"…No two adjoining beacons use the same code letters, so the pilot flying from one beacon zone into the next has no trouble picking up the new signals. Each beacon transmits two sets of code signals, which, on the true course, blend to form a third signal, The standard radio alphabet signals for the letters 'B' and 'V' are used in one set of beacons, 'D' and 'U' in a second, and 'A' and 'N' in a third. If a flyer is on a course between the A and N-signals, for example, he hears the letter 'T' in his headphones…"***
***Popular Mechanics,*** **February 1930**

1579

***"…Although the radio beacons, with two antenna systems spaced at right angles, would normally send out signals in the same way, it is possible to correct them with additional apparatus so they can be sent in any desired direction, thus shifting each of the four available courses to mark a direct course to another city, regardless of its compass bearing; in relation to the other three…"***
***Popular Mechanics,*** **February 1930**

1580

***"…The radio receiver used in the airplane is a simple set, weighing, complete with batteries, but eighteen pounds. A vertical antenna, carried by a pole above the fuselage, is used instead of the now obsolete trailing wire…"***
***Popular Mechanics,*** **February 1930**
**Caption: "One of the Bell Telephone Company's Air Laboratories in flight; the radio mast is now commonly seen on many transport and mail planes since wireless has proved so efficient in enabling pilots to guide their ships at night and through bad weather"**

1581

***"…In addition to the other devices already in use or projected, the Department of Commerce has approved short-range radio telephones for use at airports to direct planes about to land. All airports in the country will operate these transmitters on the same wavelength, so they are limited to a range of not more than five miles…"***
***Popular Mechanics,*** **February 1930**
**Caption: "Wind-driven generator which supplies filament and phase current for the plane's radio transmitter and receiver"**

1582

***"…The pilot of an approaching plane can get his landing directions from the airport manager through the same receiver used for the beacons, and, while he will not be able to talk back, unless a portable transmitter is installed on the plane, the ground crew, by listening to his motor, can give valuable advice and directions even in a dense fog."***
***Popular Mechanics,*** **February 1930**
**Caption: "Terminal equipment for plane-to-ground transmitter at airport weather station"**

1583

***"…Ultrashort-wave radio marker beacons will help the pilot with his navigation. Fan beacons that set up walls of short-wave warning signals will mark the edges of mountainous areas in the vicinity of airports…"***
***Popular Mechanics,*** **December 1938**
**Caption: "PILOT speaking over two-way radiophone of passenger transport. Below, checking instruments in nose of plane as part of the frequent overhauls. Diagram shows 'cone of silence' over radio range beam transmitting station which enables pilot to check his position in the air."**

1584

***"…Automatic pilots are being connected directly to the radio beam receivers so the robot actually keeps the plane on its course as well as attending to the mechanical details of flying…"***
***Popular Mechanics,* December 1938**
**<u>Above</u>: caption: "Measuring intensity and width of radio range beam while plane is in flight"**
**<u>Left</u>: caption: "Shielded radio direction-finding loop antenna mounted in glass nose of transport"**

1585

## Aerial Sonar

1586

***"…Research is being conducted on various ways of providing a pilot with 'fog eyes.' What is wanted is an instrument that will measure the distance to the ground. Present altimeters show the height of the plane above sea level but not the ground contours beneath the plane. Short radio waves, infrared rays and sound waves reflected from the plane to the ground and back again are being studied…"***
***Popular Mechanics,* December 1938**

1587

## The Answer to a Prayer

1588

**FOG, the last great bugbear of aviation, has been conquered. The application of the conquest to commercial aviation remains to be brought about, but a year of experiments, just completed on Long Island, have evolved an instrument that seems to be the answer to the flyer's prayer.**
***Popular Mechanics,* February 1930**
**RE: introduction to an article entitled: "The Conquest of Fog"**

1589

## Problem and Solution

1590

***"Lieut. 'Jimmie' Doolittle, the army's flying ace, did the actual experimental work, and the Guggenheim Fund for the Promotion of Aeronautics, of which Colonel Lindbergh is a director, financed it, but behind them was the combined research departments of four great organizations: the Sperry Gyroscope company, the General Electric company, the Bell Telephone laboratories and the Bureau of Standards…"***
***Popular Mechanics,*** **February 1930**

1591

***"…The solution they reached, with the combined inventive genius of several thousand trained scientists battling with the problem, is an adaptation of the sonic depth finder used on many big liners at sea, The aerial depth finder, however, is super-sonic, for it employs sounds of such extremely short wavelength and extremely high frequency that they are inaudible, not only to man, but to the highly sensitive ear of a cat…"***
***Popular Mechanics,*** **February 1930**

1592

***"…These super-sonic sounds, at a frequency of some 26,000 cycles, will descend from the plane and send back an echo from the ground, while an electrical recorder automatically measures the elapsed time and translates fractions of a second into feet and hundreds of feet…"***
***Popular Mechanics,*** **February 1930**
**<u>Caption</u>: "Pilot using special phone transmitter developed by Bell Telephone Laboratories: note how it is shaped to keep out the plane's noises and to permit easy use"**

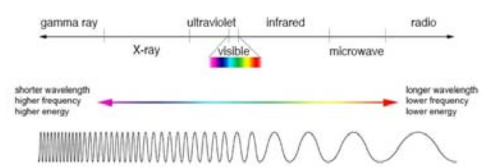
1593

## The Razor's Edge

1594

***"…In its essence the plan differs but little from the experimental work done a year ago by the General Electric company with a radio altitude finder, but that little difference represents the margin between failure and success…"***
***Popular Mechanics,*** **February 1930**

1595




***"…The difference is merely the difference in speed of light or radio waves, and the speed of sound waves. Radio, like light, travels at 186,000 miles a second. Given an altitude of 5,000 feet, the radio wave, traveling that distance and back, would return in eighteen thousandths of a second, an extremely small lapse of time to be measured, and when the plane got down to 100 feet or so, where a fog altimeter really is important, the speed of the radio wave is so great that accurate measurement becomes almost an impossibility…"***
***Popular Mechanics,*** **February 1930**
**<u>Above</u>: although they are in different parts of the *Electromagentic Spectrum*, visible light and radio waves are both a form of *Electromagnetic Radiation.* A radio station does not transmit sound waves rather, it transmits radio waves, which are *Electromagnetic Waves*.**

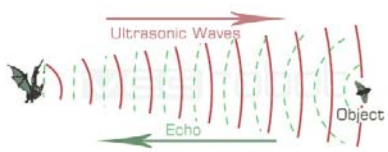
1596

***"…But compared with that, the speed of sound waves through the air is only 1,087 feet-per-second. Sonic depth finders at sea, because of the fairly slow speed of sound through water, can measure depths of a few fathoms, though sound travels 4,708 feet-per-second in this medium…"***
***Popular Mechanics,* February 1930**
**RE: the speed at which sound travels through a sound conducting media varies depending on the media. In general, sound travels faster in liquids than it does in gasses. Solids are the best conductors of all, beating out both liquids and gasses. The speed at which sound travels through most materials depends on several variables including temperature and, in the case of gasses, pressure and humidity. The speed of sound also varies with its frequency, but that effect is relatively small at most common frequencies. With electromagnetic and light waves, frequency is directly related to wavelength and, unlike sound waves, the speed of travel does not change significantly in different transmission media. Also, light and/or electromagnetic waves can travel in a vacuum, which sound waves cannot. The fact that the speed of sound varies widely depending on the conducting media means that wavelength cannot be directly related to frequency, except in cases where the media remains the same.**

1597

| Material | Temperature °F | Speed of Sound ft/sec |
|---|---|---|
| Air | 32 | 1,087 |
| Air | 68 | 1,127 |
| Aluminum | 68 | 16,700 |
| Carbon Dioxide | 32 | 856 |
| Fresh Water | 32 | 4,629 |
| Fresh Water | 68 | 4,805 |
| Hydrogen | 32 | 4,219 |
| Lead | 32 | 4,030 |
| Salt Water | 32 | 4,800 |
| Salt Water | 68 | 4,953 |
| Steel | 32 | 16,410 |
| Steel | 68 | 16,850 |

1598




***"…Moving at their relatively slow rate, sounds in the air can be broadcast from a plane, reflected back from the earth, and the time taken for the echo to return measured accurately when the plane is not more than thirty feet in the air. And as super-sonic waves, inaudible even to the family cat, are to be used, the wide-spread application of the device to thousands of planes will cause no annoyance on the ground…"***
***Popular Mechanics,* February 1930**
**Above: "ultrasonic" sound refers to anything above the frequencies of audible sound and, nominally, includes anything over 20,000 Hz. Bats use ultrasonic sound to sense distance (a/k/a "Echolocation"). By emitting high-frequency sound waves (too high for humans to hear), the time it takes for the echo to return (a/k/a "feedback") gives them information about anything obstructing their path, including the size and shape of the object.**

1599

***"…One peculiarity of super-sonic waves is the enormous power required to project them any great distance. The air absorbs them rapidly. 'It takes, says Elmer Sperry, the famous inventor of the gyroscopic stabilizer, the gyro-compass and the high-intensity arc light, 'twenty horsepower of energy to project super-sonic waves a half mile. However, as the flyer needs no warning of objects more than 1,000 feet distant, we can produce sufficient energy without too great weight of apparatus, using a battery and radio apparatus'…"***
***Popular Mechanics,* February 1930**
**Caption: "Elmer Ambrose Sperry, Sr. (1860-1930), American inventor and entrepreneur"**

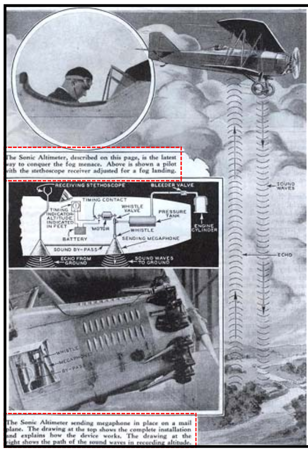
1600

## The Apparatus

1601

***"…Details of the apparatus itself are being closely guarded, and will not be made public until the Guggenheim Foundation issues its formal report, probably some time during the winter. Nothing is known beyond the tact that a radio oscillator is used to produce the high-frequency waves, and an automatic electrical recorder to pick up the reflected sound and translate the elapsed time into a measurement in feet…"***
***Popular Mechanics,* February 1930**

1602



**<u>Top: caption</u>: "The Sonic Altimeter, described on this page, is the latest way to conquer the fog menace. Above is shown a pilot with the stethoscope receiver adjusted for a fog landing."**
**<u>Bottom: caption</u>: "The Sonic Altimeter sending megaphone in place on a mail plane. The drawing at the top shows the complete installation and explains how the device works. The drawing at the right shows the path of the sound waves in recording altitude."**

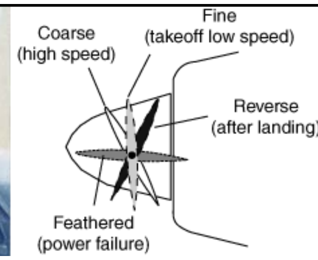
1603

## The Power to Serve

1604

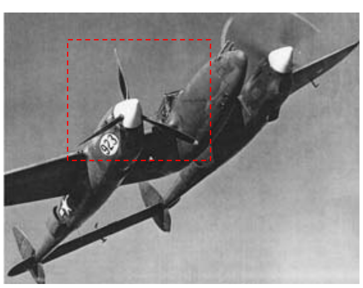
***"…Engines are sturdier even though they are developing more power than a few years ago. Automatic oiling systems have eliminated frequent overhauls and increased engine reliability…"***
***Popular Mechanics,* December 1938**
**<u>Caption</u>: American Airlines transport ready for night flight. Truck heating unit supplys warm air to cabin. Engines warm cabin in flight."**

1605




***"…The heavy drag of a 'windmilling' propeller when an engine goes dead in the air has been reduced almost to nothing by the Hamilton hydromatic full-feathering propellers. By turning a switch the pilot can turn the blades to point directly into the wind…"***
***Popular Mechanics,* December 1938**
**<u>Left</u>: caption: "Hydromatic propeller blades which can be turned to point into the wind and reduce windmilling if engine dies"**
**<u>Right</u>: caption: "Feathering: chord line of each blade is rotated so that it nearly parallels the relative wind over the aircraft. This decrease in the blade's frontal area exposed will cause parasite drag to decrease."**

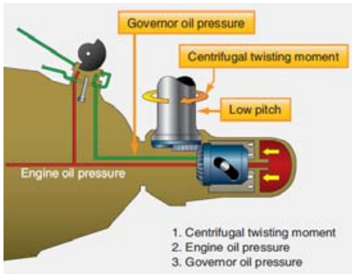
1606



1607

**The basic propeller control forces acting on the *Hamilton Standard Hydromatic* propeller are centrifugal twisting force and high pressure oil from the governor. The centrifugal force acting on each blade of a rotating propeller includes a component force that results in a twisting moment about the blade center-line that tends, at all times, to move the blade toward low pitch. Governor pump output oil is directed by the governor to either side of the propeller piston. The oil on the side of the piston opposite this high-pressure oil returns to the intake side of the governor pump and is used over again. Engine oil at engine supply pressure does not enter the propeller directly but is supplied only to the governor. During constant-speed operations, the double-acting governor mechanism sends oil to one side or the other of the piston as needed to keep the speed at a specified setting.**

1608




1609

***"…Propeller blades that may be rotated through 120 degrees of a pitch have been developed in France to enable flying boats to maneuver astern on the water…"***
***Popular Mechanics,*** **December 1938**

1610

## Propeller Development

1611

***"…Most manufacturers of high speed planes this year have sought to cut down the drag of the landing gear by fitting streamlined 'pants' over the wheels. A safe and efficient retractable landing gear would be a great step further. At the 1930 air races there were two things of especial interest shown. One was a ship fitted with a reversible propeller, to check the landing speed of the ship and enable it to be backed on the ground. The other was a variable wing ship, a low-wing monoplane equipped with hydraulic cylinders enabling the wings to be raised or lowered in flight, changing the dihedral, and at the same time the angle of incidence…"***
***Popular Mechanics,*** **January 1931**

1612

***"…Of still more importance will be the development of a practical variable pitch propeller and variable chord wing. When those come the airplane will have different speeds or weight lifts and can be geared for the job just like an auto-mobile. The Schroeder–Wentworth plane which was built for the Guggenheim competition, but which crashed owing to a fault in construction, had both those things. The propeller could be set for high pitch to get the load off the ground, and then changed to low pitch for high speed in flight. At the same time the chord of the wing could be changed, using a thick, weight-lifting wing to get off the ground, and gradually changing to a thinner, high speed wing in flight. Landing, the process could be reversed, using a thick cord wing to sustain the load at lower speed for an easy landing. In effect there was a two-speed wing and a two-speed propeller, but in each case speed could be converted into weight-lifting if desired…"***
***Popular Mechanics,*** **January 1931**

1613


**Caption: "Major Schroeder is shown with his Schroeder-Wentworth Plane entered in the Guggenheim safety contest. Top photo shows how the wing was built in three flexible sections permitting changing the camber at the will of the pilot."**

**Above: caption: "Centrifugal force is made use of in major Schroeder's variable-pitch propeller device, shown above, to change the pitch of the blades by simply throttling down the motor revolutions"**

***"The airplane of the immediate future is going to be as efficient as the modern automobile. It will have a two speed wing and a two speed prop, the one for climbing with a load and landing at fairly low speeds, and the other a high speed for straight-away flying. That is the ultimate aim just now in airplane design, and the thing we were working at in the Schroeder-Wentworth ship entered in the Guggenheim competition. Unfortunately, because of a lack of time to thoroughly test out the plane before we entered the competition, a minor weakness in design led to a crack-up before I had finished the preliminary trials, and put us out of the running…"***
***Rudolph W. Schroeder*** **(*Popular Mechanics,* March 1930)**

1614

*"…Under the most favorable conditions, the prop is capable of translating 86 percent of the engine's horsepower into useful thrust…For emergency operation in the case of multi-motored airplanes, this business of changing blade pitch has been carried a step further to permit the 'feathering' of the prop. The blades are turned in their hub through highest pitch until they are edge-on into the wind. The propeller is, of course, useless for thrusting in this position, but feathering is an expedient for flying with one or more engines out of oper-ation, either by design or accident…"*
*Popular Science,* November 1943

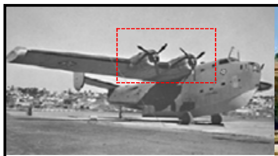
1615

*"…Four engined transports frequently cruise on only two of their engines, but this would not be considered good flying practice if full-feathering propellers were not available. Should an engine go dead in an emergency, the prop is feathered into the wind immediately; the prop in this position acts as a brake on the dead engine. In normal operating pitch, the prop would be subjected to 'pinwheeling,' just as the toy pinwheel spins when held to the wind, and this might result in a damaged engine. A windmilling prop, however, would create more than 20 times this drag…even a single-engined airplane is at an advantage when fitted with a feathering prop because, in emergency, the plane's gliding range is half again as great with this type as it would be with a windmilling, unfeathered prop…"*
*Popular Science,* November 1943

1616

*"…Carrying the pitch angle beyond the 90-degree feathered position into reverse pitch was a logical step in propeller development made first by Curtiss-Wright. The reversible-pitch prop, which delivers negative thrust, is extremely useful as an air brake. In some instances, it may be used to slow the landing run of planes, but its most practical application is found on multi-engined flying boats. Maneuvering a flying boat in water is, at best, a tricky operation. The reversible prop facilitates maneuvering in general and turning in particular. By reversing the two inboard propellers and leaving the outboard propellers in normal pitch, the pilot of a four-engined flying boat can 'come about' in one-fourth the turning radius of a smaller craft with conventional propellers…"*
*Popular Science,* November 1943

1617



**Above L&R: four-engine *PB2Y Coronado* flying boat used by the USN during WWII. At left is an early production model which used three-bladed non-reversible props on all four engines. A total of five production models of the PB2Y Coronado were produced during the war. The fifth version; PB2Y-5 (right) used two different propellers. The outboard engine props remained the non-reversible three bladed type while the inboard engine props used reversible-pitch four-bladed propellers. Though the props varied, all four engines were of the same type. The term "reversible-pitch" means that the blades are able to rotate along their axis. This motion allows the blades to change the "angle of attack" at which they meet the oncoming air so that they will produce more or less thrust depending on the new pitch angle. In particular, the blades could be rotated to a position where they produce high drag or reverse thrust, to slow the aircraft down or make it easier to steer. Many land-based aircraft also use the same technique to reduce the runway length needed for landing. In the case of the PB2Y-5, these reversible-pitch propellers gave the aircraft better maneuverability on water allowing it to taxi to pick up a buoy or steer its way to a floating gas dock.**

1618

*"Two-Way Propellers Lessen Air Torque. The latest development in airplane propellers, the product of English inventors, is called the Rotol Constant-Speed Contra-Rotating Airscrew, shown at the left. Although appearing to be a six-bladed propeller, the contrivance actually consists of two three-bladed propellers which rotate in opposite directions. Among the advantages claimed for the new type prop are complete elimination of torque and improved handling during aerial acrobatics."*
*Popular Mechanics,* December 1941

1619

## A Team Effort

1620

***"…Designing a transport is such a complex job that no one man can do it all. Specialists in wing construction, tail group design, and landing gear assembly work side-by-side. The cockpit alone needs the attention of several experts and hundreds of minor details require intensive study…"***
***Popular Mechanics,*** **December 1938**

1621

**Caption: "Removing transport plane's batteries"** 1622

## Part 20

## Safety First

1623

**Pilot Ergonomics**

1624

***"…The exact location of the pilot's seat, the angle of the windshield and the shapes of the control knobs are all important. Different control handles are given different colors and shapes so the pilot invariably can recognize the one he seeks. His seat must be close to the windshield to give him wide angle vision, yet he must be able to slide out of the seat easily without disturbing the controls…"***
***Popular Mechanics,*** **December 1938**

1625

***"…In the past, pilots were sometimes confused by lights reflected on the cockpit windows. Lights on the ground behind sometimes seemed to be ahead of the plane. Placing the windows at exactly the proper angles prevents such reflections…"***
***Popular Mechanics,*** **December 1938**

1626

***"…Pilots in the past also were almost blinded by rain or snow pounding against the windshield while making night landings during storm conditions. Designers solved that trouble in an adroit way. Instead of trying to keep the moisture out of the cockpit they let it in. Now when a pilot prepares to land during a storm, he slides open a side window and a windshield window, allowing rain or snow to sweep in one window and out the other. Sitting behind the blast of wind, the pilot can see forward and rarely receives more than a few drops from the controlled storm that invades the cockpit. The windshield is completely waterproof when closed and can take a pressure of one pound per-square-inch at 200 miles-per-hour without leaking…"***
***Popular Mechanics*, December 1938**

1627

**A Hazard No Longer**

1628

***"…Dumping fuel in flight no longer is the hazard it was. Improved vents dump the fuel free from the body of the plane and prevent any chance of the fuel igniting from collision with tail surfaces. The flame front in a combustible mixture of gasoline and air travels only forty miles-per-hour, hence even if the cloud of dumped fuel happens to catch fire from a static spark the plane remains safe because it is traveling too fast for the exploding flame front to catch up…"***
***Popular Mechanics*, December 1938**

1629

**Never Satisfied**

1630


***"…More than 1,000,000 passengers-per-year are carried on domestic air lines and the number of accidents in relation to the number of miles flown is decreasing steadily, yet the aviation engineers are never satisfied. They are constantly trying to make the big transports safer and more efficient than ever."***
***Popular Mechanics*, December 1938**
**Caption: "Typical night scene at a busy airport. Passengers are boarding plane before the start of a night transcontinental flight."**

1631

**It Can Be Done!**

1632

**Airplane fatalities must be reduced. Moreover, they can be reduced! There is absolutely no sensible reason why all efforts toward this end should be confined solely to preventing the crashes! It is obvious that accidents are still happening. The job now is to make planes withstand them better. It can be done!**

***Mechanix Illustrated,* June 1941**

**RE: introduction to an article written by George *Daniels,* MI's Aviation Editor, entitled: "Crashes CAN Be Harmless!"**

1633

## It's About Time

1634

***"TOO many people are killed in airplane crashes. It's about time to realize that pilots aren't supermen. Accidents continue to happen and there's no sense in claiming they can be entirely prevented. The only intelligent thing to do is to build the planes to withstand as violent a smashup as possible…"***

***Mechanix Illustrated,* June 1941**

1635

## Case-in-Point

1636

***"…Six years ago Lou Reichers was flying a big twin engine, fuselage-lift transport invented by V.J. Burnelli, when the ailerons came off over Newark Airport. There wasn't anything wrong with the design of the plane. It was just one of the things that sometimes happens to a test ship. A handful of bolts had been left out of the control hinge brackets during the assembly job. The result was a crash at 2 miles-a-minute. The big ship hit the ground so hard that one of the engines landed about 200 yards away…"***

***Mechanix Illustrated,* June 1941**

**<u>Caption</u>: "Upper right, ship in which Lou Reichers crashed uninjured at 2 miles-a-minute. Notice that the windshields didn't even crack. Ditch in foreground was plowed by the plane. The lower right photo shows one of the engines thrown close to 200 yards in crash."**

1637

***"…It was the thirteenth of January when it happened, and the ground was frozen as hard as a brick, but the wreck plowed a ditch big enough to hide a whale in. Every aviation engineer on the face of the earth should have wanted to know how the ship's cabin managed to come through that crash in perfect condition. As a matter of fact, Reichers and the engineer who rode with him, John Murray, walked out of the ship for a smoke as soon as it stopped plowing up the earth. They might as well have smoked inside because the gas tanks hadn't even sprung a leak…"***

***Mechanix Illustrated,* June 1941**

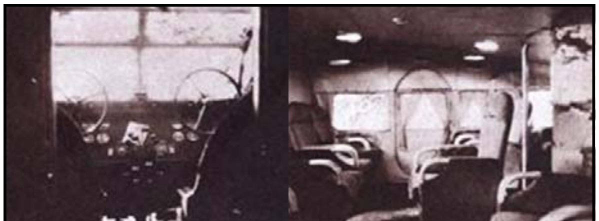
1638

***"…That ship was an unusual design. It had a broad, flat fuselage shaped like a wing. Inside there were seats for 16 people. Both engines were located in the nose of that single body, with the pilot's compartment behind them. The total weight of the thing was a little over eight tons - with about 1,500 horsepower to pull it. The lines were pretty clean, even by today's standards, giving a top speed of 250…"***
***Mechanix Illustrated*, June 1941**

1639

***"…The cross sectional dimensions of the fuselage were so generous that the amazing strength was almost easy to attain. Extruded dural beams and channels gave the cabin the toughness of a young railroad bridge. The position of the engines in the nose eliminated the likelihood of their smashing anything but themselves when the plane hit head first. And that's about all they did smash - the windshields right behind them didn't even crack when the ship crashed…"***
***Mechanix Illustrated*, June 1941**

1640



***"…The fact that Reichers and Murray weren't killed is easy to understand when you see a picture of the pilot's compartment and passenger cabin. The worst effect noticeable is the mud on the windows…"***
***Mechanix Illustrated*, June 1941**
**Left: caption: "Photograph shows the perfect condition of the pilot's compartment after the crash. Note the mud spattered on the windshields as the plane plowed through the frozen crust of the ground."**
**Right: caption: "Photograph taken of the undamaged passenger cabin after the accident"**

1641

## Thick as Pea Soup

1642

***"…When the cabin of a plane stays in one piece the passengers stand a chance in any crash. Usher Rousch proved that pretty conclusively three years after the Burnelli wreck. He was coming in from Chicago to land at that same field in Newark. The fog was so thick you couldn't see both ends of a cigarette - and there wasn't a hole in it anywhere…"***
***Mechanix Illustrated*, June 1941**

1643

***"…Rousch didn't relish the idea of slamming a plane load of passengers into the side of a hangar in a blind search for the runway, so he headed for the swamps around the airport. He hit the mud so hard that the engines doubled back under the wings, but the cabin stayed in shape. The result proves the point once more. Not a single passenger was scratched. Rousch, himself, was the casualty list. He got a few cuts from the jolt…"***
***Mechanix Illustrated*, June 1941**
**Caption: "The big airliner above was forced down when dense fog hid the intended airport. Notice that the force of the crash hurled the massive engines to the position shown – but not a single passenger was hurt. Pilot Usher Rousch was slightly cut."**

1644

## Beech on the Beach

1645

*"…Private planes bring out the importance of a strong cabin every now and then, too. A pair of sport flyers looking for a good beach to swim from, made a good example about a year ago in Florida…"*
***Mechanix Illustrated,*** **June 1941**

1646

*"…They came down to what looked like a beautyful spot to land and swim. The trouble was that they didn't notice a tangle of old, rusty cable imbedded in the sand. Their wheels had no sooner hit the surface than they jammed into the cable and whacked the ship over on its nose…"*
***Mechanix Illustrated,***
**June 1941**
**<u>Caption</u>: "The flyers behind the airplane at left didn't notice the old rusty cable (foreground) when they landed for a swim on the beach. The marks in the sand show the force of the impact as the ship nosed over – but not a single part was damaged, and neither occupant was injured in any way whatsoever!"**

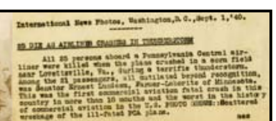
1647

*"…Nothing buckled up, and nothing bent. The little bus was well made. Even the propeller didn't break - that was almost freakish, however. Later on they pushed the tail down again, took off, and flew home. Ironically, the name of the pilot in that sandy mishap was Beech…"*
***Mechanix Illustrated,*** **June 1941**

1648

## Like it or Not

1649




*"…The scene down at Lovettsville, Virginia, last year gives a pretty clear picture of a passenger cabin in fragments - with 25 dead, United States Senator Lundeen among them. That ended a 17-month death-free record for the airlines, and proved again that whether you like it or not, accidents do happen. Although nobody will ever know just what happened to that ship, it doesn't take an expert to see that the cabin went to pieces like the rest of it…"*
***Mechanix Illustrated,*** **June 1941**
**<u>Left</u>: caption: "Completely disintegrated airliner in which 25 people were killed, including Senator Lundeen"**

1650


**AIRPLANE CRACK-UP**

**WORST CRASH IN HISTORY, KILLS SENATOR LUNDEEN**

The news U.S. air-transport men have been dreading finally came in August 31, 1940. That afternoon a Pennsylvania Central Airlines DC-3 transport dived full speed into a field near Lovettsville, Virginia. Its 22 passengers, two pilots and stewardess were all killed. It was the first fatal airline accident in 17 months and the worst in all U.S. airline history.

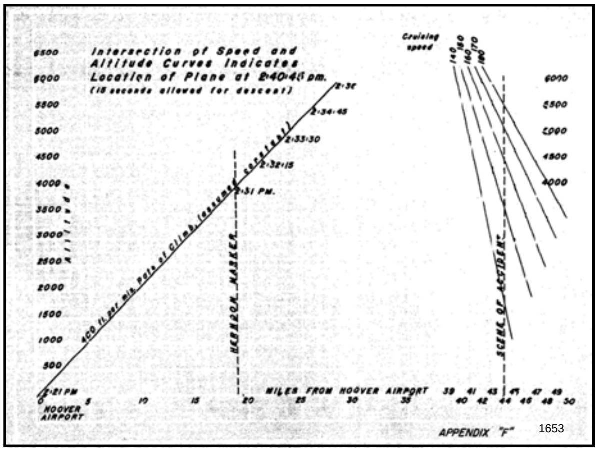
Pennsylvania Central flies between Norfolk, Virginia and Milwaukee. It had never had a fatal crack-up in 13 years of operation. On August 31 [1940] the weather was stormy. The doomed plane reported all well at 2:31 p.m., then headed into a squall. At 2:41 it crashed at top speed into a field of alfalfa, ricocheted 50 yards into a cornfield. There it disintegrated completely. Its wings flew off. Its cabin split like a dried pod. Its engines burst from their nacelles. The bodies of a passenger and the stewardess were flung 1,500 feet from the crash.

From what little was left of the plane it was hard to tell what had happened. The pilot had his engines wide open. The plane was in a 45-degree dive. The Senate threatened an investigation, for on the plane was Ernest Lundeen of Minnesota, the second U.S. Senator to be killed in an airline crash within five years.
Caption: "Sightseers are kept off the wreckage-littered field. The plane struck at lower right, made a small crater, then bounced into corn at upper left."
***LIFE*, September 16, 1940**

1651

**Grim Picture at Dawn –** As mist rose from the clover field where the big transport fell, near Lovettsville, this picture was taken early Sunday morning by a newspaper photographer, fragments of the plane and shattered bodies telling more vividly than words the horror of the scene. The pool in the foreground was formed by rainfall in a crater presumably left by the first impact of the big plane with the earth, just before it was shattered in hundreds of bits. – Photo courtesy Washington Star

1652




1653

**Captain Eddie's Crash**

1654


***"…It was only about six months later when Captain Eddie Rickenbacker startled us all by being a victim in the wreck of one of his own airliners. That crash should show what happens when only part of the cabin breaks up. Only part of the passenger list met death that night; seven at the time. Eight were injured. Captain Rickenbacker was lucky enough to come out alive, though badly hurt…"***
***Mechanix Illustrated,* June 1941**
**RE: on Feb. 26, 1941, Rickenbacker was a passenger on an EAL DC-3 which crashed outside Atlanta, Ga. Suffering grave injuries, he barely survived. The survivors were rescued after a night at the crash site.**
**Top: caption: "This crash, in which Captain Eddie Rickenbacker was severely injured, shows what happens when only a part of the cabin shatters. Although 7 people were killed, part of the total number aboard survived their injuries."**

1655

**Wood vs. Steel**

1656

*"…Airplane designers might take a tip from the railroads. A good many of us can remember the days when the railroads used wooden cars. When those cars got into a wreck casualties ran high and the sight was pretty ghastly. Today railroad cars are of steel, and they stay together well in most any collision. Railroad wrecks don't take many lives now…"*
***Mechanix Illustrated,* June 1941**

1657

*"…It's the same with automobiles. Remember when they used to scatter all over the street when they hit something? They don't do it now. Ruggedly reinforced metal bodies hold their own even in violent accidents. Modern cars can roll over and up on the wheels again, and drive away with loads of disconcerted but unscathed passengers…"*
***Mechanix Illustrated,* June 1941**

1658

1659

## Only in the Movies

1660

*"…Movie stunt men could tell the airplane engineers some interesting things about safety, too. Most designers don't expect the pilots of their planes to dive into the ground deliberately, or to try to crash in as spectacular a manner as possible. The movie boys do it, though. And what's more, they seldom get hurt doing it. Their method is just about the same as the one that saved the day for Reichers and Murray when the big Burnelli crashed. They reinforce the cabin or cockpit, as the case may be. Then, no matter what happens to the rest of the ship, the part they're sitting in holds up…"*
***Mechanix Illustrated,* June 1941**

1661

*"…In the days of wooden fuselage construction, these dare-devils added wooden reinforcements to the longerons and cross members around the cockpit. The entire cockpit structure was then heavily taped to prevent slivers of wood from impaling the pilot in the event of an unexpected fracture. Modern crackup artists reinforce with steel tubing…"*
***Mechanix Illustrated,* June 1941**
**Caption: "The old wartime, wooden framed biplane above, was deliberately crashed for a movie scene. The cockpit didn't collapse because it was specially reinforced for the crash."**

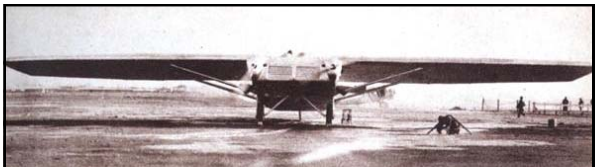
1662

***"…It might be wise if designers didn't get one-track minds. Passenger planes go fast enough for the time being. Let's see if we can build them to withstand crashes a trifle better. There's little use in trying to prevent crashes altogether, so why not try to make them less fearful. The war should turn up a few tricks along this line that even the Hollywood stunt men haven't been using for years. But if it doesn't, there are still examples to profit from…"***
***Mechanix Illustrated*, June 1941**

1663

## An Ounce of Prevention…

1664



***"…Planes should be designed so they can take a good crash. Research departments can easily boast that they have developed instruments and gadgets that make crashes entirely avoidable. They can add these things to the pilots' compartment until the walls are cluttered up with them from top-to-bottom. They can evolve all manner of flapping, fluttering doo-dads that pop out of tails and wings and accomplish some purpose or other…"***
***Mechanix Illustrated*, June 1941**
**Caption: "This is the unusual type of ship in which Lou Reichers crashed unscratched. An example like this should not be allowed to pass unnoticed by engineers who should be concerned with air safety."**

1665

***"…For the most part, these things work quite well, but most of them need considerable attention from the pilot. When something unforeseen happens you can't blame the poor pilot for making a little error. If you sat for hours in that wild array of levers, handles, buttons, gauges, and lights, you'd probably make a little error now and then, too. More gadgets won't prevent accidents. The speedometer hasn't stopped automobile accidents. Steel bodies, however, have reduced the injuries…"***
***Mechanix Illustrated*, June 1941**

1666

## A Wing and a Prayer

1667

***"…The pilot knows how to crash his ship on a wing to cushion the impact if he has time to think about it. It's up to the engineers and designers to build the ship so the pilot and passenger compartment will stand up as the rest of the ship squashes. At the present time the pilots are in a pretty hopeless spot when a crash comes. The passengers aren't much better off…"***
***Mechanix Illustrated*, June 1941**

1668

***"…If you feel foolish sometime, drop your glasses on the sidewalk. They'll break. If you drop them on the rug they won't. That quarter-inch of cushioning is enough to save them. That's why a pilot in a jam may try to come in on a wing. It breaks the fall. That's also why some planes have crash pads on forward cabin walls to save the occupants. Let's think about all this. We can save lives in the future that might have been saved in the past."***

***Mechanix Illustrated,* June 1941**

**<u>Above</u>: on Oct. 13, 1972, a Uruguayan rugby team boarded *Flight 571* in Montevideo, Uruguay, for a match in Santiago, Chile. However, inclement weather caused the pilot to crash in the *Andes Mountains* the next day, killing 12 of the 45 passengers on impact. The crash and its aftermath inspired the book: "Alive: The Story of the Andes Survivors," by *Piers Paul Read.***

1669

1670

## <u>Part 21</u>

## For the National Offense

1671

**A Steady Stream**

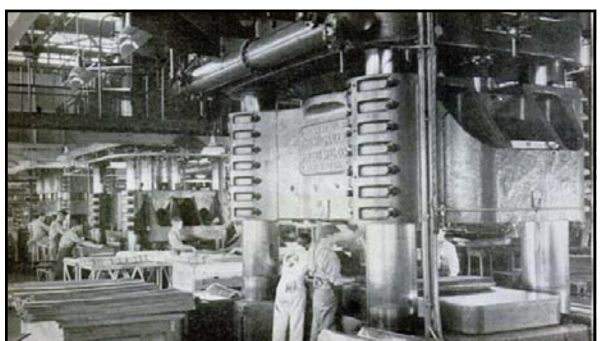
1672

**He built his engineering genius into planes that are fighting our enemies on land and sea**

***Popular Science,* March 1942**

**RE: introduction to an article written by *Andrew R. Boone* entitled: "$2,500,000 Worth of Planes a Day"**

1673

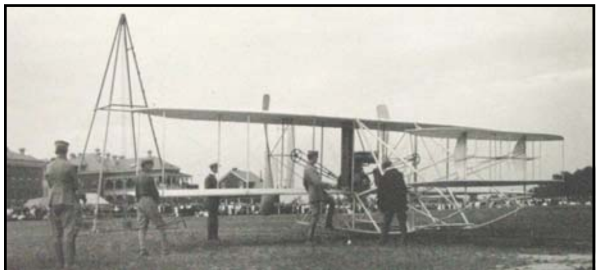


**<u>Caption</u>: "$2,500,000 Worth of Planes a Day.** Donald Douglas set that as a production goal in filling orders for $654,579,973.26 in warplanes for America and her allies. And he is reaching that goal on schedule – just as he has always come through on every job that he has ever tackled. Today, Douglas plants cover 3,338,100 square-feet of floor space, by next June will reach 5,000,-000. This is a scene in one of the mammoth factories that are turning out a steady stream of planes night and day." (*Popular Science,* March 1942)

1674

**Testing the Breeze**

1675



*"ONE afternoon in the early summer of 1909, only six years after the Wright brothers were catapulted from Kill Devil Hill into the world's first heavier-than-air-flight, a slender youth named Donald Willis Douglas hurried over from Washington to Fort Myer, Va., to catch his first glimpse of an airplane. For an hour, the famous brothers tossed wisps of dust up to test the breeze. At last they roared out over the corral, their chattering engine and beating propeller frightening men and horses…"*
***Popular Science,*** **March 1942**
**Caption: "On July 2, 1909, Orville Wright set the flight duration record at Ft. Myer, Va. The flight was over 40 miles with an average speed of +40 mph"**

1676

1677

***"…Chance got the wide-eyed youth his opportunity to be in near the birth of aviation. He had received an appointment to the U.S. Naval Academy, subject to a bit of surgery, and had gone to Washington a few days earlier to enter a hospital. A few weeks after observing the demonstration, he became a plebe, and celebrated by launching from a dormitory window a model plane put together by his own hands. The plane promptly smacked into an admiral's cap as that officer strolled along a walkway outside…"***
***Popular Science,*** **March 1942**

1678

**Guardian of a Hemisphere**

1679

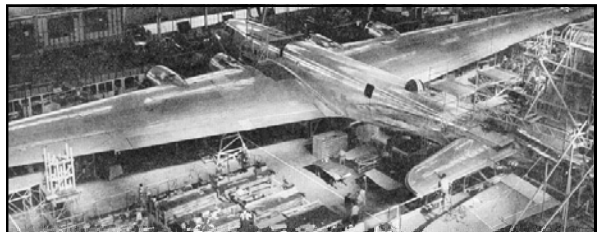
*"…Thirty-two years later, the same Donald Douglas on an early summer afternoon walked diffidently from a hangar at Clover Field, near Santa Monica, Calif., heard four powerful engines ticking methodically on the largest airplane ever built. The great bird was the B-19, a bomber capable of carrying a huge load of bombs across an ocean and returning home again…"*
***Popular Science,*** **March 1942**
**RE: the *Douglas XB-19* was the largest airplane in the world when it first flew in 1941**
**Caption: "Douglas B-19. Largest airplane ever built (82 tons). Four engine 210 mph. Fuel capacity 11,000 gallons. 7,750 miles non-stop. Wing: 212-feet. Length: 142-feet."**

1680

### Douglas B-19

The B-19 is one of the world's greatest aircraft, exceeded in size only by the six-engined Russian Maxim Gorky. It was built as an experimental bomber, and although it never will be used in combat, it offers a preview of the bomber of tomorrow. Power plant: four 1,700-h.p. Double Row Wright Cyclones. Maximum speed: 200 m.p.h. Fuel capacity: 11,250 gal. Maximum weight: 164,000 lbs. Range empty: 7,750 miles. Crew: ten. Armament: power turrets and guns; 18 tons of bombs or 125 paratroopers. Span: 212 ft. Length: 132 ft.

1681

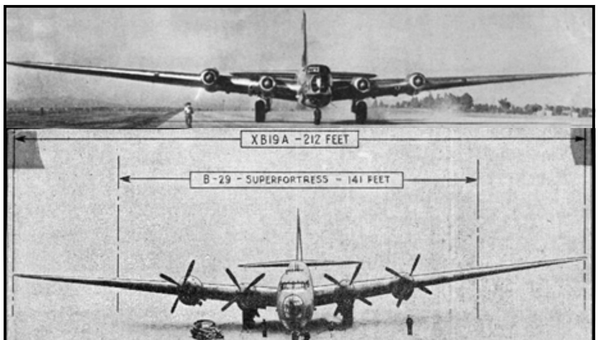


**Specifications for the XB-19 required it to carry a 36K-pound bomb load for a distance of 2K-miles. It was the first bomber equipped with tricycle landing gear and power-boosted controls. Douglas spent nearly $4 million to complete it while the USAAC paid $1,400,064 for the giant aircraft.**

**<u>Above</u>: caption: "The XB-19 nears completion in the Douglas factory at the Santa Monica Airport"**

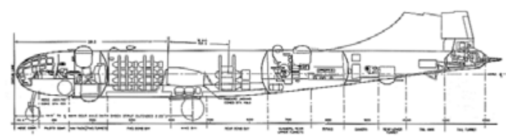
**<u>Left</u>: caption: "The XB-19 was enormous in comparison to what was the jumbo airliner of its day, the Douglas DC-3."**

1682



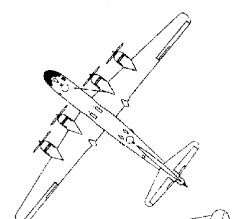

**WORLD'S LARGEST BOMBER** – Here is the largest experimental bomber in the world – the Army's XB-19A – which has just been fitted with new, more powerful engines by the Fisher Body Division of General Motors. The plane's power, range and load-carrying capacity have been stepped up considerably by the installation of liquid-cooled Allison engines. Installation of the engines, requiring construction of new, longer nacelles, was begun by Fisher Body at Romulus Army Air Field near Detroit and completed at its Cleveland No. 2 plant. Bigger than a B-29 Superfortress, the sky mammoth has a wing spread of 212 feet and length of 150 feet, compared with the B-29 wing span of 141 feet and length of 98 feet.

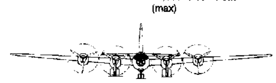
1683

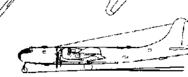


### Boeing B-29 Specifications

| | |
|---|---|
| Span | 141 ft 3 in |
| Length | 99 ft |
| Wing Area | 1,739 sq ft |
| Gross Weight | 105,000/120,000 lb |
| Top Speed | 363 mph |
| Cruising Speed | 220 mph |
| Range | 5,830 mi |
| Service Ceiling | 31,850 ft plus |
| Power | (4) 2,200-hp Wright "Double Cyclone" |
| Armament | (12) machine guns (1) 37mm cannon 20,000-lb bombload (max) |

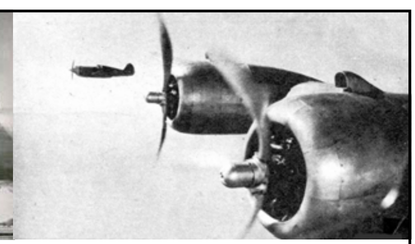






1684

1685



**Initially, the *XB-19* was powered by four 2K-hp *Wright Cyclone R-3350-5* eighteen-cylinder radial engines. When it was re-engined with four 2,600-horsepower *Allison V-3420-11* twenty-four cylinder engines in 1944, the XB-19 became the "XB-19A." Each engine was essentially two *Allison V-1710* twelve-cylinder engines placed side-by-side and connected to a propeller through a common crankcase. The top speed of the airplane rose from 204 mph to 265 mph. However, development problems with the crankcase restricted the V-3420 to use on just a few airplane types.**

**<u>Left</u>: caption: "Latest triumph of Douglas design is the B-19, world's biggest plane. This striking view shows one of the outboard engines and one of the mammoth landing wheels."**

**<u>Right</u>: caption: "From the cabin windows of the B-19 on test flight are seen two of the 2,000 h.p. Wright Duplex Cyclone engines and a Curtiss P-40 acting as a flying escort"**

1686

1687


***"…For miles in all directions, 100,000 people jammed the highways for a glimpse of another historic flight. Shortly, the pilot gunned the engines and the B-19 soared into the sky…"***
***Popular Science,*** **March 1942**
**RE: USAAC Major *Stanley Umstead* piloted the XB-19 on its 55-minute flight to *March Field,* near Riverside, Calif. While taxiing around the *Santa Monica Airport,* the great weight of the plane, on its single 8-foot diameter main wheels, broke through the pavement, in places.**
**<u>Above</u>: caption: "A crowd of Douglas Company employees lines the tarmac at the Santa Monica Airport as the XB-19 takes to the air for the first time on June 27, 1941."**

1688

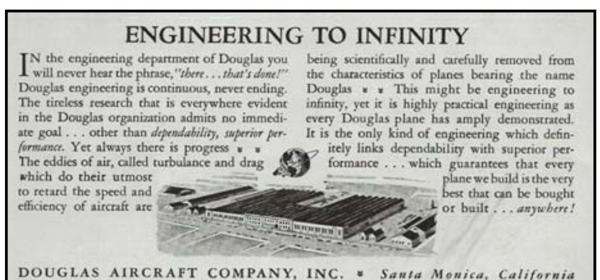

**The *XB-19A* was flown *to Davis-Monthan Air Force Base,* near Tucson, AZ., on August 17, 1946, and placed in storage. That same month, it lost its status as the largest airplane in the U.S. when *Consolidated-Vultee* completed the *XB-36*. It sat in the desert for three years before being cut-up for scrap.**

1689

1690

**To Infinity and Beyond!**

1691



ENGINEERING TO INFINITY

IN the engineering department of Douglas you will never hear the phrase, *"there . . . that's done!"* Douglas engineering is continuous, never ending. The tireless research that is everywhere evident in the Douglas organization admits no immediate goal . . . other than *dependability, superior performance.* Yet always there is progress ▪ ▪ The eddies of air, called turbulance and drag which do their utmost to retard the speed and efficiency of aircraft are being scientifically and carefully removed from the characteristics of planes bearing the name Douglas ▪ ▪ This might be engineering to infinity, yet it is highly practical engineering as every Douglas plane has amply demonstrated. It is the only kind of engineering which definitely links dependability with superior performance . . . which guarantees that every plane we build is the very best that can be bought or built . . . *anywhere!*

DOUGLAS AIRCRAFT COMPANY, INC. ▪ *Santa Monica, California*

***"…Between Fort Myer and Clover Field, Donald Douglas in three decades has achieved world eminence in aviation. From the time he set out to build an airplane, in 1921, until today he has never experienced failure…"***
***Popular Science,*** **March 1942**
**<u>Above</u>: an excerpt from a 1931 magazine ad for the *Douglas Aircraft Company* of Santa Monica, Calif.**

1692

## A Million Dollars-a-Day

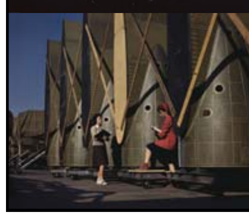
1693


*"…His passenger liners span the nation on 17 airlines, serve 52 foreign countries on another 18 lines; cargo and troop carriers, dive bombers, medium bombers, and huge four-engine bombers from his factories are fighting for Uncle Sam and his allies. Every day a million dollars' worth of new airplanes roll from his assembly lines…"*
***Popular Science*, March 1942**
**Above: caption: "Female riveter at work at Douglas Aircraft Co. during WWII"**
**Left: caption: "Aircraft engine being installed at Douglas Aircraft Company during WWII"**

1694

1695





**Above L&R: caption: "Woman machinists, Douglas Aircraft Company, Long Beach, California, 1942"**
**Left: caption: "Female workers inspect airplane wings at the Douglas Aircraft Company during WWII"**

1696

## The Quiet Man

1697

*"…Although his designs have revolutionized commercial aviation and added mightily to our aerial defense, Douglas has everlastingly avoided the spotlight. He'd rather lose a tooth to the dentist's forceps than make a speech…"*
***Popular Science*, March 1942**

1698


*"…Bronzed by frequent weekends off the California coast on his racing sloop, he spends long days at a large desk in a small office where he devotes his engineering and business genius to planning new planes to fight our enemies…"*
***Popular Science,*** **March 1942**
**<u>Above</u>: caption: "From his quiet office, Douglas looks into a future in which he foresees a vast market for commercial planes to take the place of ships and other transport facilities destroyed in the war"**

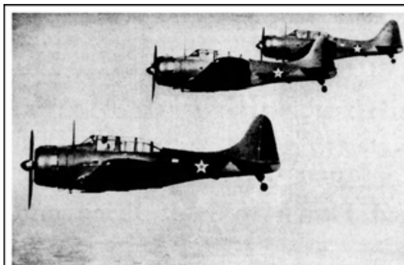
1699

## Out-Stukaing the Stuka

1700


***"…As an engineer, he has won the coveted collier and Guggenheim awards. From the business angle, his enterprises have shown a profit ever since he became a builder of airplanes 20 years ago, from the two-place Cloudster, a biplane which introduced new techniques in streamlining, to his A-24 dive bomber, so good that Army authorities declared two squadrons 'out Stukaed the German Stukas' in the recent large-scale war games down in Louisiana…"***
***Popular Science,*** **March 1942**
**RE: the Douglas *A24 Banshee* was the USAAF version of the USN's *SBD Dauntless* dive bomber (minus folding wings and carrier gear)**
**<u>Caption</u>: "Douglas A25 Banshee. Olive drab and neutral gray camouflage."**

1701



(A. P. Wirephoto)
**ARMY'S NEW DIVE BOMBERS SEE ACTION AT BALI**
These are the Army's new dive bombers, the A-24, reported by the War Department yesterday to have seen action for the first time. They took part in attacks on the Japanese invasion fleet off The Netherlands East Indies island of Bali.

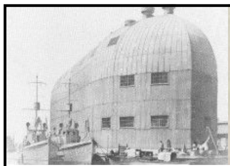
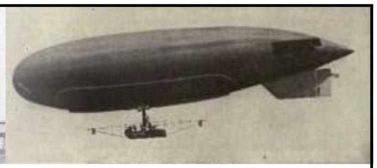
1702

## Wings and Skies

1703

***"…Douglas is a 'pilot's designer,' Above and beyond his engineering skill, however, you find a single-mindedness rare in manufacturers. When he left the Naval Academy in 1912, his mind was focused on wings and skies. That autumn he enrolled in the Massachusetts Institute of Technology, graduating two years later and receiving immediately a year's appointment as assistant in aeronautical engineering. Salary, $500 per annum…"***
***Popular Science,*** **March 1942**

1704

***"…Young Douglas moved rapidly during the next few years. At M.I.T. he helped build the first wind tunnel. Next year found him at the Connecticut Aircraft Co., building the first dirigible constructed in the United States, the DN-1. Shortly Glenn L. Martin brought him to his firm as chief engineer, and young Douglas' skill entered into the design of the famous twin-engine Martin bomber, a landmark in military aviation…"***

***Popular Science,*** **March 1942**

**RE: on the basis of having the lowest bid, the *Connecticut Aircraft Company* received the contract to build the USN's DN-1 ("D" for dirigible; "N" for non-rigid and "1" as the USN's first airship). The only airship of the type ever built, many years later the DN-1 became known as the "A-type" blimp (despite the fact that it was never officially assigned the "A" designation). Scheduled for delivery in October 1915, the DN-1 was to be ready for trials in 4-to-5 months.**

**Left: caption: "Floating hangar for the DN-1 at Pensacola"**
**Right: caption: "The DN-1 in flight"**

1705

***"…Now only 25, he already had won national recognition. Another jump landed him in Los Angeles. 'approximately broke' but blessed with boundless confidence in his ability. On the West Coast Douglas met a wealthy young man named David R. Davis, who owned a small machine shop and wanted to get into aviation. Douglas sold Davis on the idea of building a reconnaissance-type plane, streamlined and equipped with instruments. A few months later the Cloudster, conceived on drawing boards hugging the wall of a small barber shop, was perfected…"***

***Popular Science,*** **March 1942**

**RE: of wooden construction, the *Cloudster* (above) was a fabric-covered, open-bay, twin-seat single seat biplane powered by a WWI surplus 400-hp V-12 piston *Liberty* engine. On February 24, 1921, the Cloudster made its first flight; becoming the first airplane in history to airlift a useful load exceeding its own weight. Less than a month later, on March 19, 1921, Cloudster broke the Pacific Coast altitude record by climbing to 19,160-feet.**

1706

***"…I talked to Eric Springer, test pilot for Douglas and Davis when the Cloudster was born and today manager of the El Segundo plant, building A24s for the Army and their counterpart, the SBD, for the Navy and Marine Corps…"***

***Popular Science,*** **March 1942**

**Caption: "USN Douglas SBD 'Dauntless' dive bomber (1938)"**

1707

**Caption: "Douglas Devastator and Dauntless dive bombers on the deck of a carrier during WWII"**

1708

***"…'Doug knew where he was headed then, and he's never given us a chance to forget. You can think of the Cloudster, or any of the 150-odd models since, as a cocktail. It's got to have the right proportion of all ingredients before it's served to a customer'…"***

***Popular Science,*** **March 1942**

1709

**Speed, Economy and Loadability**

1710

***"…'Every Douglas ship,' Springer continued, 'represents a compromise. Not the fastest, maybe, nor the highest-flying, nor will it carry the heaviest load possible. But it'll be a pilot's airplane, combining speed, economy, and loadability…"***
***Popular Science,*** **March 1942**

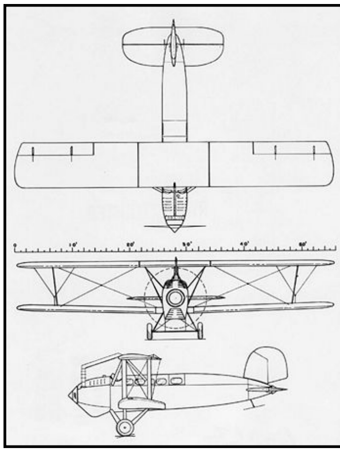
1711

## Failure Leads to Success

1712

***"…Springer and Davis took off from March Field, the Army flying base in Southern California, early on the morning of June 25, 1921, hoping to make the first transcontinental non-stop flight. They reached El Paso ahead of schedule, when one bank of the timing gears failed just as they roared over Fort Bliss. Springer slid down to a dead-stick landing, and the attempt was written off as a failure…"***
***Popular Science,*** **March 1942**

1713



**<u>Above & Left</u>: on June 27, 1921, the *Cloudster* set-out on its flight across the U.S., but engine failure caused her to make a forced landing at *Fort Bliss,* Texas. Having lost interest, Davis left the fledgling company. In 1923, the Cloudster was sold and modified for sightseeing flights with two additional open cockpits and seats for five passengers (replacing one of the fuel tanks). In 1925 she was again sold, this time to *T. Claude Ryan,* the owner of one of the first scheduled passenger lines in the U.S. Ryan had her modified by adding an enclosed cabin with ten seats and she served on his flagship San Diego-to-Los Angeles route. She was subsequently sold and used by a number of operators. In 1926, Cloudster was flying beer to Mexico when on December 26th, she made a forced landing in shallow water off the coast of Ensenada, Baja Calif. She was damaged beyond repair by the tide before it could be recovered.**

1714

*Two Record Breakers, Their Plane and Route*



*The T-2 is shown, ready for the hop-off. Lieutenant John A. MacReady (at left) and Lieutenant Oakley Kelly piloted the big monoplane on the non-stop trip from New York to San Diego, Calif.*

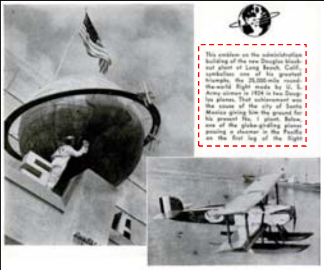
***"…Lieutenants Kelly and MacReady made the flight in a single-engine Fokker monoplane a short time later…"***
***Popular Science,*** **March 1942**
**<u>Left</u>: article appearing in the *New York Herald-Tribune* on Friday, May 4, 1923, concerning the first successful nonstop transcontinental flight by USAAC Lieutenant/s Kelly and MacReady**
**<u>Caption</u>: "The T-2 is shown, ready for the hop-off. Lieutenants John A. MacReady (at left) and Lieutenant Oakley Kelly piloted the big monoplane on the non-stop trip from New York to San Diego, Calif."**

1715



**On May 2, 1923, Lieutenants Kelly and Macready flew their single-engine, high-wing USAAC *Fokker T-2* over 2,625 miles from *Mitchell Field,* Long Island, NY, to *Rockwell Field,* North Island, San Diego, Ca., in an official time of 26 hrs., 50 min. and 38 seconds, setting the record for transcontinental flight by a heavier-than-air craft, thereby winning the 1923 *Mackay* trophy.**

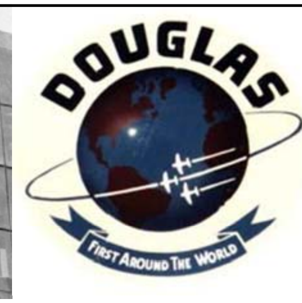
1716



*"…The failure was only apparent, however, for the Navy shortly requested specifications for a torpedo plane, inviting both American and European companies to participate. The ship was to fly from pontoons, and be powered with a 400-horsepower Liberty engine. From the data perfected in building the Cloudster, Douglas turned out the winning design, of which the Navy bought 61 copies. This led to development of a new series which U.S. Army officers in 1924 succeeded in flying 25,000 miles around the world…"*

***Popular Science,* March 1942**

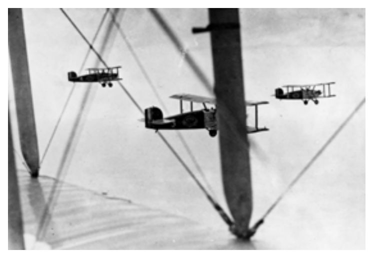
**Caption: "This emblem on the administration building of the new Douglas black-out plant at Long Beach, Calif., symbolizes one of his greatest triumphs, the 25,000-mile round-the-world flight made by U.S. Army airmen in 1924 in two Douglas planes. That achievement was the cause of the city of Santa Monica giving him ground for his present No. 1 plant. Below, one of the globe-girdling planes passing a steamer in the Pacific on the first leg of the flight."** 1717




**Above L&R: by the mid-1920s, the U.S., Great Britain, France, the Netherlands and Germany were competing to see which nation would be the first to circumnavigate the globe. The American team used two-seater, open-cockpit bi-planes built in Los Angeles by the *Douglas. Aircraft Company*. Seventy refueling and maintenance ground stations were set-up in various countries along the route to service Douglas' planes during the 25K-mile excursion. In The five-month trip ended in victory at Santa Monica's *Clover Field*. Six years later, in 1930, a very proud *Donald Douglas* selected the globe and bi-planes (left) as the company's logo. In 1935, the company's logo was updated with three more modern-looking aircraft (right), but retained the words "First Around the World."** 1718

**Crowds gather to see the *Douglas World Cruiser* aircraft at *Clover Field,* Santa Monica, Calif., March 17, 1924.**

**Caption: "Preparations for Start of 'Round the world flight. Clover Field, Santa Monica, California. March 17, 1924"** 1719



1720

**Caption: "One of the Cruisers flies over the Port of Kushimoto, Japan. The large ship is the American four-funnel destroyer USS Pope (DD-225). The Pope was on a goodwill tour to Japan in 1924 to back up the coincident arrival of the Douglas World Cruisers flight."** 1721

**Above: *Donald Douglas* ordered craftsmen to build small models of the DWC for the 16-foot diameter, one-ton copper globe that he placed over the entrance to the Douglas Aircraft Company's *Building No. 7* at the 1.4 million square-foot Long Beach plant, which was completed in 1941. Designed without windows so it could operate 24/7/365 under black-out conditions, special double-door entryways allowed planes and equipment to be moved in and out at night, without light escaping. It was also the first air-conditioned manufacturing facility in the U.S.** 1722


***Donald Douglas*** **opened the Long Beach facility on the eve of WWII, having run out of production space at his plant in Santa Monica, Calif., as well as at a second facility in El Segundo, Calif. He also started production lines in Chicago, Ill., and in Tulsa and Oklahoma City, Oklahoma. All told, the** ***Douglas Aircraft Company*** **produced more than 45K airplanes, 15K of which were built in Long Beach during its +65-years of operation.**

1723

**<u>Above</u>: caption: "Early production C-47 Skytrain transports under construction at the Douglas Aircraft Company plant at Long Beach, California"**
**<u>Left</u>: caption: "A Douglas employee at Long Beach, Calif. works on a C-47's P&W Twin Wasp R-1830-92 radial engine. Stenciling shows that the propellers were inspected 10 October 1942."**

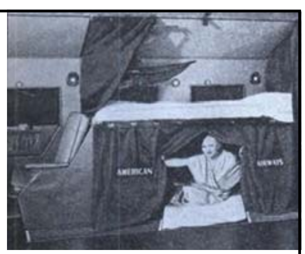
1724

## The March of Progress

1725

***"…In 1932 the airlines, just crawling up from the depression, faced the necessity of increasing their speed, providing greater comfort for day passengers and beds for those flying at night, and cutting operating costs…"***
***Popular Science,*** **March 1942**

1726



**Air Liners Have Berth Facilities**

GIANT air cruisers, equipped with comfortable sleeping quarters, will soon take flight, to mark another forward step in aviation. Each plane will have six compartments which may be converted into upper and lower berths.

These berths are longer than those in standard railroad sleeping cars and are furnished with reading lights, individually controlled air heat and the customary berth accessories. When not used for sleeping purposes, the berths are made into comfortable lounge type chairs as shown in photo, above. (*Modern Mechanix,* June 1934)
<u>Caption</u>: "Roomy lounge chairs are quickly converted into comfortable berths for over-night travel aboard the new air liners"

1727

***"…Early in 1933, TWA officials decided speed must be upped 50 miles-an-hour, that other characteristics of safety and power must be provided…"***
***Popular Science,***
**March 1942**
**<u>Caption</u>: "Speed is indicated in every line of the nose of this modern transcontinental air liner"**

1728

***"…Douglas and four other manufacturers received requests for bid, one requirement being that the plane accepted must be able to fly from any regular airport in the country on one engine, proceed to the next scheduled stop, and have a legal reserve of gas remaining in the tanks on arrival. TWA awarded the contract to Douglas, and a new era in American transport began…"***
***Popular Science,*** **March 1942**

1729

## Peacetime Flying

1730

***"…Douglas built the DC-1 for peacetime flying. The ship upped cruising speed from 100 miles-an-hour to 150. With a few changes, the production model became the DC-2. Shortly, improvements were incorporated in a third model, the DC-3…"***
***Popular Science,*** **March 1942**
**RE: in 1935, President Roosevelt presented *Donald Douglas* and his engineers the *Collier Trophy* for outstanding achievements in flight made by the DC-2**

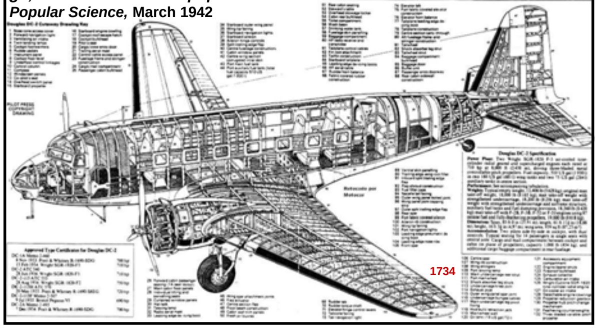
1731

1732


***"…Whereas 186 DC-2s were built, more than 1,500 DC-3s will have been constructed by early next year for the air lines, and for the U.S. Army for employment as troop and military cargo carriers…"***
***Popular Science,*** **March 1942**
**Caption: "U.S. Army test pilot stands beside a Doug-las C-47 Skytrain transport; military version of the famous DC-3, at the sprawling Douglas Aircraft Company facility in Long Beach, Calif., 1942"**

1733

***"…The DC-3 series gave world travelers their first taste of real flying comfort, and as they drew increasing numbers of passengers into the air, brought the lines out of the red. Today, these 25,200-pound planes, after five years without a major structural change, are still standard equipment…"***
***Popular Science,*** **March 1942**



1734

**The Buck *<u>Starts</u>* Here**

1735

***"…Sitting at the hub of a large engineering and manufacturing organization, Douglas can't poke his finger into every detail, but he guides the preliminary design of any new ship, whether transport or bomber. He leaves details to his experts…"***
***Popular Science,*** **March 1942**
**<u>Above</u>: caption: "Donald Douglas in the cockpit of a World Cruiser"**
**<u>Left</u>: caption: "Chairman of the Board"**

1736

**Future Vision**

1737

***"…Seated in the quiet of his paneled office, we might have been a thousand miles from the clatter of riveting and roaring of test engines just beyond the soundproof walls when I asked him to look into the future…"***
***Popular Science,*** **March 1942**

1738

**Cold War v1.0**

1739

***"…'Let's start with invisible bombing,' I said. 'How high will the bombers fly?' 'Some of our plans must remain military secrets,' he warned, 'but I can go this far: Recently we have completed a 'cold room,' where the thermometer drops down to about 105 degrees below zero. In that room we're testing oxygen apparatus, paints which we hope will not chip and flake in extreme cold, metals, and men.' The 'cold room,' whose temperatures fall below those flyers experience at the highest levels any plane today can reach, is the laboratory where he's getting ready for stratospheric bombing…"***
***Popular Science,*** **March 1942**

1740

## The Big Fellows

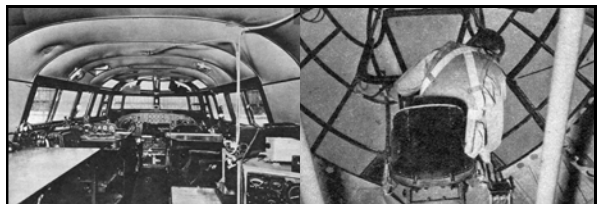
1741

*"…Douglas considers the fabulous B-19 to be the guidepost which may usher in an era of superbombers of which no more than a half dozen fighting airmen dared dream as recently as a year ago…"*
***Popular Science,* March 1942**

1742

*"…'Suppose,' he said, 'we're asked to jump from our 30-ton bombers to a machine of 200,000 pounds. The big fellow might fail unless we know where we're heading. The B-19 gives us fine supporting evidence on which to build a 100-ton bomber. She is a point from which we may embark on designs for planes capable of carrying much heavier bomb loads out of sight in the stratosphere for long distances'…"*
***Popular Science,* March 1942**
**Caption: "The XB-19 featured a capacious bombardiers station below the cockpit"**

1743



**Upper Left: caption: "Flight deck of the world's largest airplane, the XB-19A, accommodates ship's commander, navigator, radio operator. Note the floor hatch, lower center, which opens into the bombardier's compartment and nose gunner's section."**
**Upper Right: caption: "The perfect visibility from the bombardier's post in the nose. Levers release bombs."**
**Left: caption: "Top turret. An interior view of the gun mount in the power turret atop the fuselage of the B-19."**

1744

## The Needs of Peace

1745

*"…But Douglas also has his eyes fixed on the needs of peace. He sees, first, shipyards taxed to capacity turning out freighters. For several years, in his opinion, few passenger liners will be built. This leaves an opportunity for a tremendous aviation construction program. 'Low fares,' he suggested, 'should open up tremendous ocean trade for both passengers and freight'…"*
***Popular Science,* March 1942**

1746

## Swords into Transports

1747

***"…Trans-oceanic flying is receiving its impetus now, and the long-range bombers will furnish the designs from which we may turn our assembly lines to long-range seagoing land planes'…"***

***Popular Science,* March 1942**

**RE: during WWII, three models of the *Boeing Superfortress* were manufactured: the B-29, B-29A and the B-29B. "Silverplate" B-29s had modifications necessary to deliver atomic weapons. After the war, B-29s were adapted for several functions, including in-flight refueling (KB-29), anti-submarine patrol (RB-29), weather reconnaissance (WB-29) and rescue duty. Fitted with *Allison V-3420-17* liquid-cooled W24 inline engines, the XB-39 was intended to prove that the B-29 could successfully operate if the first choice of engine (the air-cooled *Wright R-3350* radial engine) ran into development and/or production difficulties. A later variant of the B-29; the B-50, made it maiden flight in 1947 (originally named the B-29D). Essentially an improved version of the B-29, this aircraft's large number of modifications caused its re-designation as the "B-50." Postwar, Boeing developed the *Model 367,* a military transport airplane based on the B-29. Its civilian counterpart was the *Model 377 Stratocruiser* - a large, long-range airliner developed from the *C-97 Stratofreighter.***

1748


The Boeing B-29 Superfortress is something more than the weapon that helped win the war against Japan. It embodies principles that will *revolutionize air transport* now that victory is won.

Not only have the great Boeing planes in which you may soon travel already been designed . . . A military version of the first true super-transport of the future – the Boeing Stratocruiser – has broken all records for transcontinental flight, with a coast-to-coast average speed of 383 miles per hour!

Boeing has had more experience in the design and building of four-engine aircraft than any other manufacturer in the world. Like the Superfortress, the new Stratocruiser has four engines – and even greater horsepower will be added.

Like the B-29, it has extraordinarily efficient Boeing wing, giving it *huge carrying capacity* – *plus* higher performance and greater economy in operations than any other transport.

Again, like the Superfortress, the Stratocruiser benefits from Boeing leadership in stratosphere research and the production of aircraft *for high-level, over-weather operation,* It has improved pressurized cabins – *plus* new refinements in sound-proofing and air-conditioning.

It has all the structural and aerodynamic advances of the last three years – all the new features contributing to safe navigation, ease of control and dependable performance – *plus* passenger comfort never before imagined. It expresses, as no other commercial airplane has yet done, man's growing understanding of the laws of flight…

1749


The 67-1/2-ton giant shown in this cutaway drawing is the Boeing Stratocruiser, the largest, most luxurious airplane ever purchased (for $1.5 million) by any airline. The first one will be delivered to Pan American World Airways in October, and within a year six major airlines will be using them for flights across both Atlantic and Pacific oceans. Here the lower deck lounge is shown in scale but pulled out from its normal position in the plane's belly aft of the wing. In its pressurized cabin the Stratocruiser will carry a crew of seven and 75 people seated (or 27 in berths and 39 seated) for up to 3,000 miles. At 25,000 feet normal ground speed will be 340 mph. Expected average time, New York to London: 10-1/2 hours.

1750

1751

## Cornerstone of American Air Power

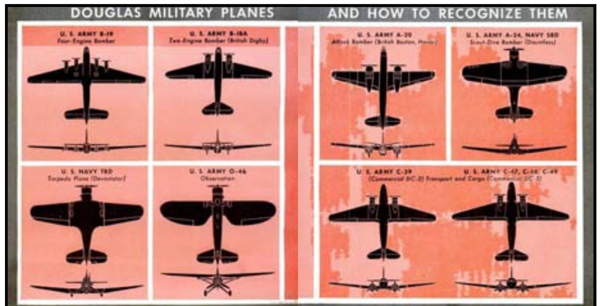
1752


***"…Engineer, salesman, executive, financier – Douglas is all of these. But first he is a builder. From his El Segundo assembly line attack bombers, A-24 and SBD, move on to the Army and Navy. The Santa Monica factory assembles DB-7 Havocs for the British and A-20s for Uncle Sam (similar to but better than Havocs), plus Army troop-cargo carriers…"***

***Popular Science,* March 1942**

**__Left__: *Donald Douglas* on the cover of *TIME* magazine, November 22, 1943. In the feature article about Douglas entitled: "The Passionate Engineer," *Major Alexander de Seversky* was quoted: "Donald Douglas is the Cornerstone of American Air Power"**

1753




***"…The new Blackout plant at Long Beach turns out more troop-cargo ships, and mighty B-17E bombers developed by Boeing for the Army Air Corps. Soon after the newest plant at Tulsa, Okla., was dedicated in October, Consolidated B-24 bombers, fabricated and sub-assembled by the Ford Motor Company, were taking wing…"***

***Popular Science,* March 1942**

1754

**__Caption__: "Silhouettes of Douglas military planes"**

***"…Today Douglas employs 32,000 men and women. By June there will be 75,000 persons on his payroll, working in plants spread over 5,000,000 square feet…"***

***Popular Science,* March 1942**

**__Above__: caption: "Instructor explains propeller characteristics to students in the aeronautics class at Washington High School in Los Angeles, CA."**

**__Left__: caption: "A noontime rest for a full-fledged assembly worker at the Long Beach, California plant of the Douglas Aircraft Company"**

1755

**__Above__: caption: "Rivet team working on the cockpit shell of a C-47 transport"**

**__Upper Left__: caption: Accurate electrical assembly and installation work at Douglas Aircraft Company, Long Beach, CA., 1942"**

**__Lower Left__: caption: "Working with the electric wiring at Douglas Aircraft Company, Long Beach, CA., 1942"**

1756


**__Above & Left__: in the early days of WWII, nearly every man under the age of 40 volunteered or was drafted, leaving a huge gap in the nation's industrial workforce. With war production a priority on the homefront, American women entered the workforce and took on jobs traditionally associated with men. At the time, many were hesitant to accept the idea thus, the *__O__ffice of __W__ar __I__nformation* (OWI) was launched to help recruit women into the work force.**

1757

1758


*"…As I write, armies and navies, with such civilian customers as priorities permit, have swamped him with a backlog of $654,579,973.26, enough to keep him going at top speed for many months."*
***Popular Science,*** **March 1942**
**Caption: "C-47s, the military version of the DC-3, fill the Douglas factory in 1943. Douglas produced more than 4K versions of the C-47 in Long Beach, Calif."**

1759

1760

## Part 22

## The Passionate Engineer

1761

### A Brown-Tweedy Sort of Man

1762

***DONALD WILLS DOUGLAS is a tall, good-looking, brown-eyed, brown-haired, brown-tweedy sort of man, who acts as if he doesn't really believe in the future of aviation. He dislikes flying, and flies as rarely as possible. Prophets of 'the coming Air Age' bore him…"***
***TIME,*** **November 22, 1943**

1763

### If You Really Want to Know…

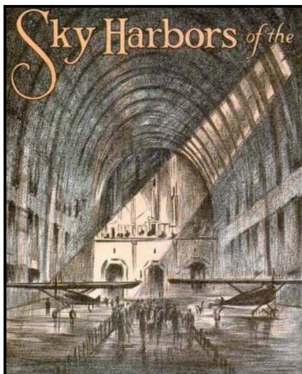
1764

"*…Two examples of his attitude toward aviation's future: On one of his grudging plane trips, he landed at air-minded Oklahoma City. Up rushed a reported. He wanted Planemaker Douglas' opinion of Oklahoma City's project: a $25,000,000 airport. Said Douglas: 'If you really want to know, I think you're crazy'…"*
***TIME,* November 22, 1943**

1765

## Every City and Town

1766




***"WITH forty million dollars having been spent on aviation development in the United States during 1929 and with the airplane leaping into popularity more swiftly than did the motor car in its early days, it is obvious that every city and town in the United States that wishes to keep in step with modern progress is developing its own airport, as the new gateway to the city…"***
***Popular Mechanics,* December 1929**

**<u>Left</u>: caption: "Architect's conception of a future Airport, designed like a Railway Terminal, the planes being towed by electric truck to a field outside after loading or unloading"** 1767
**<u>Right</u>: caption: "Another concept of a future Air-Minded City with streets radiating from a Central Airport and Railway Terminal, 7,500' in dia., with space for hangars and hotels"**

## Return on Investment

1768

***"…The desirably situated airport is to be regarded as a paying investment not only in the increased prestige and advancement accruing to the community which possesses a modern air field, but in the return from the airport itself…"***
***Popular Mechanics,* December 1929**

1769


***"…Well located suburban property near a thriving center is almost always sure to grow in value. When the great railroads selected their rights of way, switching yards and terminal locations, the land was given as a bonus by the government or could be bought for a song. It has, since those early days – generally speaking from thirty to eighty years ago – appreciated in value by billions of dollars…"***
***Popular Mechanics,* December 1929**
**<u>Left T&B</u>: the *Supplementary Act of 1864,* passed by both Houses of Congress in June 1864 and signed by President Lincoln on July 2, 1864, insured both the *Union Pacific* and *Central Pacific Railroad/s* – builders of the *Transcontinental Railroad,* against failure. By amending the *Pacific Railway Act of 1862,* the land grants were increased to ten sections per mile, within twenty miles on either side of the tracks; effectively doubling the area to 12,800 acres-per-mile.** 1770

*"…Today, aviation, the latest medium of swift transportation, is confronted, similarly, with the necessity of locating its terminals, and while it cannot buy land at the low figures obtained by the railroads, it will save money by acting with vision to provide amply for its future growth…"*
***Popular Mechanics,*** **December 1929**

1771

*"…In importance and value, experts believe the larger airports of the future will rank with the great railway terminals of today. Near the smaller cities and towns, airports will be as necessary as the local railway depots. Moreover, since the airport is the key of all commercial aviation, great air-transportation companies in the process of expansion and of the absorption of smaller rivals will undoubtedly desire to pre-empt and improve the best airport locations…"*
***Popular Mechanics,*** **December 1929**

1772

*"…The head of one of the largest real-estate associations in the United States said recently: 'Great crowds of people even now visit our airports on Sundays and weekdays to watch flying activities. Since real-estate values follow the crowds, it is easy to see the influence of airports on adjacent land areas. The modern airport is becoming a gateway to the city or community it serves. It may be very directly compared to a railroad terminal in its functions, facilities and general character. The airport crowds are in holiday mood, demanding food, care and entertainment. The field personnel, including ground attendants, the administration officials and the pilot, must be housed and fed. All this activity in connection with airports is creating new uses for real estate'…"*
***Popular Mechanics,*** **December 1929**

1773

*"…The more immediate sources of profit, however, arise from the airport itself. Like the gasoline filling station and garage, it has definite services and supplies to offer. Among them are the retail sale of gasoline and oil. Rental of hangar space is another item. The average rental is about $40 per month, ranging from $15 to $30 for a small plane up to $60 to $75 for a large one. Repair service, concessions, such as hot-dog stands, restaurants, bowling alleys and rifle galleries, and the rental of parking space for automobiles near the airport are among other profit yielders…"*
***Popular Mechanics,*** **December 1929**

1774

*"…The average cost of looking over a plane is about $2 an hour. Then there are passenger hops above the surrounding country, already an important Sunday and holiday pastime and source of revenue. The publicity manager of a southern resort city instituted bridge parties in the air and afternoon teas in airplanes starting from the municipal airport…"*
***Popular Mechanics,*** **December 1929**
**RE: following the successful 1927 transatlantic flight of *Charles Lindbergh,* flying gained much popularity with the general public. However, regularly scheduled passenger flights, particularly for sightseeing, were not yet common.**

1775

*"…As the number of airports throughout the country increases, cross-country taxi air service will come more and more into vogue as a future source of income. A fifty or hundred-mile hop to the next town will be a money-making trip for the successful salesman, increasing his number of daily calls. The visit of the taxi plane means more servicing and gas and oil and food or refreshments sold to passengers and pilot. The airport, like the successful garage and filling station, must cultivate popularity. Some fields charge from one to three cents per horsepower for every plane that lands. But usually such a plan is bad business, as it keeps planes away…"*
***Popular Mechanics,*** **December 1929**

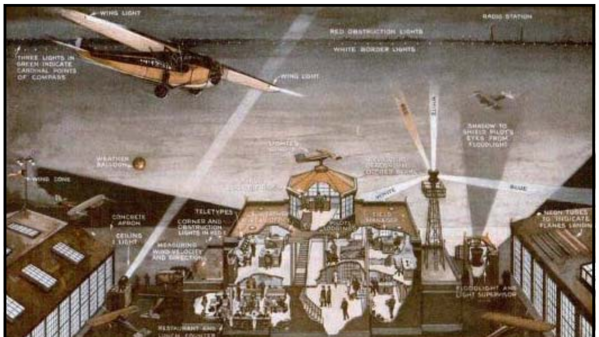
1776

*"…The first consideration in selecting the airport site is accessibility. The airport should be located on a main highway but out of the congested area. If, in the case of small towns, it can be reached in, say, fifteen minutes from the commercial center of the town, so much the better. The second consideration is ample area, which is absolutely essential. The field must be large enough to enable planes to land in safety. And third, but also of vital importance, is the nature of the terrain. The field must be level and free from obstructions and have a sufficient number of runways, long and wide enough to make landing safe, no matter from what quarter the wind blows…"*
***Popular Mechanics,*** **December 1929**

1777

*"…Of the nearly 1,500 airports now reported in the United States – and more are coming into existence every week – a competent authority states, less than 200 are considered perfectly safe in emergency landings or when the wind is from an unfavorable direction…"*
***Popular Mechanics,*** **December 1929**
**Caption: "Illustrated Route Map of Transcontinental Air Transport, 1929"**

1778



**Caption: "Some of the important details of a Modern Air Terminal: This drawing, based on the Cleveland Airport, which is one of the best equipped in the country, shows a few of the interesting activities and units required for the safe operation of planes at night and during times of poor visibility" (*Popular Mechanics,* February 1930)**

1779


**Caption: "This proposed Airport Terminal Building was designed by Outcalt Guenther & Associates and is the culmination of the efforts of Major John Berry to secure for Cleveland the world's finest, most modern airport"**

1780

*"…The question of accessibility presents a more difficult problem when the airport is to be laid out near a large town or city. The future of aviation can only be realized by the assumption that the great air terminals of the future will justify expenditures of millions of dollars for site, construction and equipment…*
***Popular Mechanics,*** **December 1929**
**Caption: "Perspective of a two-story airplane hangar developed with a concrete ramp, the second story being used for small ships, and the ground floor for large commercial planes"**

1781

*"…They will handle a volume of traffic compared with the great rail terminals of today. They must possess ticket, freight and express offices, custom, quarantine and immigration stations, post offices, baggage departments, news stands, rest rooms, drug stores, restaurants, first-aid stations, meteorological stations, pilots' quarters, managerial offices and other equipment. The landing field must be of sufficient area and of an all-way plan to permit the departure of large planes every few minutes of the day and night.…"*
***Popular Mechanics,*** **December 1929**
**Caption: "A plan for an underground airport terminal with the cone-shaped field free of every obstacle, including people; at the top are trapdoors through which planes enter and leave. The underground tunnel would contain railway lines, motor and bus lines, pneumatic mail tubes, hangars, a hotel and restaurant as well as the repair shops for the planes."**

1782

## Size Matters

1783

*"…What size should an airport be and how costly? In the opinion of a large number of experts, the size of the field, provided it meets with the minimum requirements for safety and does not ignore the possibility of future expansions, must depend upon the population of the surrounding district and nearest town…"*
***Popular Mechanics,*** **December 1929**

1784

## Cost and Size

1785

*"…There is scarcely any limit as to cost. An airport may coast a million or more. Hangars and buildings may run up to half a million. But this need not prevent any community from making a start and establishing a first-class landing field at comparatively small outlay…"*
***Popular Mechanics,*** **December 1929**

1786

*"…Every town will start with the idea of eventually acquiring a No. 1 rating. Under the airport-rating regulations of the Department of Commerce, the field, to secure this rating, should have at least 2,500 feet of effective landing area in all directions with clear approaches and must be in good condition at all times. Or it should have landing strips not less than 2,500 feet long and 500 feet in width, permitting landing in at least eight directions at all times, the landing strips not to cross or converge at angles of less than forty degrees…"*
***Popular Mechanics,*** **December 1929**

1787

*"…The very minimum of safety for the largest planes is 1,500 feet of runway, but as a matter of fact the runways should be 2,500 to 3,000 feet in length. The ideal field would be a mile square, 640 acres. A 160 to 200-acre plot of level land will serve most smaller communities…"*
***Popular Mechanics,*** **December 1929**

1788

## One-Man Show

1789

"*…Although Douglas Aircraft is his own one-man show, he now owns less than 1% of 600,000 outstanding shares – compared to the 200,000 shares he was given when the present company was incorporated in 1928. No one knows just why he dumped his stock. But some believe that at one time he actually lost faith in the potentialities of aviation…"*
***TIME,*** **November 22, 1943**

1790

## Losing the Peace

1791


"*…This attitude has roots in the strange, cool personality of Donald Douglas – and illustrates exactly the present plight of the airplane industry, which is crowding the skies of the world with warplanes, and dread the day when it must convert to making a dribble of peace planes…"*
***TIME,*** **November 22, 1943**
**RE: as WWII drew to a close, billions in war orders for aircraft were canceled overnight**
**Caption: "WWII Homefront Victory War Plane Production Poster"**

1792

"*…Douglas himself, at 51 president of the biggest aircraft company in the world, has a very simple postwar plan. Last week he stated it: 'You shut the damn shop up'…"*
***TIME,*** **November 22, 1943**

1793

## A Passion for Precision

1794

"*…Donald Douglas thinks this way partly because he is a hardheaded manufacturer, with no room in his head for nonsense – or for dreams – but mainly because he is an engineer, with a passion for airplanes as things embodying engineering designs, and a passion for precision. Dreams may be vivid but blueprints are precise…*"
***TIME,*** **November 22, 1943**

1795

**Tick-Tock Exactitude**

1796

"*…Douglas is a precision instrument himself, a man of almost fantastically unvarying habit, and of a simple efficiency that is metronomic in its tick-tock exactitude…*"
***TIME,*** **November 22, 1943**

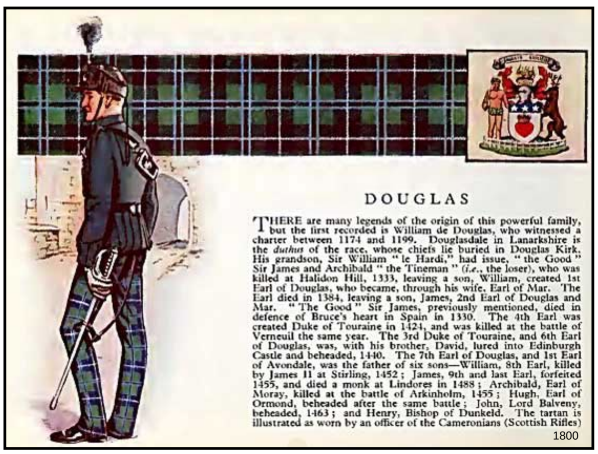
1797

"*…In his $150,000 white-brick, Spanish-style home near Santa Monica he wakes every morning at exactly 7:30 a.m. He has no alarm clock. Beside his bed, as poets have paper & pencil on which to catch a night thought, he has an adding machine on which he can punch out his own mathematical visions. At 8 o'clock he has his invariable breakfast of one egg, one piece of white toast, one cup of black coffee. Shortly before 9, he walks to his four-car garage, steps into his 1941 black Lincoln Zephyr, swings around a fishpond in his front yard and out through wrought-iron gates…*"
***TIME,*** **November 22, 1943**

1798

"*…In ten minutes, he drives to his Santa Monica factory. He steps from his car, walks an exact 24 steps into his walnut-paneled private office, sits down behind his carved walnut desk covered with his own pattern of letters, engineering reports, and half a dozen straight-stemmed pipes. On front of the desk is the Douglas coat of arms. On it is inscribed his Scottish forebears motto: 'Jamais arriere' (never behind)…*"
***TIME,*** **November 22, 1943**

1799



DOUGLAS

THERE are many legends of the origin of this powerful family, but the first recorded is William de Douglas, who witnessed a charter between 1174 and 1199. Douglasdale in Lanarkshire is the *duthus* of the race, whose chiefs lie buried in Douglas Kirk. His grandson, Sir William "le Hardi," had issue, "the Good" Sir James and Archibald "the Tineman" (*i.e.*, the loser), who was killed at Halidon Hill, 1333, leaving a son, William, created 1st Earl of Douglas, who became, through his wife, Earl of Mar. The Earl died in 1384, leaving a son, James, 2nd Earl of Douglas and Mar. "The Good" Sir James, previously mentioned, died in defence of Bruce's heart in Spain in 1330. The 4th Earl was created Duke of Touraine in 1424, and was killed at the battle of Verneuil the same year. The 3rd Duke of Touraine, and 6th Earl of Douglas, was, with his brother, David, lured into Edinburgh Castle and beheaded, 1440. The 7th Earl of Douglas, and 1st Earl of Avondale, was the father of six sons—William, 8th Earl, killed by James II at Stirling, 1452; James, 9th and last Earl, forfeited 1455, and died a monk at Lindores in 1488; Archibald, Earl of Moray, killed at the battle of Arkinholm, 1455; Hugh, Earl of Ormond, beheaded after the same battle; John, Lord Balveny, beheaded, 1463; and Henry, Bishop of Dunkeld. The tartan is illustrated as worn by an officer of the Cameronians (Scottish Rifles)

1800

“*…As he works carefully and methodically through the day’s problems, he puffs steadily at a pipe or an occasional cigarette. For visitors, even if it is one of the vice presidents, he has a routine. When someone enters, he takes off his spectacles, places them on his desk, snaps off the desk lamp and listens. At some point he will pick up his spectacles and snap on the light. This means the interview is over, even if the visitor is in mid-flight of an eloquent peroration…”*
**_TIME,_ November 22, 1943**

1801

“*…At precisely 12:10 p.m. he walks from his office, across Ocean Park Blvd., and into his private dining room. There he has his invariable daily lunch of hamburger steak, black coffee, a chocolate sundae. Finished, he returns to his office and his work. Sample answer to a letter: ‘Tell him nuts.’ About 5:30 p.m., he leaves his office, steps into his car, drives home – again in a measured ten minutes. Dinner is at 6:30 on the dot. Dessert is always a chocolate sundae…”*
**_TIME,_ November 22, 1943**

1802

“*…Donald Douglas spends almost all his evenings in his favorite chair near the fireplace in the library. The study is much the best furnished room in the house. The huge living room is bare of rugs and furniture, except for a few camp chairs. Reason: after Pearl Harbor, cautious Planemaker Douglas was sure the Japs were going to bomb the West Coast. He shipped most of the furniture in his house to Salt Lake City…”*
**_TIME,_ November 22, 1943**

1803

“*…From the chair, which must never be moved an inch, he can see over the mantel a painting of his 70-ft. schooner ‘Endymion.’ He usually spends his evenings alone, because his wife and daughter and young twin sons are upstairs listening to the radio. He hates radio programs, will not permit a radio downstairs. Usually he reads one of his prized books on yachting. He keeps these behind a secret panel in the study, out of reach of the family…”*
**_TIME,_ November 22, 1943**

1804

“*…He does not like company. He simply refuses to go out socially in the evening. Recently, he promised to take his wife to a Los Angeles performance of ‘This is the Army.’ He got one arm into the coat of his tuxedo. Then he reconsidered, stayed home…”*
**_TIME,_ November 22, 1943**

1805

“*…The only time he breaks his routine is when he is aboard his ‘Endymion.’ Before the war sent West Coast yachts scuttling to harbor, he spent weekends cruising along the coast, doing the cooking for his crew (mainly Douglas executives). His specialties: steak with two sauces and curried lobster or shrimp…”*
**_TIME,_ November 22, 1943**
**Caption: “The 130-foot yacht _Endymion_”**

1806

1807

**"*…His one musical taste is for the bagpipe, as played by himself. When he decided to learn the bagpipe some years ago, he was methodical as always. He bought a chanter (mouthpiece) and by practicing finger exercises on it in his office soon became expert. Then he formed a Douglas bag-pipe band, outfitted everyone with kilts, and regularly cruised in the 'Endymion' to Catalina Island. There he led the bag-pipes up & down the hills, skirling his favorite songs, 'Lord Lovat's Lement' and 'Will Ye No' Come Back Again?'…"***
***TIME,* November 22, 1943**

1808

## Two Passions

1809

**"*…Even as a boy in Brooklyn, where he was born, he had two passions: for precision and for aircraft. His banker father wanted him to be a naval officer, but Douglas, his engineer's eye on the Wright brothers, had other ideas. He went to Anna-polis but he spent all possible time there in building model planes…"***
***TIME,* November 22, 1943**

1810

**"*…After three years he switched to Massachusetts Institute of Technology. He finished the grueling four-year course in two years. While at Tech he helped design one of the first airplane tunnels in the U.S. – and wind tunnels are to airplane research what the Bunsen burner was to chemistry. On the strength of this he got a job with the up-&-coming Glenn L. Martin Aircraft Co. By the time he was 28 he was 1) a vice president and chief engineer, and 2) unhappy. He wanted to make his own planes…"***
***TIME,* November 22, 1943**

1811

**"*…With $600 in his pocket, he quit, went to California, set up office in a Los Angeles barbershop. His backlog: one plane. Soon after, a Douglas-designed torpedo plane turned out so well that the navy gave him a $120,000 order, with cash bor-rowed from Los Angeles businessmen, he set up shop in an abandoned studio, and later bagged an Army order. It was for only four planes, but they shot him to the top of the aviation world. For those planes were the famed DWC's, which were the first to fly round the world (1924)…"***
***TIME,* November 22, 1943**

1812

## Outeverythinging the Competition

1813

"*…Then in 1932 Transcontinental & Western Airlines came to Douglas with a proposition: they needed a new two-motored passenger plane that would outfly, outcarry and 'outevery-thing' every plane in the commercial air. Douglas had kept strictly to military craft because Uncle Sam's credit was good. Would he break this rule for T.W.A.? In a week the designs were whipped out…"*
***TIME*, November 22, 1943**

1814

"*…The plane was the DC-1, the first of the famed broad-winged DCs that eventually carried 95% of all U.S. Air traffic, and are now as familiar in the U.S. sky as sparrows…"*
***TIME*, November 22, 1943**

1815

## Shanghaied

1816

"*…When war clouds rolled up in 1939 Douglas was a middling-sized company with plants at Santa Monica and El Segundo. But he had a big-company backlog of $69,000,000. Cautious Donald Douglas did not want to grow any bigger and did not intend to. All this planemaking interfered with his engineer's urge to design planes. But the Army changed his mind…"*
***TIME*, November 22, 1943**

1817

"*…One day late in 1940, General Arnold phoned from Washington, saying: 'Don, you're going to Tulsa to run a plant.' 'The hell I am.' said Mr. Douglas. 'The hell you aren't. You're there now.' From then on, the company did not expand. It exploded. Conservative Mr. Douglas, who never wanted to get any bigger, soon found himself not only in Tulsa, but all over the globe. He says mournfully: 'We were Shanghaied'…"*
***TIME*, November 22, 1943**

1818

"*…His Shanghaied company now operates:*
- **A $36,000,000 plant in Tulsa, employing 16,000.**
- **A $45,000,000 plant in Oklahoma City, employing 20,000.**
- **A $33,000,000 plant in Chicago, employing 11,000.**
- **A $30,000,000 plant in Long Beach, employing 40,300.**
- **A $30,000,000 plant in Santa Monica, employing 40,000.**
- **A $20,000,000 plant in El Segundo, employing 21,000.**

***And more than 100 other small plants and repair stations tucked away in worldwide spots from Persia to China. The Santa Monica and half of the El Segundo plants represent Douglas Aircraft investment. Government money built the others…"***
***TIME,*** **November 22, 1943**

1819

"***…His payroll soared from 7,589 employees in 1939 to 156,000 as of last week – a cross section of people that includes Betty Grable's sister, Carole Landis' mother, famed Dancer Ruth St. Denis. The weekly payroll is $7,300,000 in the $250,000 worth of plants…"***
***TIME,*** **November 22, 1943**

1820


"***…In this galaxy of plants, the company turns out:***
- **The slim-bodied, two motored, over 200-mile-an-hour Douglas A-20, known to the British as the ground-strafing Boston and the night-flying Havoc.**
- **Four-motored Flying Fortresses and Liberators, under lease from Boeing and Consolidated (Douglas makes almost as many Fortresses as does the parent Boeing company; one fifth as many Liberators as does the parent Consolidated)**
- **The transport DC-3, the Army's C-47.**
- **The four-motored, 65,000-lb. (standard gross weight) C-54, transport and cargo plane that hauls a freight car load through the skies.**
- **The Navy's single-motored SBD dive-bomber, which is generally credited with sinking more combatant enemy tonnage than any other weapon in the U.S. war kit…"**

***TIME,*** **November 22, 1943**
**Left: caption: "Douglas transports on the line"**
**Right: caption: "Douglas dive-bomber over Wake Island. Enemy ships know and dread the SBD."**

1821

**The Douglas Way**

1822

"***…Despite its explosive expansion, the company has avoided the production headaches of many another aircraft plant because 1) it has an immense knowledge of what not to do in building planes; 2) Douglas has always surrounded himself with top-notch engineering brains; 3) Douglas picks a man for a job, then lets him do it…"***
***TIME,*** **November 22, 1943**

1823

**Top-Tier**

1824

*"…Some of the men doing the job are:*

• Arthur Emmons Raymond, high-domed, lucid, 44-year-old vice president in charge of engineering. His hotel-owning family wanted him to be a hotel man. Instead he went to Boston Tech; after graduation he returned to California. In 1925, Douglas wired Boston Tech for the name of their best stress analyst. The answer came back: 'Arthur E. Raymond and he works for you.' Douglas found him in the shop.

• Frederick Warren Conant, 51, leather-skinned, dry-spoken vice president in charge of manufacturing. Santa Barbara-born, Cornell-educated as a civil engineer, he went to work for Douglas at $0.50 an hour…"

*TIME,* November 22, 1943

1825

• Ava Michael Rochlen, 52, intense, Russian-born, Hearstwhile reporter, who directs Douglas' industrial and public relations. 'Rocky' Rochlen came to the U.S. as an immigrant boy, learned English by reading the late Arthur Brisbane's column and rereading English classics he had previously read in Russian. At 17 he was earning $7 a week in a New Britain, Conn. Hardware factory, and carried a Socialist Party card. He was a top West Coast newspaper reporter when he joined Douglas in 1937.

*'Rocky' Rochlen's biggest job is to try to 'humanize' his boss. In that, he has been singularly unsuccessful. Donald Douglas does everything, even his enormous production job, in such a precise way that it never seems to be news…"*

*TIME,* November 22, 1943

1826

## Without Flagging

1827

*"…A prime example is Douglas' handling of the manpower problem that has graveled all planemakers. The turnover of Douglas workers actually runs as high as 85% in a year, about average for the Southern California industry. But somehow, through his genius for organization and efficiency. Douglas has kept production up without flagging…"*

*TIME,* November 22, 1943

1828

*"…In the aircraft industry, with its outstanding manpower problems at Ford's Willow Run and Boeing's Seattle plants, this is a sensational achievement. Vice President Constant's explanation for the phenomenon: 'We have good airplanes. We didn't have to stop and swallow any debacles'…"*

*TIME,* November 22, 1943

1829

## Tell it to the Skunk

1830

*"…Douglas has not achieved this efficiency through any special golden-rule-and-free-showers treatment of workers, though his paternalistic Welfare Department is large. Nor does he have any exquisitely sympathetic labor relations. He operates one of the biggest and last great open shops in the U.S. Union leaders make no secret of their alarm. Douglas' attitude is direct, as usual. On his desk sits a small pottery model of a skunk, which many visitors instantly link mentally with the colloquial axiom: 'Never get in a squirting match with a skunk.' It is said that when visitors mention labor problems to him, he merely points at the skunk…"*
***TIME,* November 22, 1943**

1831

**Scooping**

1832

*"…His strategy in labor relations is very simple, as always. After six years of intensive effort, less than 15% of his 156,000 employees are union-organized. A main reason is he always keeps the union off balance, 'scooping' it again and again. The union never gets a chance to announce good news…"*
***TIME,* November 22, 1943**

1833

*"…Example: after long union agitation for pay raises for the Southern California aircraft industry, the War labor Board decided to grant the increases. Douglas Aircraft somehow got an advance tip, and rushed through the presses a special four-page edition of the company house organ, telling all the workers how the company had won them a raise. The U.A.W.-C.I.O, caught flat-footed, limped to press a day later. Its claim for credit for the raise fell flat…"*
***TIME,* November 22, 1943**
**Caption: "Douglas Management Committee; union is kept off balance"**

1834

**More or Less**

1835

*"…Another, even greater, factor is the large labor turnover. The union proselytizes twelve men to get one more or less permanent member – and sooner or later he quits too…"*
***TIME,* November 22, 1943**

1836

## Balancing the Books

1837

*"…For the job of running his company, Donald Douglas collects $120,000 salary a year, which he spends sparingly. Dividend-wise, the returns have not been rich, although the company has not lost a dime since it started. The best year was 1941, when net profits were a fat $18,177,000 after taxes on its gross of $42,877,000…"*
***TIME,*** **November 22, 1943**

1838

*"…After the company wound up its foreign orders in 1942, the net profits dropped sharply to $11,055,000. This year they will be still lower, with the percentage of profit to gross, which was a firm 8% in 1938, now dropping below 3%. Compared to a 1938 net profit of $3,147,000, these figures are high…"*
***TIME,*** **November 22, 1943**

1839

## A Black Future(?)

1840

*"…But despite its present position with an annual business of $1,000,000,000 and a backlog of over $2,500,000,000 (fourth largest of any U.S. company), the company has been able to pile up only $36,000,000 in net working capital, and contingency reserves of only $6,875,000. This is enough to meet one week's present payroll. And this may be one reason why the future of aviation looks black to Douglas – as, it must be said, it does to many other aviation men…"*
***TIME,*** **November 22, 1943**

1841

## Plight of an Industry

1842

***"…For the plight of Douglas is the plight of the entire industry, despite its $20,000,000,000 annual business and its 2,000,000 employees. There is hardly an aircraft company which has enough cash reserve to meet its present payroll for more than a few weeks at the most, if contracts should be cancelled. The eleven biggest manufacturers, the bulk of the industry, have only $138,000,000 in current assets over current liabilities – as compared to $650,000,000 for General Motors…"***
***TIME,*** **November 22, 1943**

1843


***"…What will happen to the tremendous Douglas plant, the acres upon acres of machines, the 156,000 employees, when peace comes? A tiny part of this empire will be used to convert military to commercial transports. But for the rest, the Douglas answer, that 'You shut the damn shop up,' is inadequate. For the thousands who would become unemployed – plus the rest of the industry's two million – might set a whole cycle of postwar depression in motion…"***
***TIME,*** **November 22, 1943**
**Left: ca. 1943 print ad from the *War Advertising Council* encouraging people to "BE A SAVER - NOT A BUYER"** 1844


PERHAPS you haven't really got a wrench in your hand . . . Perhaps you're not actually swing a hammer.
But it's you who are building the tanks, gun carriages, rifle springs, turret parts, bombs, steam and Diesel locomotives coming out of our plants . . . And hundred of other factories in this country.
It's *you,* the American people, with the money you put into war stamps, bonds, taxes, who are turning out the weapons coming off America's production lines . . . A volume of mobile power that will help to assure a decent world. (ca. 1942 print ad for *American Locomotive*)
1845


***"…But already, to make sure that Douglas is not caught with its payrolls up when contracts go down, supple-fingered girls are riffling through the work cards, neatly tabbing them, ready for the torrential layoffs. The problem, Douglas feels, is not to keep the swollen aircraft industry operating at wartime levels, even if it were possible, but to get millions of workers back into peacetime jobs…"***
***TIME,*** **November 22, 1943**
**Caption: "POSTWAR planning meetings are no longer adjourning with the rosy and reassuring thought that enough people will WANT enough things, after this war, to keep America's productive capacity busy and provide plenty of jobs…" (ca. 1944 print ad for *The Standard Register Co.*)**
1846


THE FIGURES SHOWN ABOVE, taken from 1942 data of the U.S. Bureau of labor Statistics, shows what happens in peacetime when family income doubles. *Family expenditures also virtually double* . . . Not merely for luxuries and gadgets, but all along the line.
This means that if, after the war, we could double the prewar income of the average family, we as a nation could consume twice as much as we did before the war.
Upon our capacity to produce and consume at this high level depends *our whole post-war standard of living.*
An analysis made by the J. Walter Thompson Company reveals some illuminating facts regarding our post-war potential, as regards production, consumption, and average family income. Those who have seen it have found it stimulating and thought-provoking. It will be available in booklet form Sept. 1st. Would you care to have a copy? (1945 print ad for the *J. Walter Thompson Co.*) 1847

***"…In general, Douglas' attitude thus implies a deep pessimism toward aviation's future. But this pessimism is a curious blend of financial caution and his own passionate preference for aircraft engineering, as against just making planes…"***
***TIME,*** **November 22, 1943**

1848

**The Great Hereafter**

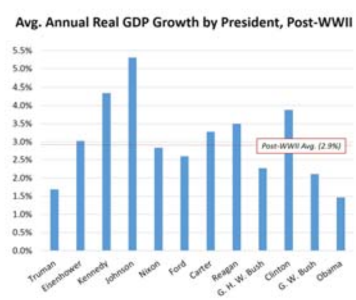
1849

***"…This pessimism is directed mainly at the immediate future. The question: What ceiling in the postwar sky? Donald Douglas would probably answer: Zero. But he would be thinking of the first few years, not of the Great Hereafter. He has a busy postwar planning department which concentrates on designs for new and better commercial transports…"***
***TIME,*** **November 22, 1943**

1850

***"The most deadly and widespread war in modern history acted as a devilish bellows on the fire of the American economy. Developments in industry, aviation, medicine, electronics and atomic energy were accelerated; what would have taken years to evolve took months during the war. The national economy prospered as a result. The GNP before the war in 1940 was just over $100 billion; by 1955 it had tripled to $310 billion. Average Americans, with the horrors of war behind them, were enjoying unparalleled economic security…"***
***National Real Estate Investor,*** **September 1999**
**RE: after WWII, the U.S. was the greatest military and economic power on planet Earth. By 1950, the U.S. had:**
- **7% of the world's population;**
- **Produced 50% of the world's manufactured goods, and;**
- **Created 40% of the world's income.**

1851




1852


1853

**30-to-1**

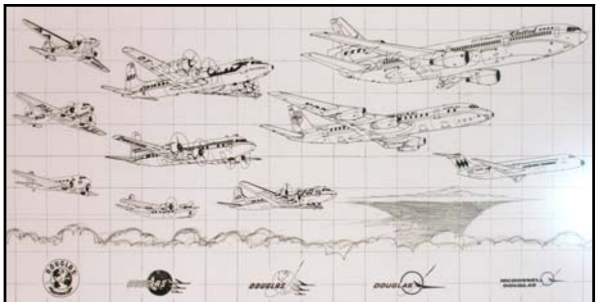
1854

***"…But all this is small fry. All U.S. plane companies, thus busily spewing out planes, are thus industriously digging their own financial graves. By the end of this year 15,000 transport planes, many of them readily convertible to peacetime transports, will be in the air. This is some 30 times as many planes as were needed to handle pre-war U.S. air travel. And bigger, better ones will be coming off the production lines shortly…"***
***TIME,*** **November 22, 1943**

1855

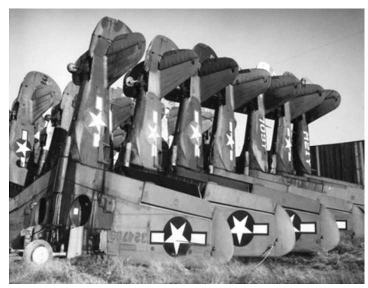
## The Postwar World

1856



***"…No one knows how many commercial planes the postwar world can support. But can it be more than 30 times what it was? Thinking thus, many airplane makers are convinced that they can survive only if the Federal Government steps in and underwrites the industry until the glut of war planes is removed."***
***TIME,*** **November 22, 1943**
**RE: ultimately, in the post-WWII era, the world would benefit greatly from the fierce rivalry between *Boeing* and *Douglas* as they competed for orders, and supremacy, in the commercial airliner market**

1857



1858

**Both companies entered the "Jet Age" with winning designs; *Boeing* with its *707* and *Douglas* with the *DC-8*. In 1967, Douglas merged with the *McDonnell Company* to become "McDonnell-Douglas." Although *Donald Douglas* had turned over the reins of the company to his son in 1957, he remained with the firm as "Honorary Board Chairman," until his death on Feb. 1, 1981. On Aug. 1, 1997, *McDonnell-Douglas* was acquired by Boeing, thus ending the nearly 75-year history of the *Douglas Aircraft Company.***
**Caption: "Donald W. Douglas, Sr. holds a model of the DC-8, ca.1955"**

1859


**Caption: "The Douglas DC-8 brought the company into the Jet Age and in direct competition with Boeing's 707"**

1860

1861

**Part 23**

**Prerequisite for Victory**

1862

**First Things First**

1863

**In recent months a great deal of speculation has centered around the postwar role of cargo transport by air. Interesting and important as the discussion has been, one thing is still more important, and that is winning the war. We must not overlook the fact that cargo transport by air is a vital part of the war effort right now. Its expansion at the fastest possible rate is a prerequisite for victory.**

***Popular Science,* September 1942**

**RE: introduction to an article authored by *Col. Royal B. Lord, U.S. Army Corps of Engineers,* entitled: "Cargo Planes for Victory"**

1864

**Equipped for the Job**

1865

***"SINCE March, 1942, the United States Army has been utilizing what is probably the hardest-working air cargo fleet in the world. The Contract Air Cargo Division is in charge of a former air-line official, Lieut. Col. Robert J. Smith, and functions as part of the Air Service Command under Maj. Gen. Henry J.F. Miller. The word 'Contract' is in there because while the Army gives the orders, actual operation is left to civil air lines equipped to do the job…"***

***Popular Science,* September 1942**

1866

## All the Angles

1867

*"…There are at present some 17 of these lines, with a personnel of over 20,000. Rather than build up its own specialized organization, the Army in effect took over more than an army division of highly skilled and experienced men who knew all the angles of preventive maintenance and overhaul of planes, loading and unloading of freight, dispatching, communications, etc. So organized, this fleet carries both freight and passengers for the Army, Navy, and all Federal agencies directly engaged in war work…"*
***Popular Science,*** **September 1942**

1868

## Hub-and-Spoke Network

1869

*"…Routes operated within the United States form the hub of a wheel from which spokes radiate to Alaska, Greenland and Iceland, Trinidad and Natal, and Panama. The Air Service Command operates only in the Western Hemisphere…"*
***Popular Science,*** **September 1942**

**RE: "Air Service Command" (ASC) was organized as the "Air Corps Provisional Maintenance Command" on March 15, 1941, with its headquarters at *Patterson Field* (Ohio). It was then reorganized as *Air Service Command.* Upon America's entry into WWII, it became "Air Technical Service Command" (ATSC), with considerably expanded functions. It was "housekeeper" for the combat elements overseas and was responsible for the distribution and installation of newer-type mechanical airborne equipment. ATSC technicians served on all fronts repairing and modifying aircraft.**

1870

## Ferrying Command

1871

*"…Service to bases abroad, in or near combat zones, is in charge of the Ferrying Command of the Air Corps under Brig. Gen. Harold L. George. The Ferrying Command is already spanning 10 times the number of miles covered by all the world's air lines at the start of the war, and flying supplies, mail, personnel, and planes to American and United Nations force all over the world. The cargoes consist of such items as ordnance supplies, fuses, armor plate, parts of jeeps, blood plasma and other medical supplies, extra-priority materials, and bottleneck-relieving stuff generally…"*
***Popular Science,*** **September 1942**

1872

Loading Sky Freighters with Cargoes for Fighting Fronts

A big plane swallows a little one: At left, a complete set of wings for a Piper YO-59 "Grasshopper" being stowed in an Army cargo ship for transportation from the factory. Right: preparing to load a pair of Allison liquid-cooled engines into a C-47. How these are handled is shown in photographs below

When plane engines have been put through the cargo door, a pulley is attached to a ring near the ship's nose to drag them forward

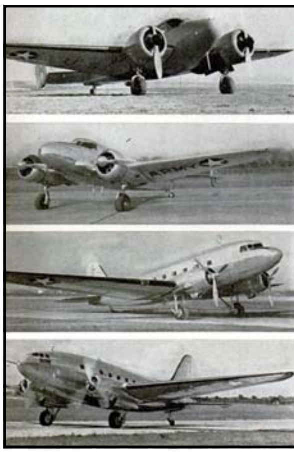
Here an engine is in place and its wheeled carriage has been bolted to the floor, taking the weight off the wheels and securing it for the flight

Ropes also tether the carriage to rings at the side and miscellaneous cargo is stowed in spaces around it

1873

**Troika**

1874



***"…The Army has a four-engine cargo plane, the Douglas C-54, in production. Three types of cargo planes are now in use – the C-53, which is essentially a converted DC-3 transport, and the smaller Lockheed Lodestar and Boeing 247. These planes carry payloads of 3,000 – 5,000 pounds. The Contract Air Cargo Division has many such planes in daily service, each averaging 1,500 miles-a-day…"***

***Popular Science,*** **September 1942**

**<u>Caption</u>: "Four types of cargo planes. Top-to-bottom: Beechcraft C-45, Lockheed C-40, Douglas C-42, Curtiss C-46. The last-named can carry 50 or more fully armed troops or 9-1/2 tons of freight, with a long-range and high safety factor. A four-engine cargo plane is now in production for the Army, the Douglas C-54.**

1875

1876


Last August nearly 4,000 Moslem pilgrims bound for Mecca were stranded in Beirut 800 miles from the holy city.

In one of the finest demonstrations of international good will, the Department of Defense provided a "magic carpet" in the form of the Military Air Transport Service to speed these pilgrims on their way.

Fourteen U.S. Air Force Douglas C-54s roared into Beirut from Europe and Tripoli and then flew the 12-hour shuttle to Jidda (near Mecca). Four days later the last pilgrims arrived at Jidda with two hours to spare.

The performance of the rugged C-54 on this occasion was in keeping with the history of this great airplane. For it was the C-54 which flew billions of transport miles during the war and performed so nobly on the "Berlin Airlift."

Again the C-54 proves Douglas leadership in aviation. Planes which can be produced swiftly and in quantity, *to fly farther and faster with a bigger payload.* Are a basic Douglas concept. (ad appearing in *Scientific American,* Jan. 1953)

1877

**A Nuclear Organization**

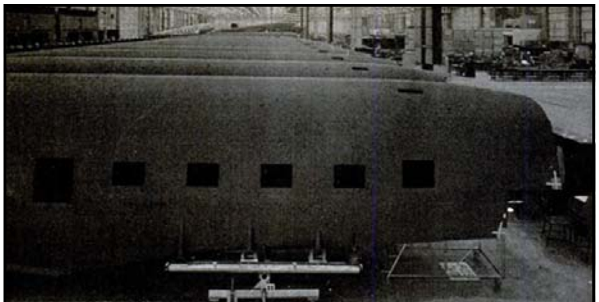
1878

*"…The total of ton-miles per week is very little compared with, say, railroad tonnage hauled in the same time. But this service must not be judged by the number of planes in actual operation at the moment, nor by the load capacity of each plane. It is essentially a nuclear organization…"*
***Popular Science,*** **September 1942**

1879

**Winning the War**

1880



*"…Winning the war calls for a production schedule of cargo planes which must be well under way in nine months and at a maximum output in 18 months or less. These planes will not be C-53s. They will be much larger than anything we now have in the commercial field…"*
***Popular Science,*** **September 1942**
**Caption: "Looking like a school of whales, a line of cargo-plane bodies in the factory await their wings and engines. Our production schedule on these freighters-of-the-sky will be at its maximum within 18 months."**

1881

**The Ratio**

1882

*"…The ratio of payload to gross weight must be increased – which means big planes. The C-53, gross weight about 12.5 tons, will carry some two tons of cargo on a 2,000-mile trip. The useful load in this case is, therefore, around 16 percent of the gross weight. For shorter jumps the ratio may be 25 percent or even higher. But the cargo plane strategists still shake their heads. They want more than 16 percent and more than 25 percent…"*
***Popular Science,*** **September 1942**

1883

| Distance | Gasoline Load | Cargo Load | Ratio of Cargo Load to Gross Weight (32.5 tons) |
|---|---|---|---|
| 1,000 miles | 3 tons | 16 tons | 50 percent |
| 2,000 " | 6 " | 13 " | 40 " |
| 3,000 " | 9 " | 10 " | 31 " |

*"…They are thinking – for the time being – in terms of planes with gross weights between 32.5 and 50 tons. With planes of this size, the engine drag and aerodynamic interference are appreciably less; the plane is faster and carries more payload in relation to its gross weight. Minimum payload should be 10 tons. The big plane must replace the little plane for carrying purposes. A 32.5-ton plane will perform somewhat as shown above…"*
***Popular Science,*** **September 1942**

1884

***"…These figures are more or less conjectural and are given only for purposes of illustration, but the principle is clear. The 32-ton plane will jump 3,000 miles with a better ratio of cargo to gross weight than the C-53 can show at 1,000 miles. A 40-percent ratio at 2,000 miles is what the freight-plane designers regard as a feasible standard right now. Later, with still larger airplanes, they may do better…"***
***Popular Science,*** **September 1942**

1885

**In the Quantities Required**

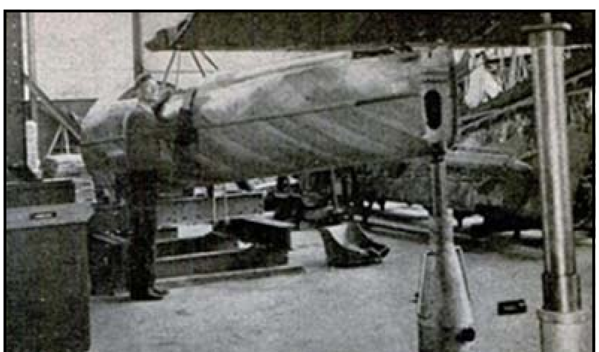
1886

***"…Another compelling reason for going to big aircraft for carrying purposes is that they are easier to manufacture. These air freighters are to be built by tens or hundreds, but by thousands and tens of thousands. A project like this immediately runs into stupendous figures in man-hours and materials required. Our fighter and bomber designs are all based on the use of aluminum, and that material is very much on the scarcity list. Even if it were the best material for cargo planes, it would be unattainable in the quantities required…"***
***Popular Science,*** **September 1942**

1887

**Flying Boxcars**

1888



***"…Plywood, then? For trainers, yes; perhaps for some cargo planes also – but better not put too many eggs in that basket. The answer, then, is steel. These planes are just flying boxcars, and, like boxcars, can be made of steel…"***
***Popular Science,*** **September 1942**
**Caption: "Testing plane parts of plywood plastic"**

1889

**Two Types**

1890

***"…Two types of steel are now acceptable for plane construction – stainless steel and low-carbon steel. Stainless steel is already being used in the construction of some 900 small cargo planes. This type of steel, however, uses critical materials such as nickel and chromium…"***
***Popular Science,* September 1942**

1891

**Dealer's Choice**

1892

***"…Low-carbon steel appears to offer the best solution to the problem. A series of studies and tests of low-carbon steel has proved conclusively that this material can now be used for such construction. Its use entails no weight handicap and no difficulty with corrosion. Low-carbon steel welds easily (over 50,000 tests with no spot failures). It is easily handled and formed by conventional shop methods…"***
***Popular Science,* September 1942**

1893

***"…Steel production capacity is now about 90,000,000 tons-per-year. Two hundred steel air freighters per month require only 2,000 tons of steel per month. There is idle rolling-mill capacity for airplane-size sheet. There are many concerns with available manufacturing capacity such as automobile, refrigerator, stove, and many others thoroughly familiar with the technique of manufacturing in this material. This makes available men and facilities in large quantity…"***
***Popular Science,* September 1942**

1894

***"…Extensive tests have proved that corrosion is not a serious problem. The material welds perfectly through the corrosion treatment. Welded steel construction permits the production of at least two airplanes for the same amount of labor and facilities now necessary to produce one airplane…"***
***Popular Science,* September 1942**

1895

***"…For example, in aluminum, a fin required 8-1/2 man-hours for completion in an airplane plant. An extensive study by automotive planning engineers reduced this to 2-1/2 man-hours by the use of elaborate jigging. The same part was actually constructed in steel with 12 <u>minutes</u>' labor…"***
***Popular Science,* September 1942**

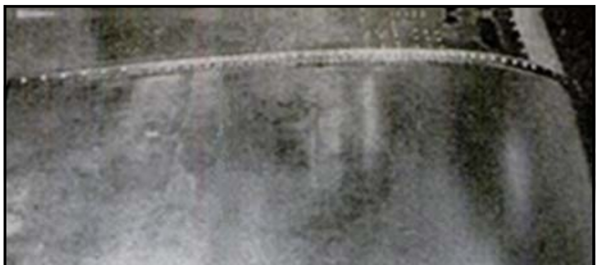
1896

## Advantage: Steel

1897

*"…The basic structure of a military airplane is a comparatively small portion of the total weight. In the freighter a much larger portion of the total airplane is the basic structure. Consequently it is certain that a much greater saving than two-to-one can be effected with quantity production of cargo planes when steel is employed…"*
*Popular Science,* September 1942

1898



*"…With the stiffness of the low-carbon steel sheet used in this structure, the skin is very smooth, producing greater aerodynamic efficiency. Other advantages are obvious, such as the fact that it is possible to cut out large sections of the structure and weld in replacements for damaged parts in the field with portable equipment…"*
*Popular Science,* September 1942
Caption: "Spot-welded low-carbon steel, seen above in contrast with riveted aluminum alloy on an adjoining wing section, saved the lightweight metal for use on combat planes"

1899

## Air-Express Service

1900

*"…Cargo planes can transport urgently needed supplies at high speed to our own forces abroad and to those of our allies, free from the submarine hazard, without convoying, zig-zagging, or other time-consuming expedients. Forty cargo planes carrying 12.5 tons apiece can deliver 500 tons of strategic material in Europe overnight. Likewise they can carry troops. As we have seen, such an air-express service is already being operated, at present on a relatively small scale, which should be greatly expanded in the near future…"*
*Popular Science,* September 1942

1901

## Multi-Role

1902

***"…If the General Staff should decide on simultaneous land operations, cargo planes can be used as air transports for large bodies of troops – still larger numbers if gliders towed by cargo planes are provided in sufficient numbers…"***
***Popular Science,*** **September 1942**
**Caption: "A pattern of transport planes and gliders is pictured against a grey English sky"**

1903

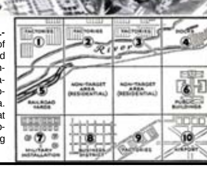
***"…Many other possibilities may be envisioned – cargo planes towing small fighter planes to Europe from the United States, refueling operations carried on in the air, glider trains to carry loads greater than a single cargo plane can pull off the ground, perhaps gliders used for crash landings with bomb loads, etc…"***
***Popular Science,*** **September 1942**

1904

***"…But there is another job which cargo planes are capable of doing. It is based on the theory that mass bombing operations may be carried out most effectively in two stages: reduction of defenses, and dumping of explosives. The first is a military procedure and must be left to escort planes and bombers of the regular types. The second is essentially a demolition-engineering procedure which calls for the use of large, comparatively cheap cargo planes…"***
***Popular Science,*** **September 1942**

1905

**BOMBING WITH CARGO PLANES.** Flying in the wake of waves of armed bombers and escort planes that have silenced all resistance, cargo planes can dump tons of explosives on a hapless target area. A grid plan like that seen at right would serve as a template for rough pattern bombing of objectives.




***"…So used, bombers of standard design, and cargo planes equipped with bomb bays and simple aiming devices, can complement each other to produce demolition effects which will make the Nazi practitioners of aerial terrorism regret that they ever went into the business…"***
***Popular Science,*** **Sept. 1942**

1906

## Part 24

## Air Travel for Everybody

1907

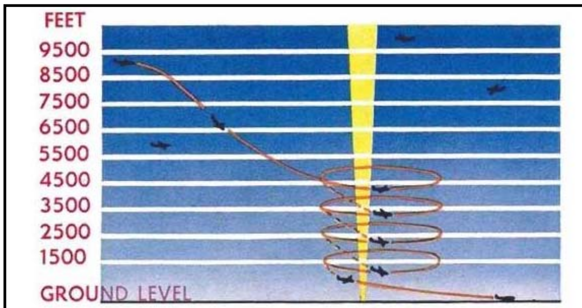
### Peace Dividend

1908

***"…Very few people live in a state of urgency that requires them to travel 500 miles-an-hour, and microscopic fractions of those who do can afford to trifle with the probability of being drastically late or set down in Framingham, Massachusetts, instead of Washington, D.C. The flying machine is tolerably safe, and that is taken for granted. It isn't at all reliable and it isn't comfortable."***

**RE: excerpt from a letter to a NYC newspaper (ca. 1947). After achieving a sterling war record, the airlines found themselves deluged with criticism. Air travelers, weary of delays and irritated by uncertain arrivals of planes, began to object, often vociferously. High fares, keeping passengers in airplanes for several hours waiting to take-off and/or the practice of "stacking" planes for long periods waiting to land was not wining many converts to air travel.**

1909




***"…Holding patterns are divided vertically into layers of 1000 feet. Planes are handled on a first-come, first-served basis; you enter the top of the deck and work your way down. …"***
***Popular Mechanics,* January 1956**
**<u>Caption</u>: "Each holding stack is looped around a radio beacon. Incoming plane enters top of the stack and works its way down. Controller's big problem is to feed planes through the stack and onto runways with minimum delay."**

1910

***"…Eventually, when you reach the bottom and the tower man gives you permission to make your approach, you pass through the 'gate' (the final wave-off point if anything is wrong) and land. It takes the average plane two minutes to descend from one level to another so, until recent improvements, one landing every two minutes was the maximum possible rate. CAA controllers shuffle you through this deck of planes with an expert hand. Your safety is their primary consideration. Indeed flying today, despite the traffic jams in some areas, is safer than it has been throughout its history. But the slightest hitch can cause an aerial misdeal…'We know that air-space and traffic-control problems are serious and must be solved if we are to have sound aviation,' says F.B. Lee, Administrator of Civil Aeronautics. 'We have no doubt they can be solved'…"***
***Popular Mechanics,* January 1956**

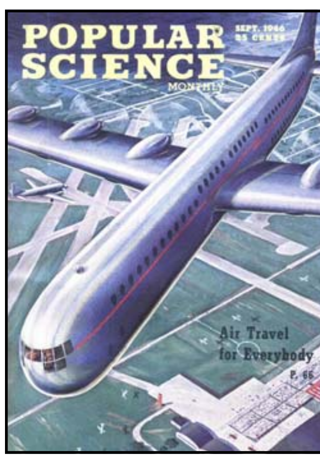
1911

***"…Slow take-offs can be as exasperating as stacking. It often takes an hour to get a clear runway at crowded terminals. In the summer the passengers boil; in winter they freeze until the plane gets into the air . . . Reservations, flights without reservations, waiting time, 'no-shows,' ground transportation, meals aboard, terminal restaurants: these are still big problems…"***
***Science Illustrated,* February 1947**

1912

## Purpose-Built

1913




***"IN a half-dozen plants converted to peacetime pursuits, riveting hammers are pounding out aircraft to bring transportation by air to thousands of American hamlets at a price almost any traveler will be able to afford. Some of these air liners, built from design lessons learned during the war, will be able to cross the United States in less than seven hours. Some, engineered specifically for local flights on interurban schedules, will be only half that fast. All of them, for the first time in the history of the U.S. air transport, are being built for specific purposes…"***
***Popular Science,***
**Sept. 1946**

1914


***"…Conveniences for the traveler that these planes will provide reflect the public's criticisms of the air carriers for the last decade. They also provide a pretty good picture of what the public wants - and is going to get from the air lines in the next five years…"***

***Popular Science,*** **September 1946**

**<u>Left</u>: caption: "Eating from lap trays will be a thing of the past. Roomy tables will be available for meals or card playing. They will supplement lounges and buffets on the larger intercontinental transports."**

**<u>Right</u>: caption: "Telephone service will be available to passengers on the ground. This will be one of the conveniences for through travelers, who will no longer have to leave transports at intermediate points."**

1915


***"…The 21-passenger DC-3 and the 42-passenger DC-4 that have served so nobly are going to be too slow, too antiquated, and too costly to run in a few years if the airlines are to live up to all the fine claims they're constantly making in advertisements and publicity releases. Major lines are writing every one of these planes off as fast as possible. In their time they've done yeoman duty. Yet some of these planes had been hopped up in seating capacity in 1946, with DC-3's carrying 28 passengers, DC-4's carrying 60. When you pack air passengers sardine fashion, they howl. They have every right to howl. Regardless of rates, people have been led to believe air transport is something special, as advanced in comfort as it is in speed…"***

***Science Illustrated,*** **February 1947**

**<u>Left</u>: caption: "Airlines workhorse, the DC-3, cruises 185 m.p.h., seats 21"**

**<u>Right</u>: caption: "The DC-4 has a range of 3,000 miles"**

1916

## A Flier's Dream

1917


***"…The two decks of the Stratocruiser have been created by building one fuselage above the other. The bottom section is as wide as the Army's Superfortress. The upper is slightly larger…"***

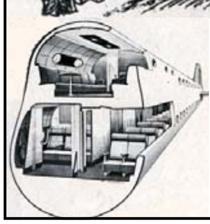
***Popular Science,*** **April 1946**

**<u>Above</u>: caption: "Double-decked Boeing Stratocruiser has made a record of slightly over six hours from Seattle to Washington D.C. This comfortably upholstered airliner will carry up to 114 passengers or 39,000 pounds of cargo at speeds well over 300 m.p.h. Cabin is pressurized to the atmospheric equivalent of a 6,000-foot level."**

**<u>Left</u>: *Northwest Airlines* ad featuring the *Boeing Strato-Cruiser,* ca. 1950**

1918





**<u>Upper Left</u>: caption: "The greater space and comfort provided for Stratocruiser pilots inspired Ernest Norling, Boeing designer, to draw this conception of a flier's dream"**

**<u>Upper Right</u>: caption: "Stratocruiser Cockpit"**

**<u>Left</u>: caption: "A cross-section of proposed Pan American Clipper, showing the interior of the 204-passenger transport. Upper deck has lounge and rest rooms, lower has staterooms."**

1919

## Fed Up

1920

***"…The public is fed up with traveling at 200 m.p.h. between terminals and then waiting 20 minutes or more to retrieve a traveling bag, laboriously unloaded from badly designed transports. So, presently, the air passenger will be able to carry his own bag aboard and stow it under his seat or in a rack over his head, or in a special baggage compartment at the plane's entryway…"***
***Popular Science,*** **September 1946**
**Caption: "Luggage space in the passenger compartment will obviate the need for tipping since travelers can carry their own bags aboard"**

1921

***"…The public is fed up with all the hocus-pocus paper work, at reservation counters, airport terminals and even aboard the airplanes themselves, that takes passengers' time and delays departures. So, on shorter runs at least, a passenger presently will be able to walk up to an airport ticket desk, buy his passage, show it at the gate and go aboard without the bother of a reservation…"***
***Popular Science,*** **September 1946**

1922

***"…The public is fed up with time wasted at stops. So in one type of transport the time spent on the ground will be cut by providing one door for boarding passengers and another for those getting off…"***
***Popular Science,*** **Sept. 1946**

1923

***"…Everyone who travels regularly is having his trouble getting service anywhere. It's only human to think of your troubles, and to forget someone else's. When it became hard to buy a plane ticket, seasoned travelers simply said, 'To hell with it,' and tried the trains. Airline traffic slumped. Winter, the airlines' poorest season, set in and caused other setbacks. Under such circumstances, aviation stocks, good and bad, take a slide…"***
***Science Illustrated,*** **February 1947**

1924

## What the Public Wants

1925

***"…The public wants airlines that go to a lot more places on the map. It wants to be able to travel by plane when the weather is stinko. It wants adequate ventilation in planes that are not too hot and too cold by spurts. It wants altitude conditioning on all transports, so a man's ears won't hurt as his plane descends to land. It also wants more speed for its dollar…"***
***Popular Science,*** **September 1946**

1926

***"…All these it is going to get, plus a few more. By 1951, air transports and the airline pattern itself, both domestic and intercontinental, will confound the most extravagant predictions of the men who were nursing a few scrawny airlines to maturity in 1931. But for all the planning that is underway, the growth and character of airline service are bound to be somewhat hodgepodge for the next few years. The carriers themselves are guessing at exactly what's coming. They are in the midst of a tepid reenactment of the railroads' expansion three-quarters of a century ago. It is a tepid performance because the airlines are rigidly - some critics say too rigidly - controlled by the Government…"***
***Popular Science,*** **September 1946**

1927

## What's Best?

1928

***"…What's best - cheap transportation in economically run 'day coach' planes, or higher-cost transportation on plush seats? American Airlines, biggest U.S. carrier, favors low-cost travel for everybody. Many of its competitors are increasing, instead of cutting down, the plush…"***
***Popular Science,*** **September 1946**

1929

***"…What's best - 200-m.p.h. planes at a cost to the passenger of three-and-a-half cents a mile, or planes that will fly at 350 or 400 m.p.h. with considerably higher fares? That question is in a fair way to being answered. The slower planes will go on interurban runs, the faster ones on trans-ocean and one-stop and nonstop transcontinental runs. In-between planes will fly middle-distance runs…"***
***Popular Science,*** **September 1946**

1930

***"…What's best - planes that sacrifice cruising speed for the ability to get into tiny airports, or faster planes that need more runway? That is the hardest question to answer. Good airports are few, and cities and towns are loath to put up money for better ones even if the Government chips in…"***
***Popular Science,*** **September 1946**

1931

***"…What's best - 14-passenger planes that leave every hour, or 28-passenger planes that leave every two hours? Some aircraft manufacturers, hawking their wares among the airlines, are betting on the smaller plane…"***
***Popular Science,*** **September 1946**

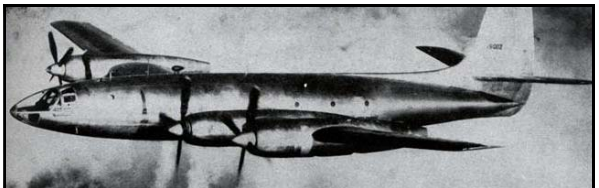
1932

***"…One thing is certain: Faster, more efficient planes are coming. They will go farther on a gallon of gas, and that means lower fares. One manufacturer already is talking about the possibility of New York-to-San Francisco flights in less than eight hours for as little as $86. That compares with $118.30, tax extra, at present. The Pullman fare for the same trip is $127.13 (or 4.01 cents a mile); that by rail coach, $63.12; by bus, $45.25…"***
***Popular Science,*** **September 1946**

1933

***"…The first half of this year domestic airlines alone carried 5,225,299 paying passengers, or 666,666 more than in all of 1944. Postwar traffic is 400 percent greater than wartime bookings. But the day of the 90-percent load factor is over. The airlines will have to be able to make money on normal load factors: somewhere between 65 and 75 percent…"***
***Science Illustrated,*** **February 1947**

1934



***"…The Air Transport Association, the airline trade group, figures that average domestic fares in the next few years will drop to three-and-a-half cents, and in its boundless and evidently warranted optimism forecasts flights made on 'trolley-car frequency,' while Wellwood Beall, Boeing's chief engineer, believes that long-distance flights at altitudes 'considerably in excess of 30,000 feet may soon be commonplace.' The Rainbow, in fact, is designed to climb to 40,000 feet, above the weather. Even combat planes seldom went that high during the war. Designed specifically for great altitude, the Rainbow costs less to operate at a height of almost eight miles…"***
***Popular Science,*** **September 1946**
**Caption: "Republic Rainbow, sensational newcomer, has a 4,000-mile cruising range, carries 40 passengers at speeds of 400 to 450 m.p.h."**

1935

## War Dividend

1936

***"…Planes with great improvements can be produced rapidly because it's relatively easy to convert warplane research to peaceplane progress…"***
***Science Illustrated,*** **February 1947**

1937


***"…In five more years, and maybe less, the person who makes an air trip of considerable length will draw his final dividend from the war in comfortable flying…"***
***Popular Science,*** **September 1946**
**Left: caption: "Some of the individual conveniences in store for the air passenger of tomorrow. More personal comfort is the keynote."**
**Right: caption: "On long flights, electric stoves will permit preparation of varied meals aloft, in contrast to the vacuum-bottle menus that are served on air liners in use at present"**

1938


***"…It was the war that accelerated work on the turbine as a power unit. Today the turbine, driving a conventional propeller and spewing burned gases from a jet pipe for supplemental thrust, is being installed in a version of the new Martin transport for experimental cargo work by United Air Lines. When it has proved its reliability, it will be fitted to passenger transports…"***

***Popular Science,* September 1946**

**<u>Above L&R</u>: caption: "Latest jet plane is this new Consolidated Vultee XP-81, the first plane ever to fly with a gas-turbine engine developed for propeller drive. Powered by a gas turbine engine in the nose and a jet engine in the tail, the sleek fighter will fly at a speed of more than 500 mph. At the right is a cut-away sketch showing the placement of the turbine and jet engine."**

1939

***"…Turbine power, in contrast to that obtained from reciprocating gasoline engines, is practically vibrationless. Gone will be the aggravating, often nerve-wracking shaking that has always characterized powered flight. Because turbines produce more power-per-pound of weight, their adoption will mean even greater speeds; 400 m.p.h. will be no novelty. It will also mean bigger planes if the volume of passenger traffic calls for them…"***

***Popular Science,* September 1946**

1940

## Shrinking the World

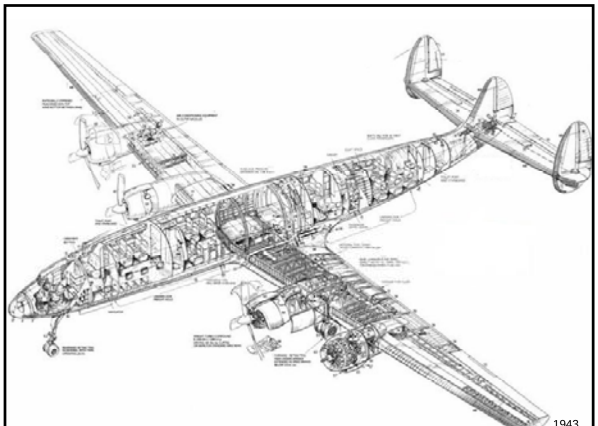
1941


***"New commercial transport planes, shrinking the United States to 1/200 the size of a century ago in terms of time, are incorporating a brand-new concept of comfort for the passenger. When airliners began operations in the late 1920s, the mechanics of operation were a primary consideration with designer and air-carrier companies. Today cushion-rubber chairs, modernistic lounges, and temperature controls are deemed as important as the navigational devices up front. To those are added speed; transcontinental flight in the Lockheed Constellation, for instance, is a matter of 10 hours, and crossing the Atlantic Ocean between Washington, D.C, and Paris, France, takes less than 13 hours…"***

***Popular Science,* April 1946**

1942

**<u>Caption</u>: "PAA Lockheed 049 Constellation"**



1943

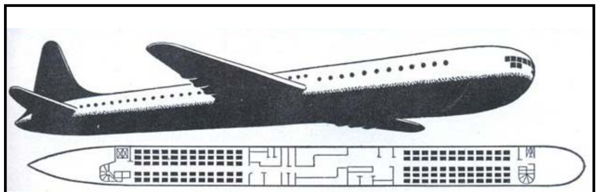

***"...Constellations carry 57 passengers more than twice as fast as the familiar veteran, the 180-mile-an-hour DC-3. The fuselage in cross section is a perfect circle. Two super-chargers pour fresh air into the cabin to hold pressure at a simulated level of not more than 8,000 feet, and heating and refrigeration control the temperature. Circular windows enable passengers to enjoy the unfolding view. More than 100 Constellations are being rushed to completion…"***

1944

***Popular Science,* April 1946**

*"…Designers and engineers are preparing other titans to speed the new era of air travel - Douglas' DC-6, the huge Stratocruiser by Boeing, and the gigantic Model 37, by Consolidated Vultee. Soon a passenger may breakfast in London, enjoy a late lunch in New York, and go to bed that evening in Los Angeles…"*
*Popular Science,* April 1946
Caption: "Here's the biggest airliner of the lot – Consolidated Vultee's Model 37. Weighing 320,000 pounds, it will be nearly twice as heavy as any land plane yet flown. Six gas-turbine engines will drive the giant."

1945

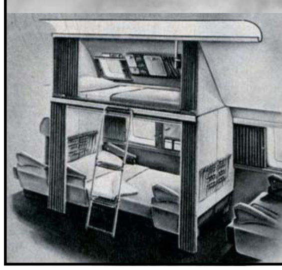


*"...Consolidated Vultee's Model 37, developing 30,000 horsepower, will have a cruising speed of 342 m.p.h. This monster will be nearly twice as heavy as any land plane yet flown. On nonstop flights up to 4,200 miles, 204 passengers will enjoy the comfort of four cabins on two decks. These planes use plenty of gas. At take-off, the Model 37's six big engines will consume fuel faster than you could bail it out of a barrel with a 10-quart pail, but they develop more power than 360 Ford V-8 engines. The electrical system would supply a town of 5,000…"*
*Popular Science,* April 1946
Caption: "When they enter commercial service, giants like the Convair Model 37, carrying up to 200 passengers at speeds in the 350-m.p.h. class, will handle intercontinental and express transcontinental traffic"

1946

*"…Consolidated-Vultee won't attempt to build a Model 37 until it can get turbines of 5,000 horsepower. The general adoption of turbines for long-range flying, incidentally, will make operation at high altitudes mandatory. Turbines work better higher up. Altitude flying will obviate the 'bumps' encountered in the turbulent air of storms, high winds and heat reflected from the earth…"*
*Popular Science,* September 1946

1947



*"...When the DC-6 makes its appearance, it will be 80 inches longer than the DC-4 and will cruise at about 275 m.p.h. Passengers will enter this plane through a door aft of the wings. They will relax in cushion-rubber chairs, and stewardesses will serve meals from buffets near the door…"*
*Popular Science,* April 1946
Top: caption: "UAL Douglas DC-6"
Bottom: caption: "Up to 70 passengers will be carried by day in the Douglas DC-6, while at night the capacity will be 26. Speed and comfort are stressed. Each berth of the DC-6 has an outside window. Lowers are 76-inches long, uppers 78-inches, both about 40-inches wide. Bedding and end panels are stored in upper berth."

1948

## Shooting the Works

1949

*"…Give the aircraft manufacturers credit. Trying to keep their heads above water amid ruthless competition, they have done most of the work in the year since the war ended to make flying more enticing to the airline customer. The carriers themselves, spoiled by six years of more business than they could handle, too often have been characterized by the reservation clerk who is snippy over the telephone. The plane makers weren't blessed with that problem They had to go out and get business. To sell planes they had to build better ones, with more appeal. So they are shooting the works…"*
*Popular Science,* September 1946

1950

**<u>Top Left</u>: caption: "The pilot's needs have not been forgotten. This windshield has two glass panels, with warm air flowing between them to prevent fogging on the inside and icing outside. Each panel is crash-proof, a safeguard against collisions with birds."**

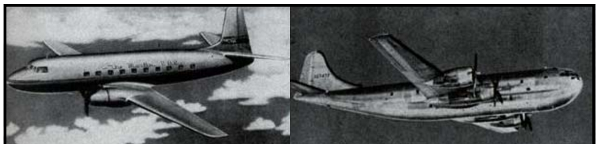
**<u>Middle Left</u>: caption: "Automatic radiant heating for cabins will maintain perfect temperature control, eliminating the now-it's-too-hot, now-it's-too-cold complaints. Other comforts will include complete air conditioning and pressurized cabins in high-altitude craft."**

**<u>Bottom Left</u>: caption: "Improved facilities, such as the Pullman-type fixtures illustrated, will be among the features of more spacious powder rooms for women and lavatories for men on main-line planes"**

1951

## Comfortwise and Courtesywise

1952



***"…What planes will replace these old stalwarts that have been scientifically outmoded? On the shorter hops there will be planes like the twin-engined Martins, flying almost twice as fast as the still-standard DC-3s. They'll carry more passengers per plane, all the instruments and other safety devices, including thermal de-icing. This means wing edges will be heated to eliminate an old hazard, icing on the takeoff and in landing. For the longer coast-to-coast and trans-Pacific runs lines will be using big planes like the Boeing Stratocruiser, the commercial plane that grew out of the famed warborn B-29, the Superfortress that shattered the Japanese mainland. Cabins will be pressurized, speed will be doubled. All of these are improvements the airlines have to make. They have to move faster comfortwise and courtesywise than the railroads, because people expect more of the airlines than they do of the other carriers…"***

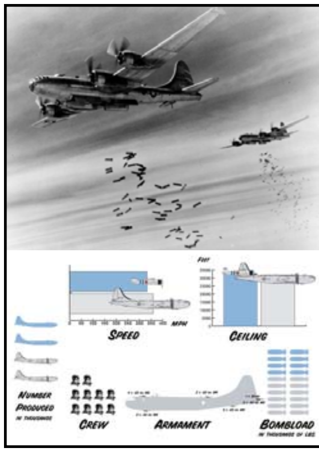
***Science Illustrated*, February 1947**

**RE: the *Boeing Stratocruiser* was uneconomical to operate thus, Boeing only built 70 commercial models of the type**

**<u>Left</u>: caption: "Martin 2-0-2 is a 40-passenger liner, cruises 270 m.p.h."**

**<u>Right</u>: caption: "Boeing Stratocruiser seats 100, flies at 340 to 400 m.p.h."**

1953




**Although the first specifications for the *Boeing B-29 Superfortress* were made in 1940, the first B-29 (built in Boeing's Renton, Wash. facility) was not delivered until 1943 (the B-29 did not reach full service until 1944). The B-29 was the most technologically advanced aircraft in the USAAF inventory during WWII. The U.S. government had asked Boeing to produce a long-range, accurate strategic bomber that could travel the long distances across the Pacific to Japan. Originally produced for the long-term bombing campaign planned for Japan, the B-29 was used to deliver the atomic bomb/s to Hiroshima and Nagasaki respectively. Later models of the B-29 were developed for use in weather programs and geological surveys.**

1954

***"…The A.T.A. believes that the current, frenzied purchase of new transports by the air lines to cash in on a war-born bonanza of patronage ultimately will create an orderly, stepped-down pattern of air-line equipment:***

- **Planes with 80 to 200 seats for intercontinental flights.**
- **Planes with 40 to 60 seats for main trunk lines.**
- **Planes with 20 to 25 seats for smaller trunk lines, such as those of considerable length over sparsely settled areas.**
- **Planes with 10 to 15 seats for feeder lines serving communities with populations as small as 2,500.**

***The main trunk lines also will have a certain number of 80- to 125-passenger planes for one-stop or nonstop coast-to-coast schedules. Some of these, in turn, will be fitted as sleepers…"***

***Popular Science*, September 1946**

**<u>Left</u>: caption: "Planes with 10 to 15 seats will be used on feeder lines to bring even small communities into the U.S. air network"**

**<u>Middle</u>: caption: "Transports seating 20 to 25, cruising at 200 m.p.h., will step up present speeds on minor trunk lines"**

**<u>Right</u>: caption: "Faster runs on major trunk lines will be provided by 300 m.p.h. planes seating 40 to 60 passengers"**

1955

## In a Dither

1956

*"…In their anxious, keep-up-with-the-Joneses buying of new transports - a windfall, by the way, to aircraft manufacturers who had billions in war orders canceled overnight – the air lines really deserve a little sympathy. They are in a dither. They are filthy rich in patronage but they want more…"*
***Popular Science,***
**Sept. 1946**
**<u>Left T&B</u>: surplus WWII aircraft storage facility**

1957

*"…In casting around for answers, the only real truths the carriers can get their teeth into are those that can be proved on a slide rule. They know that the volumetric capacity of a conventional airplane varies as the cube of its linear dimension, while fuselage structure weight varies roughly only as the square. Put in plain language, that means the bigger the airplane, the more profit. As yet the theory of small planes for short runs is only a theory. People may begin using airplanes as they use buses. If the airlines buy big planes, which can be operated more economically per seat than small planes, they stand to lose their shirts if they don't carry good-sized loads. If they get timid and buy small planes of only fair speed in anticipation of modest patronage, they not only risk the larger profits on more expensively operated equipment but may lose customers as well to competitors with bigger, faster planes. They can't hook on a glider to take care of overflows as a railroad hooks on an extra car…"*
***Popular Science,* September 1946**

1958

*"During the war, flying in zero-zero weather was no uncommon thing. Now the problem is to adapt equipment and methods to the commercial airlines, and get approval of the Civil Aeronautics Board. The adaptation is not too simple, will take time, but it will be worked out. This will mean that if an air traveler is scheduled to reach Shanghai, China, at 9 a.m. next Friday, he will be quite certain of getting there right on time."*
***Don King*, VP in charge of Orient routing for *Northwest Airlines***

1959


*"…Whatever they buy, the public will benefit. More than 300 companies have filed applications with the Civil Aeronautics Board, the agency which rules the industry with an iron hand, to establish feeder routes. Right now only 61 of the nation's 665 communities with populations of 10,000 to 25,000 enjoy airline service. Almost half the nation's counties have no airports. Of the 678 points that feeder and trunk lines propose to add as stops, only 93 have satisfactory airports. That means a lot of heat is to be put on American cities and towns to build new airports or improve old ones. The more airports, the more places the airline customer can fly…"*
***Popular Science,* September 1946**

1960

*"…Some cities have their airport so close to the heart of town you can get to it in a cab in five minutes. But there are often some pretty high buildings in these cities. So at a 1,000-foot ceiling, the minimum for landing with safety under these close-proximity conditions, only 60 percent of the airport's actual facilities can be used. We'd all like downtown airports! Nearby may be a city with even higher buildings, but with an airport so far out of town the buildings don't count. Approaches can be made at a 500-foot ceiling and 98 percent of the airport's facilities are utilized. Though everyone would like airports as close to the heart of town as possible, this isn't practical for most large cities. We ought to have airports where landings can be made at 1,000-foot ceilings, and almost 100 percent of the time. This means instrument flying, the safest flying there is. Many pilots will tell you they feel safer, and have less concern for safety of their passengers, when flying fully on instruments. But you can't get downtown in nothing flat, if you want a port with a 100-foot ceiling…"*
***Science Illustrated,* February 1947**

1961

*"We are not masters of our own destiny insofar as airports are concerned"*
**Airline Executive (ca. 1947)**
**<u>Caption</u>: "WASHINGTON, D.C., had one of the most inadequate airports in America. Only way to improve facilities to meet current and future demands was to build the new municipal port pictured here. And yet this fine field, built as recently as 1941, already is approaching its capacity of 50 planes-an-hour. You are looking across the runways (from the passenger terminal interior) of what's currently the best airport in the U.S. The old field nearby is still usable for small planes, but not much more. New airports are badly needed throughout the U.S. New York's LaGuardia is out-of-date. Even with huge Idlewild, New York may need another big airport in three years. Chicago has to use Douglas Field (Douglas Aircraft) besides the field at Cicero. San Francisco, Philadelphia, Phoenix – all have big expansion plans. Building airports is a tremendous task and will require tremendous joint effort by all concerned."**

1962

## The Last Word

1963

**After three years, the National airport at Washington, D.C., emerges as the last word in commercial service. Here are a few of its sidelights.**

***Popular Mechanics,* October 1941**

**RE: introduction to an article entitled: "National Airport Rests on 'Filled' River Bed." Between 1926 and 1938, *Congress* produced multiple (37) committee reports on the need for a new airport, but no action was taken. In the Fall of 1938, FDR announced at a press conference that he was "tired of waiting for Congress" to select a site for the new airport and stated that it would be built on mudflats on a bend of the *Potomac River* at *Gravelly Point,* 4.5 miles south of Washington, D.C. Two months later, on November 21, 1938, the first ceremonial shovelful of dirt was moved to signal the start of construction. Before the final site selection, flights were made over the area with representatives of airline pilots and year-round studies of weather conditions were made by the *U.S. Weather Bureau*. Several government agencies cooperated with the newly formed CAB in the construction of *Washington National Airport*. Additional assistance came from the *Works Progress Administration* (WPA), the *Public Works Administration* (PWA), the *U.S. Army Corps of Engineers* (USACE), the Department of the Interior's *National Park Service* (NPS) and the *Fine Arts Commission* (FAC).**

1964

**Left: caption: "A 1932 photo of the 14th Street Bridge over the Potomac River, looking from Virginia towards the District of Columbia. At the bottom left of the photo is Hoover Field, a major airport serving the city of Washington, D.C. The road (bottom, curving right) is Military Road. At the bottom right is the northern end of Washington Airport, another major airport serving the city."**

**Right: caption: "Looking NW along the Potomac River in 1938. Washington, D.C., is to the right, and Arlington County, VA, is to the left. The point of land jutting into the river at the bottom of the image is Gravelly Point. In September 1938, Pres. Roosevelt chose Gravelly Point as the location for a new airport, Washington National. Soil dredged from the bottom of the river would enlarge the Point so the airport could be built there. To the center-left of the image, just where the bridge lands on the VA side, are the runways of Washington-Hoover Airport."**

1965


**Caption: "Postcard issued in late 1928 or early 1929 showing 'Washington Airport' (later part of 'Washington-Hoover Airport') within the upper left circle on the far side of the Potomac River"**

1966

**Caption: "Aerial view of new Washington National Airport showing its four runways, 1941, the year of its inauguration. The deactivated Washington-Hoover Airport field can be seen at the empty land just northwest of the new airport."**

1967

**Most of the proposed airport site was underwater. Between November 1938 and December 1939, nearly 20 million cubic-yards of sand and gravel were moved onto the site. The airport was originally designed with four runways:**

- **the main north-south runway at 6,855 feet;**
- **a northwest-southeast runway at 5,210 feet;**
- **a northeast-southwest runway at 4,892 feet, and;**
- **an east-west runway at 4,100 feet.**

**On September 28, 1940, FDR laid the cornerstone of the terminal building at the dedication ceremony. The design, reminiscent of nearby *Mount Vernon,* represented an attempt to create a "modern" structure while still integrating architectural references to the Colonial and Neoclassical style/s. An observation terrace allowed visitors a spectacular view of the airfield. Over two million people visited the airport during its first year of operation (including 344,257 passengers). *Washington National Airport* opened for business on June 16, 1941 (FDR attended a ceremony and observed the first official landing). The airlines drew straws to determine who could land at the new airport first (*American Airlines* won the honor).**

1968

When it opened, ***Washington National Airport*** **was considered the "last word" in airports - a concentration of the ultramodern developments in design of buildings, handling of planes, air-traffic and field-traffic control, field lighting, facilities for public comfort and convenience and surface-vehicle traffic control. On February 6, 1998, President Clinton signed a bill into law that changed the name "Washington National Airport" to "Ronald Reagan Washington National Airport."**

**Caption: "The terminal and administration building of Washington National Airport, ca. early 1940s"**

1969


1970


1971

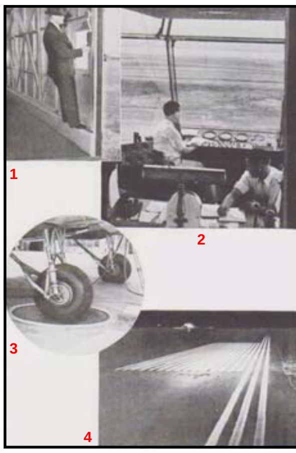

1972


1973


1974


1975


1976



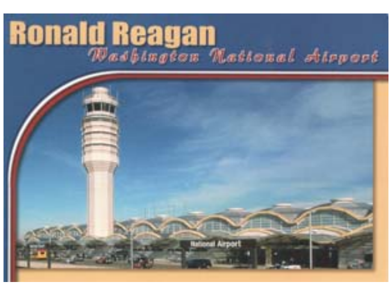

***"The airport, which cost $16,000,000, was built up from the Potomac River bed. It is the first airport operated by the Civil Aeronautics Administration."***

***Popular Mechanics,*** **October 1941**

**<u>Caption</u>: "(1) Operator, riding sliding door, opens and closes it by pressure of switch button; instantly as button is released the doors stop, reducing the chance of damaging planes that might be in the way. Hangar doors are intercommected and all move simultaneously but at different speeds so they all open and close together. (2) Interior of the air traffic control tower. (3) Tiny turntables on which the pilot can place one wheel and pull the plane around with his propellers. (4) Light-reflecting lines show pilot his position in relation to runway ends. There are 15 lines, 6 inches wide and 6 inches apart; they blend into a solid block at a short distance."**

1977

1978




1979

**Hurry-Up and Wait**

1980

*"…The big lines were a major part of the Air Transport Command, so they're all familiar with instrument flying. As an example, Northwest Airlines' planes, on their wartime run to Attu, were equipped with every safety instrument the Army, Navy, and the airlines were able to devise. Northwest's pilots on this run (notorious the world over for its bad weather) made a record that is something for Northwest to be proud of. Two round trips a day, day and night, almost always 'on instruments,' were routine. And yet, pilots on this difficult run turned in better operating results than were being maintained over continental United States. Why were they able to make such a record? You know the answer: instruments. Radar instruments and others, plus landing facilities…"*

***Science Illustrated,*** **February 1947**

1981

1982

***"…The war's over now, but the instruments are still there, and they are still doing the same marvelous job. The trouble is there aren't enough instruments and landing facilities to do the job the airlines would like. All lines and their pilots want the same facilities that helped on the Attu run, and others. They want them right away. But you want a new car . . . you want another apartment . . . you want a new coat of paint for your house. You can't get them. Neither can the airlines get the fields, approaches, instruments you think they should have for your speed, convenience, and safety. And they can't get them for the same reasons that you're on the waiting list…"***

***Science Illustrated,*** **February 1947**

1983

## Three-Miles-a-Minute Plus

1984

***"…In the next five years he will be flying faster, too. Yesterday's standard airline speed of 170 m.p.h (advertised tongue-in-cheek as 'three miles-a-minute') is being boosted right now with transports, some of them re-modeled from the war, that do 200 to 275 m.p.h. Even short-haul trans-ports like the new 14-seat Lockheed Saturn will travel 200…"***

***Popular Science,*** **September 1946**

**RE: in late 1946, Lockheed announced that it had decided to temporarily shelve development of the "Saturn," citing the lack of a reliable engine at the desired power rating. In Feb. 1947, Lockheed announced a renewal of the *Saturn* project due to the availability of the *Wright Cyclone* engine (which were fitted to the first prototype, above). Though flight tested, the project came to an end late in 1947. Despite an earlier announcement of 500 possible orders, Lockheed declared that the market was not strong enough to support the $100K unit cost.**

1985

***"…The 24-passenger Boeing 417, a pint-sized companion of the same company's Strato-cr-uiser, will fly at 196 m.p.h. The 40-passenger Martin 202 will make a bit less than 300; the 40-passenger Consolidated-Vultee 240 type, a full 300; the 52-passenger Douglas DC-6, a little more; the 80-passenger Stratocruiser, 340; the 200-passenger Consolidated-Vultee 37 model, 340, and the 46-passenger Repub-lic Rainbow, 400…"***

***Popular Science,*** **September 1946**

**Above:** ***Convair 240***

**Upper Left:** ***Boeing 417***

**Middle Left:** ***Martin 202***

**Lower Left:** ***Republic Rainbow***

1986

*"…All of these planes are on order. No deliveries to air lines will be made on any of them before the end of this year, and most of them won't be off the production lines until 1947 or 1948. The Convair 200-passenger job, commercial version of the U.S. Army's C-99, won't be flying before 1950…"*
***Popular Science,*** **September 1946**
**RE: Convair briefly considered building a commercial version of the XC-99 but, in the end, they built only one (left).**

1987

1988

**Flying High**

1989

*"…The airline customer may expect to fly higher. All the new transports except those devoted exclusively to short hauls will be pressurized for altitudes of at least four miles and new techniques will maintain sea-level pressure to as high as three miles."*
***Popular Science,*** **September 1946**

1990

**<u>Part 25</u>**

**Fade Away**

1991

**Still Flying**

1992

***"…Certainly, everyone who flew the DC-3 - which would stop production in 1945 as the next generation of passenger planes came on line - was devoted to the plane for its reliability, even in icing conditions or turbulence (today, at least 400 DC-3s are still flying, mainly on cargo runs, all around the world). 'The sheer strength of the DC-3 is what sets it apart,' says Holden. 'And it is a forgiving plane, incredibly forgiving of pilot error. At times, you could almost say, she flew herself.'"***
***smithsonianmag.com,* April 2013**

**RE: during WWII, the DC-3 and its military derivatives became so well known - and respected, it was hardly surprising that, from 1945 onward, DC-3s became the mainstay of newly formed and established airlines around the world. It was not the fastest, quietest or most luxurious post-war airliner and, although it was often described as: "a collection of parts flying in loose formation," pilots and airline operators liked to say: "The only replacement for a DC-3 is a DC-3." However, by the early 1960s, turboprop airliners such as the *Convair 580* surpassed the DC-3's efficiency as a regional airliner. They could operate from the same short runways as the DC-3 with similar fuel consumption but at greater range, speed and the added comfort of a pressurized cabin.**

1993


**Large numbers of C-47s were freed for use at the end of WWII, but airlines soon adopted the larger, faster DC-4s and DC-6s for their main routes. Smaller regional airlines (i.e. *North Central*) eagerly bought surplus DC-3s sold-off by major airlines such as TWA, AA and UAL, while surplus C-47s were readily transformed into cargo freighters.**

**<u>Caption</u>: "The Flagship Detroit was the 21st DC-3 built for American Airlines in 1937. This airplane is one of the oldest airworthy DC-3s in existence."**

1994


1995

## A Unique Challenge

1996

***"'IT groaned, it protested, it rattled, it ran hot, it ran cold, it ran rough, it staggered along on hot days and scared you half to death. Its wings flexed and twisted in a horrifying manner, it sank back to earth with a great sigh of relief. But it flew and it flew and it flew.' This is the memorable description by Captain Len Morgan, a former pilot with Braniff Airways, of the unique challenge of flying a Douglas DC-3…"***
***dailymail.co.uk,* February 25, 2008**

1997

## Workhorse of the Skies

1998

***"…For more than 70 years, the aircraft known through a variety of nicknames - the Doug, the Dizzy, Old Methuselah, the Gooney Bird, the Grand Old Lady - but which to most of us is simply the Dakota has been the workhorse of the skies…"***
***dailymail.co.uk,*** **February 25, 2008**

1999

***"…With its distinctive nose-up profile when on the ground and extraordinary capabilities in the air, it transformed passenger travel and served in just about every military conflict from World War II onwards.…"***
***dailymail.co.uk,*** **February 25, 2008**
**<u>Caption</u>: "1:32 scale model of the legendary DC-3, one of the most important aircraft in aviation history, with cockpit door open"**

2000

## Last Hurrah

2001

***"…Now the Douglas DC-3 - the most successful plane ever made, which first took to the skies just over 30 years after the Wright Brothers' historic first flight - is to carry passengers in Britain for the last time. Romeo Alpha and Papa Yankee, the last two passenger-carrying Dakotas in the UK, are being forced into retirement because of - yes, you've guessed it - health and safety rules…"***
***dailymail.co.uk,*** **February 25, 2008**

2002


***"…Their owner, Coventry-based Air Atlantique, has reluctantly decided it would be too expensive to fit the required emergency escape slides and weather radar systems required by new European rules for their 65-year-old planes, which served with the RAF during the war…"***
***dailymail.co.uk,*** **February 25, 2008**
**<u>Caption</u>: "The DC-3 served in World War II, Korea and Vietnam and was a favorite among pilots"**

2003

## A "Dakota" by any Other Name

2004

***"…Mike Collett, the company's chairman, says: 'We're very saddened.' The end of the passenger-carrying British Dakotas is a sad chapter in the story of the most remarkable aircraft ever built, surpassing all others in length of service, dependability and achievement…"***
***dailymail.co.uk*, February 25, 2008**
**RE: "Dakota" is an acronym for "<u>D</u>ouglas <u>A</u>ircraft <u>C</u>ompany <u>T</u>ransport <u>A</u>ircraft" (DACTA)**

2005

***"…It has been a luxury airliner, transport plane, bomber, fighter and flying hospital and introduced millions of people to the concept of air travel. It has flown more miles, broken more records, carried more passengers and cargo, accumulated more flying time and performed more 'impossible' feats than any other plane in history, even in these days of super-jumbos that can circle the world non-stop…"***
***dailymail.co.uk*, February 25, 2008**

2006

***"…Indeed, at one point, 90 per cent of the world's air traffic was operated by DC-3s. More than 10,500 DC-3s have been built since the prototype was rolled out to astonished onlookers at Douglas' Santa Monica factory in 1935…"***
***dailymail.co.uk*, February 25, 2008**

2007

## War Horse

2008

***"…When General Eisenhower was asked what he believed were the foundation stones for America's success in World War II he named the bulldozer, the jeep, the half-ton truck and the Dakota. When the Burma Road was captured by the Japanese and the only way to send supplies into China was over the mountains at 19,000 ft., the Chinese leader Chiang Kai-shek said: 'Give me 50 DC-3s and the Japs can have the Burma Road'…"***
***dailymail.co.uk*, February 25, 2008**

2009

***"…In 1945 a Dakota broke the world record for a flight with an engine out of action, travelling the 1,100 miles from Pearl Harbour to San Diego, with just one propeller working. Another lost a wing after colliding mid-air with a Lockheed bomber. Defying all the rules of aerodynamics, and with only a stub remaining, the plane landed, literally, on a wing and a prayer. Once, a Dakota pilot carrying paratroops across the Channel to France heard an enormous bang. He went aft to find half the plane had been blown away, including part of the rudder. With engines still turning, he managed to skim the wave-tops before finally making it to safety…Another DC-3 was peppered with 3,000 bullets in the wings and fuselage by Japanese fighters. It made it back to base, was repaired with canvas patches and glue and then sent back into the air…"***
***dailymail.co.uk*, February 25, 2008**

2010

## Was and Is

2011

***"…'The DC-3 was, and is, unique,' wrote the novelist and aviation writer Ernest Gann, 'since no other flying machine has cruised every sky known to mankind, been so admired, cherished, glamorized, known the touch of so many pilots and sparked so many tributes. It was without question the most successful aircraft ever built and even in this jet age it seems likely the surviving DC-3s may fly about their business forever'…"***
***dailymail.co.uk*, February 25, 2008**

2012

## The Long Goodbye

2013

***"…This may be no exaggeration. Next month, Romeo Alpha and Papa Yankee begin a farewell tour of Britain's airports before carrying their final passengers at the International Air Tattoo at RAF Fairford on July 16. But after their retirement, there will still be Dakotas flying in the farthest corners of the world, kept going with love, dedication and sheer ingenuity…It's long been an aviation axiom that 'the only replacement for the DC-3 is another DC-3.'"***
***dailymail.co.uk*, February 25, 2008**

2014


2015

## Buses of the Jungle

2016

**CARURU, Colombia - Quite suddenly, the endless green of Amazonian forest opened up, a river appeared portside and Flight 1149 softly banked along the water. And in the distance, a narrow strip became visible just past the treeline - a dirt runway, all ruts and holes. But that's all there is to this Amazonian jungle outpost of 800 souls, and few pilots have landed here more times than Capt. Ricardo Fajardo.**
***washingtonpost.com,* March 12, 2012**
**RE: introduction to an article written by *Juan Forero* entitled: "Aging DC-3s Serve as 'Buses of the Jungle' in Colombia"**

2017

## Link to Civilization

2018

***"'WE'RE here!' the captain said, as the Sadelca Airlines's twin engine prop, a DC-3 built during World War II, hopped along the runway and came to a stop. Out here in the Colombian outback – a roadless land dotted with nearly forgotten hamlets, straggling bands of Marxist guerrillas and grizzled soldiers of fortune searching for El Dorado – the only link to civilization is the DC-3 and Capt. Fajardo…"***
***washingtonpost.com,* March 12, 2012**

2019

***"…'There's nothing out here,' said Fajardo, a pilot for 44 of his 63 years, as he lifted himself from his seat. 'This airplane is everything here, everything.' This region bordering Brazil and Venezuela, 10 states where the Andean foothills sweep into flat plains that turn into jungle, is the size of France. But only 5 percent of Colombia's 46 million people live here, and the most isolated make their homes in villages carved out of the forest…"***
***washingtonpost.com,* March 12, 2012**

2020

***"…Those people-farmers, Indians who have migrated to villages, miners, store owners, even troops running down rebels - face arduous days on a river boat to get to a town of any size. Out here, the only fast, viable way to travel and move cargo is aboard the DC-3s operated by airlines with names like Air Colombia, Andean Airlines, the Airline of the Plains or Sadelca…"***
***washingtonpost.com,* March 12, 2012**

2021

***"…'There's no other way,' said Wilson Hernandez, a government technician who took Flight 1149 into the interior to oversee a construction project. 'You can go by water, but that can take weeks.' Colombia, with rugged Andean peaks and narrow and poorly maintained roads, long ago spawned pioneering air travel…"***
***washingtonpost.com,* March 12, 2012**

2022

2023

*"…The national airline, Avianca, is the world's second-oldest, founded in 1919. And these days, modern jets offer regular service to provincial capitals – just not here in the Amazon, a region whose dirt landing strips seem tailor-made for the durable DC-3…"*
***washingtonpost.com,* March 12, 2012**

2024

*"…'Here they call them the buses of the jungle, or the tractors of the jungle, because we fly over everything that is jungle,' said Carlos Martinez, one of the owners of Sadelca. 'These planes are 60 years old and, as you can see, they are intact. We find the parts and the pilots. And they can land on any strip, paved or not paved'…"*
***washingtonpost.com,* March 12, 2012**

2025

*"…Indeed, Hans Wiesman, a Dutchman who has researched DC-3s for a book and documentary film, said Colombia probably has the biggest fleet of flying DC-3s. He attributes that, in part, to the mechanics at the airport in this region's only city, Villavicencio, who have made a fine art of overhauling DC-3 engines. 'I was totally flabbergasted to see how they worked on those engines out there,' he said. 'They repair to new again'…"*
***washingtonpost.com,* March 12, 2012**
**RE: located between the foothills of the *Andes Mountains* and the edge of the *Colombian Plain,* Villavicencio, is the capital city of *Meta Province,* which is located southeast of Bogota, Colombia's capital city. It's known as the "Douglas DC-3 Capitol of South America." The city's airport has a single asphalt runway, which is 1,384-feet-long.**

2026


**<u>Caption</u>: "In the hey-day of the big prop-driven airliners, Villavicencio Airport was very active. Numerous companies with DC-4s, C-46s and DC-6s flew passengers and cargo to many savannah and Amazon destinations. Nowadays, the veteran DC-3/C-47 has taken over much of that work."**

2027

## A Plane From WWII

2028

***"…Introduced in 1935 by the Douglas Aircraft Co., the DC-3 revolutionized air travel, offering 14-berth sleeper transports that allowed passengers to fly from New York to Los Angeles. In World War II, they transported allied troops to Normandy and operated in the heat and sandstorms of North Africa and the frigid Arctic Circle…"***
***washingtonpost.com,*** **March 12, 2012**

2029

***"…That history was not lost on the passengers of Flight 1149 as it began a milk run - like most of the other flights in the region, on an ad hoc schedule - over the plains and into the jungle loaded with boxes of newly hatched chicks, big jugs of gasoline, a 32-inch LG television, boxes of flowers and a refrigerator…"***
***washingtonpost.com,*** **March 12, 2012**

2030

***"…'Yes, this is a plane from World War II, in fact one of the oldest that exists,' said Carlos Diaz, 42, moments after getting off at Caruru, where he serves the village government. 'But it is one of the surest planes around. That has been proven around here.' Still, an aircraft built in 1943 has its quirks, which means Jhon Rujana, mechanic, goes on every flight…"***
***washingtonpost.com,*** **March 12, 2012**

2031

***"…When the plane stops at some forlorn village, Rujana peers into the engine cowlings and looks for oil leaks, wrench in hand. When Flight 1149 is in the air, he stands between Capt. Fajardo and the co-pilot, flipping switches and pulling the yellow lever that lowers the flaps and the red handle that puts down the landing gear. 'You have to make sure the landing gear is down, that the flaps, the lights and pumps are working,' Rujana said after the flight stopped in the hamlet of Mitu, notorious here for having once been overrun by rebels…"***
***washingtonpost.com,*** **March 12, 2012**

2032

***"…At many of Colombia's provincial airports, decaying hulks of DC-3s that crashed lie covered in weeds, a reminder of the pitfalls of faulty maintenance…***
***washingtonpost.com,*** **March 12, 2012**

2033

**Real Flying**

2034

*"…Capt. Fajardo said he also uses his own intuition to detect problems. 'The DC-3 is a very noble plane,' he explained. 'But it is an old plane.' So he said that he has to be aware of vibrations in the engines, or any noise that sounds out of the ordinary. A few years ago, the engines began to go as Flight 1149 approached a runway. The captain of that flight – it was not Fajardo – determined the plane would not make it and opted to belly-flop in a rice paddy. The plane, though, was repaired – it always is – and Capt. Fajardo flew it out…"*
***washingtonpost.com,* March 12, 2012**

2035

*"…In an era of Boeing Dreamliners, Airbus A380s and aviation breakthroughs, the DC-3 gets praise from Capt. Fajardo and his co-pilot, Victor Valencia, for its simplicity and reliability. 'I tell you, they haven't been able to replace this plane and its performance,' Fajardo said. 'There may be superior planes, but at what cost?' Valencia calls piloting a DC-3 'another type of flying – real flying'…"*
***washingtonpost.com,* March 12, 2012**

2036

*"…Though the DC-3 has radar and GPS, Valencia said, there is no automatic pilot. Valencia and Fajardo keep track of where they are by noting the curve of a river or the thatched roofs of an Indian village they have flown over countless times. Such landmarks are easy to spot from a plane that travels at less than 130 mph and rarely higher than 8,000 feet…"*
***washingtonpost.com,* March 12, 2012**

2037


*"…Fajardo, though, acknowledged that the end may be near as the costs to keep DC-3s flying rise and runways in the outback get paved, making it possible for jets to land. Colombia may have more DC-3s hauling passengers and cargo than any other country, he said, but at most there are fewer than 10 serviceable planes left…"*
***washingtonpost.com,* March 12, 2012**

2038

*"…In the meantime, Fajardo said he will continue piloting Flight 1149, sure that he will reach his destination. 'The day you get nervous is the day you have to retire,' he said. 'Imagine getting nervous!'"*
***washingtonpost.com,* March 12, 2012**

2039

## Still Revolutionary

2040

**The Douglas DC-3 was introduced in the 1930s, played a key role in World War II, and still flies commercially today. How has it endured?**
***bbc.com*, October 10, 2013**
**RE: introduction to an article written by *Jonathan Glancey* entitled: "The Douglas DC-3: Still Revolutionary in its 70s"**
**<u>Caption</u>: "The U.S. Army Air Force used DC-3s extensively in WWII, like this Dakota transport variant flying urgent war supplies over Egypt in 1943"**

2041

***"LOG in to a live flight-track website and follow BFL168 as it climbs to 6,000 ft. and cruises at 155 mph (250 kph) just south of the Arctic Circle. This is a scheduled flight from Yellow-knife to Hay River in the Northwest Territories of Canada. You will see that the 45-minute trip, operated by Buffalo Airways, is nearly always on time…"***
***bbc.com*, October 10, 2013**

2042


***"…What might surprise you is the type of aircraft that makes this daily journey in what can be decidedly harsh conditions. No, not some smart new jet equipped with every latest safety device and digital gizmo, but a 28-seat Douglas DC-3 (twin-piston)…"***
***bbc.com*, October 10, 2013**

2043


***"…What this means is that the very youngest of the aircraft operated by Buffalo Airways on flight 168 are two years shy of their 70th birthday. And, if all goes to plan, the legendary DC-3 will be the first airliner to fly into its second century…"***
***bbc.com*, October 10, 2013**

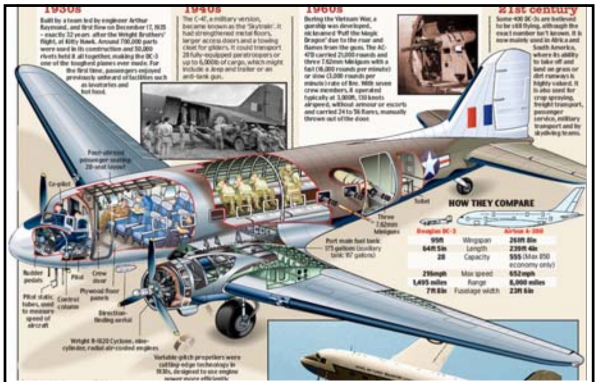
2044

***"…Altogether about 16,000 American, Russian and Japanese-built Douglas DC-3s, and also C-47 Skytrains, 'Dakotas', Lisunov Li-2s, and Showa and Nakajima L2Ds – the near identical military versions built in the 1940s – took to the air from December 1935…"***
***bbc.com*, October 10, 2013**
**<u>Caption</u>: "DC-3s served on both sides in World War II. Licence-built versions by Japanese plane-makers Nakajima and Showa flew against the Allies during the conflict."**

2045

**<u>Caption</u>: "DC-3s were also among the heroes of the Berlin Airlift of 1948-9 when Allied aircraft fed Berlin as Stalin tried to starve the city into Soviet submission. If ever an airliner deserved a medal, it was the Douglas DC-3."**

2046




*"…Around 2,000 fly today. Some of these sleek, stressed-metal aircraft are used for fire-fighting and crop spraying, some for rescue work, research and exploration, and others for freight, films, and joy flights…"*
***bbc.com*, October 10, 2013**

2047

*"…The DC-3 has flown through dramatic times. It seems a wonder that this beautifully-designed and engineered airliner should still be flying a daily scheduled route in northern Canada in the second decade of the 21st Century. But it does, and does it well: DC-3s have a long life ahead of them yet."*
***bbc.com*, October 10, 2013**
**Caption: "Dozens of DC-3s remain in service, with some even carrying on as airliners on scheduled services to this day"**

2048

***"Old soldiers never die, they simply fade away"***
***Douglas MacArthur*, U.S. Army General**
**RE: excerpt from his April 19, 1951 farewell address to *Congress***

2049


2050