

# A Potted History Of Airships

Aviation Week

Barbara Cockburn

Airships have been developed since the 1800s but Aviation Week began publishing 100 years ago, so it is worth noting that a revival was taking place as far back as November 1916 when we reported that the U.S. was to start work on a lighter-than-air-vehicle, another name known for airships.

## Lighter-than-Air Craft for 1917

It is safe to predict that great progress will be made in the developments in lighter than air craft in the United States in 1917. The United States Army has organized a lighter than air section at Fort Omaha, Neb., under Captain Charles de F.

Candler, and reports from officers who have seen the operations of these craft in Europe lead to the belief that substantial developments will be made in their construction during the coming year.

### Connecticut Aircraft Company

All types of lighter-than-air craft are being designed and will be constructed by the engineers of the Connecticut Aircraft Company, New Haven, Conn. This company delivered recently the first navy air-

the standard foreign type with large cylindrical bag and torrus or rudder. Tail cups are used for stabilizing purposes. The balloon has a capacity of 30,000 cubic feet of hydrogen. The main gas bag is built of a double texture rubberized cotton fabric cemented and sewn in the correct shape. It is equipped with a ballonet to maintain proper gas pressure in the bag. The advantages claimed for this type of military balloon are that its design gives minimum drift and maximum lift. A criticism has been that the use of the steering rudder or torrus causes greater resistance, but aerodynamic experiments have shown that the rudder simply acts as a stabilizer and the increase in resistance is very slight.

A new individual suspension patch developed by the company has just been announced. This patch is expected to revolutionize the manner of suspending weights from all types of non-rigid balloons. The patch eliminates the use of the old type belly-band suspension. It can be placed on the surface of the balloon at any point and at any angle and it saves considerable weight. In actual test of strength one of the new patches held over 1,700 pounds.



INDIVIDUAL SUSPENSION PATCH

dirigible DN 1 to the Pensacola Station, where it is being assembled. This dirigible is of the non-rigid type equipped with ballonets.

The company recently received an order from the Signal Corps, U. S. A., for an observation balloon of the latest type. This craft is now complete at the company's plant at New Haven. It represents

### The French American Balloon Company

The French American Balloon Company of St. Louis, Mo., is engaged at the present time in manufacturing kite balloons for the United States Government under a contract recently awarded to them. Plans and specifications for a big dirigible on Zeppelin lines are also being prepared. The company is also actively engaged in promoting a great national balloon contest for 1917.

### The Goodyear Tire and Rubber Company

The Goodyear Tire and Rubber Company, of Akron, Ohio, are devoting the efforts of their organization to the pro-



GOODYEAR BALLOON'S KEEL

duction of military lighter-than-air craft. It is thought that up to the present time the importance of kite balloons has been underestimated in this country.

One of the latest Goodyear products is 80 feet long and of 25,000 cubic feet capacity. The manufacturer claims that it will not shift, veer or yaw even in a stiff gale.

A journalist predicted in the February 1, 1917 issue of Aviation Week, that great progress would be made in developments of lighter-than-air craft in the U.S., and similar predictions for Europe were foretold.

All types of lighter-than-air aircraft would be designed and built by one company, the Connecticut Aircraft Co. Its qualification? It recently received an order from the Signal Corp for an observation balloon.

It had a capacity of 30,000 cubic feet of hydrogen. The main gas bag was built of double textured rubberized cotton, cemented and sewn together.

In 1925, the Goodyear Pilgrim performed its first flight at Akron, Ohio. It was 110 ft long, 45 ft. high, powered by 80 hp Lawrance radial engine. It could transport two passengers plus a pilot and motor mechanic.

It was known then as the world's smallest airship, and first commercial lighter than air craft inflated with helium. It was intended for pleasure cruising, but a demonstration ship would be built for certain tests and experimental work.

PW Litchfield, vice president of Goodyear said the future of these ships might bring mooring masts at country clubs, and on private estates and even airship regattas in the same way the motor boat and yachting clubs now have similar events.

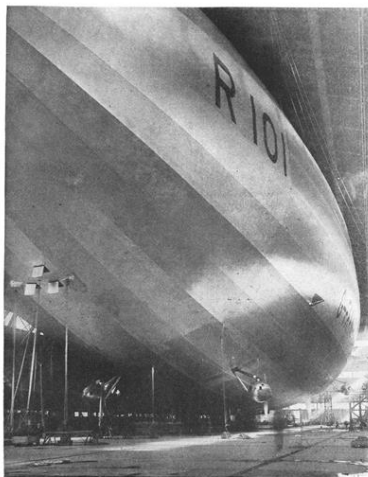
In 1927, Goodyear printed a booklet about the evolution of airships. The lighter than air vehicles take many forms, airships, balloon designs, non-rigid airships, semi-rigid airships, rigid airships, commercial and military uses of airships.

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Rear quarter view of the British State airship in her hangar at the Royal Airship Works, Cardington, England.

**T**HE STATE AIRSHIP, R101, is complete at last after some four years effort, in which the first 18 months was mainly devoted to pure research work in wind tunnels and upon the old R35, now broken up, and the last two years given to actual construction. By the time this dispatch appears the ship should have actually flown, but at the time of mailing she is waiting complete in the shed for a windless dawn to be manhandled on to the new mooring tower 200 ft. high at the Royal Airship Works, Cardington, 50 miles from London. [It was not until Oct. 12 that it was possible to take the ship out to the mast, and it was not possible to make the first test flight until Friday, Oct. 18.—Ed.]

Before she was due to leave the shed the Air Ministry permitted a very full examination of the completed ship, and also gave out certain details of weights and expected performance. These add considerable to facts previously made public, and in view of American interest in airship development some of the impressions which followed a careful examination of the ship may also be useful. It is not necessary to describe the general construction of R101 at any great length, as this is common property

better system of transfer of gas lift to the ship, and avoids all undesirable strains through surging of the gas or the deflation of one bag and consequent abnormal pressure conditions within the hull. [The use of duralumin and steel structural members together has been generally avoided in America. Dr. Dornier's flying boats furnish the most notable precedent for employing a composite structure of that kind.—Ed.]

**T**HERE HAS BEEN much criticism from a small but vocal band of opponents of airships at the delay in completing the R101 and the other vessel; but much of it has been completely ill-informed and it may be said that it has little substance as applied to the airship itself, but has some apparent force when directed to the actual expected performance. So far as can be judged at this moment, when the ship has not flown, there is not a single idea among the many novel features in the design and actual construction of the R101 which justifies destructive criticism; but undoubtedly the new Diesel-cycle engines of R101 have not come up to expectations and have seriously affected the performance.

## THE BRITISH State Airship R101

By AVIATION'S  
British Correspondent

These are eight-cylinder-in-line Beardmore Tornado Diesel engines, each cylinder with a bore of 8 1/2 in. and a stroke of 12 in., developing 585-650 hp. per engine. This is about 100 hp. less than was originally expected, and the engines have worked out very much heavier than was originally anticipated, two serious disappointments. The cumulative effect of the extra weight in the engines throughout the power nacelles, and of the modifications in the structure of the ship necessary for carrying this extra distributed load, has meant the addition of an extra 8 1/2 tons, and, of course, the passenger load is correspondingly reduced.

**C**ONSEQUENTLY the ship with her present engines is not expected to carry more than 52 passengers instead of the 100 for whom accommodations, on most comfortable lines, have been provided, and the top speed, already reduced by the fact that so far no hollow metal propeller has stood up to the torque of the engine, due in part to the high peak torque load in the Diesel cycle. This means that the variable-pitch propellers, the operating mechanism of which is otherwise satisfactory, cannot be used simply because the blades fail, and wooden propellers of fixed pitch have had to be substituted. This, in turn, has necessitated one power unit being reserved entirely for reversing purposes, being fitted with an airscrew for going astern, so only four engines totalling 2,430-2,600 hp. are available for forward speed.

Therefore, instead of a designed top speed of 80 m.p.h., the official estimate is now 70 m.p.h. with a cruising speed of 63 m.p.h., and to this extent the critics have been able to make capital out of the failure of the power units, and not of the airship itself, to come up to promise. But even with the present engines certain notable successes are being attained. When R101 takes the air she will be the first airship which does not rely upon gasoline. She has divorced that unpleasant companionship of hydrogen and volatile fuel; she is burning a fuel oil which costs \$25 a ton as against the \$125 needed for gasoline per ton. [In the U. S. this figure would be about \$70 for gasoline.—Ed.] The fuel, weight for weight, gives from 25 to 30 per cent more range; the engines have become simpler by the elimination of all electrical installation, and, so far as type tests can show, appear to be perfectly reliable within the powers at which they are now rated.

Wing Comdr. T. R. Cave-Brown-Cave, who is in charge of the machinery installation, is definitely satisfied

*Both of the British airships contracted for some five years ago are now nearing readiness for trial. Contrary to the general expectation a year or so ago, the government-designed ship is receiving its first test ahead of that constructed by Commander Burney and the Airship Guarantee Company. The designers of both ships have broken boldly away from past experience and Zeppelin practice, and have introduced a great number of structural innovations, which make their trials of acute interest to the whole world. In anticipation of the first flight of the R101, our British correspondent gives a number of details of its design and construction not previously available for publication.*

with it. The weight of these Diesels is, I understand, between 4 and 6 lb. per hp., taking only the engine. Wing Comdr. Cave-Brown-Cave says that they start up with the utmost ease, and more trouble is caused by the small auxiliary gasoline engine used to turn over the big ones for starting.

Perhaps the power eggs or nacelles, had better be explained in more detail at this point. Each is of excellent streamline form to reduce head resistance, and contains the main Tornado engine. Linked thereto by a clutch is a Ricardo four-cylinder gasoline engine. This engine is fed by a gasoline tank contained in the power car in a tubular tank. At the first hint of fire, a release handle is pulled, and the whole tank disappears into the blue. This auxiliary engine in two of the five cars can be clutched into an air compressor, the purpose of which

The British State airship R101 was completed in 1929. It took four years. The first 18 months were dedicated to "pure research work in wind tunnels" and the last two years on actual construction.

The writer described its construction: "The main longitudinal girders are triangular in section with booms, of high tensile steel strip drawn into tube form with duralumin webs and forged duralumin end fittings all attached to pin joints... which helps to improve the accuracy of the stress analysis."

At the time of this report [the later doomed] R101 had not yet made first flight, but the writer said that when it does take to the air it will be the first airship which does not rely on gasoline.

In May 1936 the Hindenburg flew on its first scheduled commercial flight across the north Atlantic. A sketch within the article is captioned: "A glimpse into the future. These sketches (showing passengers enjoying the view from the airship) are made from a study by Goodyear-Zeppelin Corp. and its accommodations compare favorably with those found on luxury steamships of today."

The writer said: "I believe the airship is destined to be successful in the transoceanic field because its inherent qualifications permit it to carry large payloads economically over large distances."

Sadly, however, The Hindenburg burst into flames in 1937, bringing into question the future of airships.



**GOODYEAR ZPG-3W**, airborne early warning airship, carries a 40 ft. search radar antenna within its helium envelope. Pod atop the airship contains height-finding radar. The 403 ft. blimp has an absolute ceiling of 10,000 ft. and a useful load capacity of 22,907 lb.

## **First Goodyear ZPG-3W Blimp Delivered**

In July 1959 the first of four Goodyear airborne early warning airships was delivered. "The ZPG-3Ws are the largest non-rigid airships ever built, at 1.5 million cu. ft. helium volume, and are being produced by Goodyear under a \$48 million Navy contract. It has a large antennae carrying capability, has long endurance, easy station keeping over a fixed geographical position, and lower noise and vibration."

The airship power plants are two Wright R-1820-88 engines rated, 1525 hp. Maximum fitted with Curtiss Electric propellers.

In 1984 the US Navy wanted an airship capable of performing coast guard missions which would fly with turboprop engines in 1989.

From 1987 the US Navy funded the project. Then discontinued its support due to budget cuts. However, the Navy followed to program with much interest according to a Westinghouse official.

Airship Industries partnered with British firm Westinghouse to produce a design to meet the Navy's needs. It would provide real-time data on the location, movement and identification of air surface and subsurface targets. The Sentinel 1000 had its first flight June 26, 1991.

In 2008, Aviation Week reported on airship manufacturer Worldwide Aeros ' "new class of aircraft", much like an airship with gas buoyancy, aerodynamic lift, and thrust vectoring for better performance and operability than traditional airships."

The Aeroscraft ML866 is a 210 ft. long vehicle aimed at the business aviation market. It is a buoyancy-assisted aircraft with adjustable static heaviness. Its key technology is the dynamic buoyancy management system. "The control of static heaviness works by compressing storing, then decompressing helium within the envelope to adjust the vehicle's buoyancy. Aeroscraft ML866 is a 210 ft. long vehicle aimed at the business aviation market. It is a buoyancy-assisted aircraft with adjustable static heaviness. Its key technology is the dynamic buoyancy management system. "The control of static heaviness works by compressing storing, then decompressing helium within the envelope to adjust the vehicle's buoyancy.

"Static heaviness is the ratio of buoyancy to gravity; it is increased to land, and decreased for takeoff."

The ML866 was five times that of a large business aircraft with a huge cabin area of 5,400 sq. ft. and would be able to carry 28 passengers.

# Rise of the Airship

The need for persistent surveillance could give airships a new lease on life

GRAHAM WARWICK/WASHINGTON

**A**irships are survivors—a genus of aircraft that has been around since the dawn of aviation and is now being offered another chance at lasting success. This time the mission is persistent surveillance, but can undisputed endurance carve out a role for unmanned airships that lasts beyond today's war?

As it embarks on a \$517-million contract to develop the Long-Endurance Multi-Intelligence Vehicle (LEMV) for deployment by the U.S. Army to Afghanistan in early 2012, Northrop Grumman believes the unmanned airship can find long-term roles in border security and disaster relief, as a communications and

surveillance platform. "There is a lot of emphasis on today's war, but tomorrow the airship can provide inexpensive surveillance," says Alan Metzger, Northrop Grumman LEMV program director. The vehicle will use 15,000-20,000 lb. of fuel to stay aloft for 3-4 weeks in the surveillance role. "That's only \$20,000-25,000," he says. The Army calculates it would take 12 MQ-9 Reaper-class fixed-wing unmanned aircraft and their crews to sustain the same mission.

The LEMV's role is to maintain continuous surveillance over a wide area, providing correlated video, radar and signals intelligence data to the brigade combat team on the ground. Stripped of its sensors and long-endurance fuel tanks,

the same vehicle could lift 20 tons of cargo with minimal modification, says Metzger, adding: "Airships are not for everything, but there are opportunities they are suited for. It will come down to economics."

Part of Northrop Grumman's optimism is built on the characteristics of the hybrid airship, a heavier-than-air design that combines buoyant, aerodynamic and propulsive lift to provide extended endurance in a vehicle that is easier to operate than traditional lighter-than-air craft. The efficiency of aerodynamic lift is key to LEMV being able to provide "unblinking eye" surveillance from 20,000 ft. for at least 21 days, carrying a 3,500-lb. payload of sensors.

Northrop Grumman's partner in the LEMV program is Hybrid Air Vehicles (HAV), custodian of the long legacy of Airship Industries and a pioneer in the development of hybrid airships. HAV is responsible for design of the LEMV air vehicle, and the 300-ft.-long, optionally



Northrop Grumman's LEMV will orbit unmanned for at least three weeks at 20,000 ft. carrying a 3,500-lb. payload of sensors.

manned platform, called the Condor 304, is scaled up from the HAV's unmanned demonstrator the U.K. company has been flying for some time.

The endurance goal would be "difficult to do with a conventional airship," says Gordon Taylor, HAV's sales and marketing director. About 60% of the lift is aerostatic, from helium buoyancy, and the remaining 40% is aerodynamic, from the vehicle's shape. "We take advantage of aerodynamic lift in flight for the sustained capability," says Kelly Whalen, Northrop Grumman strategy development director. Additionally, powered lift is used during takeoff and landing by vectoring the thrust from four ducted propellers.

The Army wanted a vehicle that could be delivered within 18 months, so Northrop Grumman looked for a low-risk design and an experienced partner, says Metzger. The companies that preceded HAV developed the Skyship 500 and 600 commercial airships and the Sentinel 1000, a half-scale demonstrator for a U.S. Navy airborne early-warning airship that never materialized. Roger Munk, who formed what became Airship Industries and began development of the hybrid airship, was HAV's president and technical director until his death in February.



Hybrid Air Vehicles' one-sixth linear scale HAV3 demonstrator is being used to develop control laws for the 300-ft.-long LEMV.

In 2010 Aviation Week featured a new generation of airships capable of "persistent surveillance".

"Airships are survivors", having been around since the dawn of aviation, but questions whether "an unmanned airship can last beyond today's war?" Northrop Grumman believes so, and that it has a role to play in border security and disaster relief as a communications and surveillance platform."

"Airships are not for everything," said a company executive, "but there are opportunities they are suited for. It comes down to economics."

Northrop Grumman's long endurance multi-intelligence vehicle (LEMV) would be able to provide surveillance for 21 days from 20,000 ft.

It would work with Hybrid Air Vehicles (HAV) – companies which preceded HAV developed the Skyship 500 and 600 and the Sentinel 1000, which never materialized.

The LEMV, "an aircraft the size of an A380 with rotating engines" flew for 90 mins. on its first flight on August 8, 2012, "a remarkable achievement to go from concept to first flight in 25 months."

Hybrid Air Vehicles, a U.K. airship developer launched the "return-to-flight" program for its Airlander 10 vehicle back in 2015 and has now begun flight tests. The Bedfordshire-based company is rebuilding the 302-ft.-long HAV304/Airlander 10 after acquiring it from the U.S. Army following cancelation of the Northrop Grumman-led Long-Endurance Multi-intelligence Vehicle (LEMV) program.

The craft is awaiting its Permit to Fly from the U.K. Civil Aviation Authority and the European Aviation Safety Agency. A first flight date has yet to be set.