Title: Engineers Visit Zep

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Issue Date: Feb-1931

Publisher: Ohio State University, College of Engineering

Citation: Ohio State Engineer, vol. 14, no. 4 (February, 1931), 4-5, 16.

URI: http://hdl.handle.net/1811/34746

Appears in Collections: Ohio State Engineer: Volume 14, no. 4 (February, 1931)

ENGINEERS VISIT ZEP

By ALBERT W. CONNAR, C.E. 1

The engineering students of the Ohio State University were given an opportunity to visit the world's largest dirigible and its gigantic hangar at Akron, Ohio. Both the aircraft and the building in which it is housed are of great interest to all engineers of today.

The industrial engineering department under the supervision of Professor John Younger, obtained permission to visit the hangar. The invitation was not limited to the industrial engineers but was extended to all the departments. Two hundred and sixty-five students assembled at the Union Station at 7 o'clock, Sunday morning, February 1, to go to Akron. Sixty other students, of a more or less adventurous nature, journeyed to the same place by auto.

Upon their arrival at the Akron Union Station they were met by buses furnished through the courtesy of the Goodyear Zeppelin Corporation, which transported them to the hangar. The airdock is located in the southwest corner of a large valley which has been filled up to provide a level landing field for the ships. Our first view of the structure was from the tops of the surrounding hills and due to the fact that we were looking down on the dock, it seemed very much smaller than what we had expected. Our disappointment was not removed entirely on closer approach because there was no other structure nearby by which we might form a comparative estimate of its immense size.

Our only means of establishing a true conception of its real size was by means of the lettering on top of the roof. Each letter of the words "Goodyear Zeppelin" appeared to be three or four feet high, but actually was twenty-two feet high and ten feet wide. Aprroximately two gallons of paint were required per coat per letter.

The unusually cold weather made us doubly anxious to get inside of the huge building, not only to see the ship, but also to seek protection from the cold wind. When we first entered, the temperature seemed warmer, but in less than a half hour we were quite cold. The guide explained that the average inside temperature did not vary more than ten degrees from that on the outside. We soon forgot our discomfort as there were before us things that were vastly more interesting than the weather. Engineers have tried to heat the building but have been unsuccessful in the attempt. They have estimated that the best heating system known would cost approximately $1,000,000 a month to operate, and would not raise the temperature more than five degrees.

The two doors on the airdock are of the "orange peel" type, each door consisting of two quarter sections of an approximate sphere. The sections are mounted on a number of four wheel trucks which run on standard gauge railroad rails. An electric motor of 125 h.p. for each section revolves a huge horizontal gear which meshes with cogs in the side of the door. The secret of success in using doors of this type is in having the radius of the section greater than half the diameter of the building. A solid king pin, 48 inches long and 17 inches in diameter, provides sufficient bearing area for a section of a door. Opening and closing is a rather expensive proposition since its costs one dollar to complete one cycle of moving the 600 ton doors.

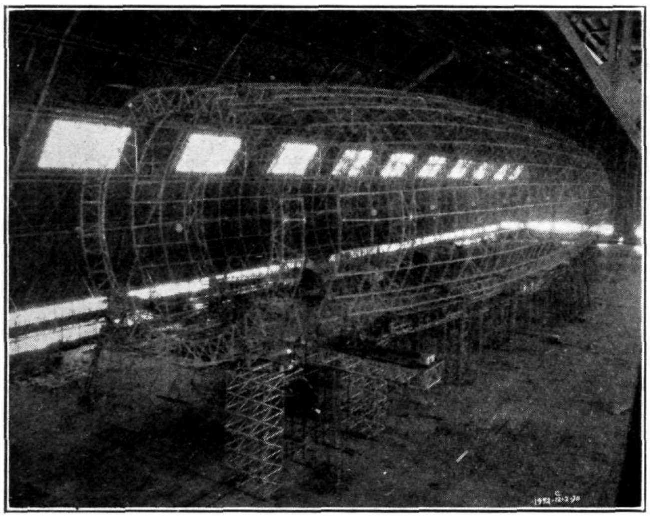
The hangar is the largest building in the world without a center support. Some idea of its size may be gained from the following comparisons. It is 1175 feet long, 325 feet wide and 211 feet high, which corresponds to the height of an ordinary twenty-two story apartment building. The Woolworth building and the Washington Monument could be housed within its spacious interior at the same time. The volumetric contents of the structure is estimated at 45,000,000 cubic feet and ten football games could be played at the same time on its spacious floor.

The statement that the building will expand and contract 16 inches from one extreme of weather condition to another, is incredible to the average layman, but it is an actual fact. This longitudinal variation of length is taken care of by mounting all of the arches except the center one on rollers. This permits each half of the hangar to move eight inches. Lateral expansion is taken care of by so designing the arch that it will move up or down as the stresses dictate; a hinge at the center of each truss facilitates this movement. In addition to supporting their own weight, the arches also carry the superimposed loads of five cranes that run on parallel tracks at the top of the dock. Four of them are of the monorail type while the fifth is a two-track crane. They are used to lift parts of the ship to the proper position and also act as working platforms for the men.

The regular visiting crowds are permitted to go only a short distance beyond the ends of the doors which is still several hundred feet from the nose of the ship. The special privilege extended to the Ohio State students enabled us to walk down along the side of the ship toward the tail where we saw the last sections and the fins being constructed and put into place.

The nose of the huge ship was practically completed and as we walked towards the other end, the enormity of the craft became more evident. The skeleton built of thousands of tons of duraluminum without a single knee brace or cross brace was easily recognizable as a masterpiece of engineering.

Illumination is provided by 12 windows in each side of the hangar about half way up the center. A series of smaller windows extends around the base of the dock but does not enter into the illumination problems at the top of the ship. Looking up at these sky-lights one has the impression that they are of about the size of the ordinary house sash, but in reality they are 24 feet by 42 feet or large enough to drop an average house foundation through. These mammoth windows are the source of the greater part of the illumination. However, local lighting units are used for the more detailed part of the work.



Zeppelin Frame under Construction.

To facilitate work on the underside of the ship, ladders having small platforms large enough for one man to work on are used. They are mounted on four-wheel trucks in much the same fashion as is seen on the modern city fire fighting apparatus. Swinging platforms suspended from the overhead cranes expedite the erection on the upper part of the skeleton. Experience has proven that the cold affected only the hands and feet of the men who were obliged to climb around on the framework. Local electric heaters have overcome this difficulty.

An elevator of the small cage type operates along the underside of the roof, carrying men and tools to the top of the hangar. A unique feature of this elevator is that although the track follows parallel to the curvature of the roof, the platform of the cage always remains level. This is accomplished by changing the relative position of the wheels under the cage. To reduce the cost of operation, another cage on the opposite side of the hangar acts as a counter-balance, the former one going up when the other one is coming down.

The framework of the ship consists of two kinds of transverse rings, the main ring and the intermediate rings. The main rings are constructed by lacing together three rings with secondary girders so connected that they form triangles within themselves. The intermediate rings are seen to be connected to the main rings by longitudinal girders. Another remarkable feature is that all the members are of the same size, the only exceptions being the motor connections. The rings are hoisted into place and their alignment determined to the hundredth of an inch with a transit. The number of intermediate rings placed between the main rings varies from one to three, depending upon the stress.

The most remarkable feature of the whole structure is the method of transmitting the loads of the lifting gas cells to the skeleton structure itself. All the direct lifting loads and all of the diagonal stresses produced by air currents will be resisted by small piano wires. These tiny threads, as they might be called, are drawn from special heat treated steel and develop a unit tensile strength of 140,000 pounds per square inch. To eliminate the secondary stresses imposed by direct connection of the wires from a center point of the main rings to the ring itself, the wires are curved in such a fashion that their contraction will merely reduce the amount of curvature and not increase their stresses.

The wires in the plane of the main rings also serve the purpose of dividing the ship into twelve compartments. There are no transverse wires in the intermediate rings. Ramie netting panels, a specially designed cord netting, prevent the gas bags from chafing on the framework.

The gas cells are made of gold beater's skin which is practically leak-proof, but at the same time so thin that its weight is very small in comparison with the weight of other parts of the ship. Over-pressure gas valves will be located near the top of the bags and may be operated either automatically or mechanically.

Three cat-walks will be constructed within the giant zep to enable the crew to pass from one end to the other while the ship is in flight. One of these is in the top and the other two appproximately one-third of the circumference down from the first. The term catwalk probably derives its name from the similarity of these walks to the backyard fence since they are only nine and one-half inches wide. To maintain repairs on the outer fabric, the gas bags will be kept about five feet on the inside of the frame work. A ladder completely encircling the ship is to be built within each main girder.

Platforms will be built near the main rings and within the ship to support the eight motors that develop a total of 4480 h.p. Power for driving the propellers will be transmitted from the engines through horizontal shafts terminated by bevel gears which allow the propeller to revolve parallel to the shaft. Each one can be tilted through 90 degrees and also changed from full speed ahead to full speed reverse in less than a half a minute. This feature will be of great value in assisting in raising or landing the ship.

An installation of 170 gasoline tanks of 140 gallons capacity each will be the storage reservoirs for fuel. A special system of condensers condense the water in the exhaust gases which will then be pumped into tanks to compensate for the loss of weight by the burned gasoline.

The control cabin is located near the nose of the ship and contains the latest devices for navigation. Men stationed at the engine room will operate the motors in accordance with the instructions as sent down by the signal system.

At the time of our visit the workmen were just starting to put the fabric covering on the nose. This material is patented and is very light, weighing only about 2.9 ounces per yard. It undergoes succesive applications of spraying and stretching before finally assuming its permanent shape.

The ship when completed will be 785 feet long, by 132.9 feet in diameter with a gross lift of 403,000 pounds and a useful lift of 182,000 pounds. Its cruising range will be 10,580 miles and will develop a maximum speed of 84 miles per hour. One hundred passengers may be carried in addition to a crew of from fifty-five to sixty. Special devices are to be included whereby this mighty monarch of the air can carry five airplanes within its hull. The planes will be able to leave and return to the ship while it is in flight.

This is undoubtedly one of the greatest engineering projects under construction today and

(Continued on Page 16)

ENGINEERS VISIT ZEP

(Continued from Page 5)

indeed was a sight that will be long remembered by the engineering students that made the trip. It was of great educational interest and we hope that it has been a source of inspiration to those who made the trip.