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CONTRIBUTION TO THE TECHNIQUE OF LANDING LARGE AIRSHIPS

By O. Krell

PART I

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PART I.*

The chief thing in landing is to expose neither the craft nor its occupants to harm. This applies to both air and water craft. The danger of the landing shock increases with the size of the craft, and still more with its speed at the moment it comes in contact with fixed objects on the earth's surface. The smoothness of a landing depends on the sensitiveness of the pilot to kinetic energy. How great the difference in this sensitiveness may be, is illustrated by the two following cases. One submarine commander brought his craft smoothly alongside the dock with three maneuvers, while another commander gave 84 orders to accomplish the same result. Many aircraft pilots fall off on one wing or did tail slides with their craft before Pegoud demonstrated the practicability of his spirals and loops. It is a thankless task continually to point out the importance of the role played by the sensitiveness to kinetic energy possessed by constructor and pilot, as this inborn feeling is seldom found in educated technicians.

*"Ein Beitrag zur Landetechnik grosser Luftschiffe," from Zeitschrift für Flugtechnik und Motorluftschiffahrt, September 28, 1928, pp. 401-421.

Even with the comparatively small volume of a free balloon, the elegance of the landing depends on the accurate appraisal of the force of gravity. One who possesses this intuition is enabled to make an intermediate landing in the heart of a city and step out of the balloon basket right in front of the entrance to an aircraft factory, which would not be unlike some of the exploits of Robert Petschow, to whose kindness I owe the fine picture (Figure 1) of a "smooth" landing of a free balloon. That such a situation as that depicted should be called a "smooth landing," is proof that in a free balloon one must be prepared to make landings under all sorts of conditions. In free-ballooning there is little means of mitigating the landing shock. The more thrilling is it, therefore, through expert handling, to accomplish an artistic landing.

With heavier-than-air craft the difficulties of landing lie in the fact that, in order to develop the necessary lifting power, they must have a certain amount of horizontal speed even when landing. With this speed the aircraft taxi on their landing gears or floats on land or water, and obviously there must be no obstacle in the way of this horizontal motion if the aircraft is not to be damaged. For this reason efforts have been made to shorten the landing run of aircraft, as shown by Figure 2, in which the operation of a braking device may be seen, which was brought out in a competition for shortening the landing run.

Lighter-than-air craft do not suffer under this necessity

of heavier-than-air craft to provide themselves with dynamic lift. On the other hand, the construction, which is necessary in an airship to hold the lifting gas, so increases its volume and mass that contact with fixed objects on the ground is dangerous. In order to increase the useful lift (i.e., the carrying capacity), it is necessary to increase the gas capacity and hence the size of the airship. Thereby, however, large surfaces are presented to the wind and consequently, the forces exerted on the airship will soon pass beyond control by ordinary means, less because of the inability of the men and mooring devices to withstand these forces than because the airship itself will not be strong enough to withstand the forces exerted on the mooring lines.

An altogether new landing technique was demonstrated by the constructors of the Siemens-Schuckert balloons in the use of a revolving airship shed. The Siemens-Schuckert airship, with its original 13,500 - later 15,000 m³ gas capacity - exceeded at that time even the Zeppelin airships with their 12,200 m³, and consequently the landing maneuver presented the greatest problem of the whole undertaking. Nearly all of the ideas which were presented later for the mitigation of landing dangers were then tried out by them until they were convinced that only a revolving shed would would solve the problem. To the technical daring of Engineer Janisch and the great initiative of Wilhelm Von Siemens must be credited the fact that, in spite of about

50,000 marks greater cost, the wishes of the constructors in regard to a revolving shed were carried out. This shed was in use for 4.5 years and sheltered in turn the various types of German airships, proving during that time its outstanding value. Nevertheless, this revolving shed in Biesdorf remains today an unfollowed example, partly on account of the unwillingness of the Zeppelin Company to try other ways, and partly owing to the conditions of the war.

Even before the war, the German Navy had decided, on account of the favorable results of the Biesdorf shed, to erect a revolving shed near Kuxhaven. The Siemens-Schuckert Company were unsuccessful in their efforts to convince the Navy that a double shed would not have as favorable air-current conditions as a single shed, and so it was decided to build a double revolving shed near Nordholz, especially in view of the much greater cost of building two separate revolving sheds for one airship each.

We will return later to the subject of the floorless revolving sheds whose design and construction were undertaken by the Army, but it may be pointed out here that they were torn down before they were completed, so that, up to the present time, the only experience had in docking airships in revolving sheds has been with the sheds at Biesdorf and Nordholz. Every possible type and combination of types of sheds has been proposed, but as yet they remain on paper. In England and America, however, as a substitute for the expensive revolving sheds, they

have developed the mooring mast. The saving in cost was also the reason for the application for a patent, in July, 1910, on the "Ankermast" with all its unique features, by the author of this article through the Siemens-Schuckert Works in Germany. Through the lack of understanding by the patent examiner at that time, the application met with such great opposition that, after 15 months of wasted effort, it was dropped by the Siemens-Schuckert Works since, in view of the success of the revolving shed in Biesdorf, it could no longer be of any great interest to them.

Many treatises in regard to construction of airship sheds are lacking in data on air currents, for which reason this phase of the problem will be here thoroughly discussed in connection with the accompanying photographs of currents. In the absence of actual experience with air streams, these photographs give valuable information in regard to the currents to be anticipated. The pictures published here were produced by that master of flow-line photography, Professor Fr. Ahlborn of Hamburg, with the assistance of Dr. Wagner, at my request, and I must not fail to express here my deepest gratitude to these two gentlemen for the great interest and unfailing perseverance which they contributed to the carrying out of my wishes.

In spite of the great need of better docking facilities for airships during the war, the conditions of the war itself made this interest subordinate to that of building the airships.

The increased man power required for handling the large airships was comparatively easy to provide, while time was lacking for the technical solution of the problems of docking. The use of rails to bring the airships into the sheds, as well as the use by some operators of storm doors or screens at one end of the shed to divert wind currents, were only temporary makeshifts to offset the fundamental defects of fixed hangars.

Figures 3 and 4 show that the entrance into the shed can be made easier in this way, even with wide, roomy sheds inside of which the eddies are not entirely negligible. The American patent of P. Jaray, September 9, 1924, is based on the idea shown in these two photographs.

The advantages of airships over airplanes as a means of transportation are certainly great enough so that we may expect their continued use, especially for long distances. This fact has led me to develop further the idea of a revolving shed, especially because its principles are generally misunderstood, as evidenced by various useless proposals.

Without assigning any exaggerated power of proof to the photographs, they are certainly well suited to facilitating the difficult task of explaining air-flow phenomena. It seems to me that the demonstration of the existence of these currents and eddies in a naval towing tank is evidence that similar formations may be expected in the air-flow stream.

It is owing to the devoted work of Professor Ahlborn that

I have such a valuable series of flow pictures, and I wish to give a description of his work as an introduction to the study of the airship landing problem.

The towing models of sheds and airships were about twice the size of the pictures shown here, 12 cm in height, and so mounted on the towing platform that they projected $\frac{1}{2}$ cm above the surface of the water. The surface of the water was sprinkled with lycopodium powder, and a relatively long exposure of 0.1 second was chosen for the photographic camera, which was mounted on the towing platform over the models, in order to obtain lines showing the character of the flow rather than the dots that would have resulted from an instantaneous exposure. There has been absolutely no retouching of the accompanying flow pictures, in order not to rob them in the least of their documentary value. In all the flow pictures, the direction of flow is from left to right.

Figures 5 to 8 represent revolving sheds for one airship, pointed in the direction of the wind. In all these pictures the eddies on the lee side can be plainly seen, and it will be noted that the smooth flow narrows these eddies to the width of the sheds, at least immediately behind the end of the shed. The various photographs were taken in order to show the effect of different forms of end construction on the air flow. As was to be expected, the strongest eddies were formed to the left and right of the head of the shed with the square end, while they were weakest around the shed with the rounded head. In Figure 8 an effort was made to imitate the construction of the Biesdorf shed, in which the uncovered steel structure projects from the sides, by inserting small metal plates in the model. It is seen that this completely eliminates the eddies behind the head of the shed and does not in any way disturb the smooth flow past the shed. The eddy formations, under closer scrutiny, prove to be the same as Professor S. Bastamoff found in his wind tunnel at Kutschino, near Moscow. He also used lycopodium powder and photographed the traces left on the walls of the wind tunnel by the wind currents. Through the kindness of Mr. Bastamoff, I am able to present here two very good pictures (Figs. 9 and 10), in which the formation of eddies between the walls or screens may be seen. These photographs also serve another purpose, namely, to point out how carefully rain gauges must be installed if erroneous results are to be avoided. In Figure 9 the gauge is seen to the left, while in Figure 10, it is installed between the two slightly separated walls.

If, now, the model of an airship is brought into the current behind the shed, the eddies are suppressed (Figure 11), and the smooth flow adheres to the streamlined form of the airship body, affording it trustworthy guidance. So long as the eddies are not too great in extent in comparison with the size of the airship, either their pressure on the airship will be evenly distributed, or else they will be completely suppressed, as shown in the experiment. At the Biesdorf revolving shed an effort was made to force the airship sidewise out of the axis of the shed. The strength of the wind, however, was such that the effort was not successful. The two photographs (Figures 12 and 13), show the flow produced by the airship when at different angles with the axis of the shed. It is seen that the directional force is affected on the one hand by the pressure of the smooth flow on the airship's surface and, on the other hand, by the strong suction produced by the eddies in the lee of the airship. These experiments show that the directing force of the wind has such an effect that the airship tends to assume a position in the smooth side currents behind the shed and to continue in the axis of symmetry of the stream, whereby the suction and pressure forces of the stream are equal on both sides. In this knowledge lies the key to the fact that the double revolving shed at Nordholz offers much less favorable conditions for taking airships in and out of the shed than does the shed in Biesdorf, which is for one airship only. At the latter shed the military airship M IV was easily docked by a small landing crew in a 16 m/s wind, whereas at the Nordholz shed, walking an airship in or out of the shed was very difficult, even with a wind of only 5 to 6 m/s, and in gusty weather it was impossible.

This experience with the Biesdorf revolving shed, often repeated in equally strong winds, is the most valuable contribution from the history of the Siemens-Schuckert Airship Company, to aeronautics. According to "Der Krieg zur See," 1914-1918, published by the Marine Archives, none of the airships of the Nordholz air station were able to take off at the hour designated by the commander, for reconnaissance before the battle of Jutland. Our air fleet was not able therefore to avail itself fully of its one great opportunity of the war (reconnaissance before a great sea battle), because of the lack of properly arranged revolving sheds. Figure 14 shows the flow around the double shed at Nordholtz. The airship is obliged to enter at one side of the axis of the double shed, first because the shed is divided through the center by a partition, and second, because even if there were no partition, the other side of the shed might be already occupied. On account of being obliged to keep on one side of the axis of the shed, the airship is scracely touched on one side by the smooth flow while, on the other side, it is exposed to the strong drag of the eddies, so that with a sufficiently strong wind it will be thrown against the dividing wall. A view of the double revolving shed in Nordholtz is given in Figure 15. This shows the very ingenious doors (the idea of Engineer Janisch), like folding blinds or screens. These avoid the formation of eddies, which is always occasioned by opening doors which stand out at right angles to the axis of the shed.

In Figures 16 to 18 an effort is made to show the air flow which would be found around the big shed at the American air station in Lakehurst. The flow pictures show the shed with open

doors. Figures 16 and 17 show the air flow with the wind in the direction of the shed's axis. The strong eddies in the lee are chiefly due to the open doors. These eddies are so great that they would act as currents on the airship. In Figure 17, through a slight dissymmetry in the flow, the eddies also become unsymmetrical. Under these circumstances an entering airship would unfailingly be driven against the left wall of the shed. Figure 18 shows the same shed in an oblique wind of about 20°. The strong eddies in the lee would make it impossible to take the airship into the shed safely. The air flow around the Biesdorf shed in an oblique wind was also investigated. Figure 19 shows that some of the lee eddies push around the side of the shed up toward the head. Under these conditions and with a strong and gusty wind, an airship attempting to enter would be "wound around the shed," as it is expressed in airship circles.

Opinions in regard to the great shed at Lakehurst differ so widely, that a more minute study of the question of air flow around this structure will be helpful. The shed is 64 meters high, and 106 meters wide. The LZ-126 (LOS ANGELES) being only 31 meters high, her cross section is almost lost in the enormous entrance of the Lakehurst shed. The disproportion of its size to the size of the entrance is apparent; whereas, with an entrance corresponding in size to the size of the airship's cross section, as in revolving sheds intended for only one airship (e.g., the Biesdorf shed), the eddies in the entrance disappear

the minute the nose of the airship enters the shed. In the great entrance of the Lakehurst shed the eddies remain and constitute a danger to the airship even after entering. Also, the vertical air currents become more troublesome on account of the difference in height of the airship and of the entrance to the shed, as shown in Figure 20 (regarded as an elevation). Here the eddies fall from the high roof of the shed down on the top of the airship and, with a gusty wind, downward gusts may be expected, while, as seen in Figure 21 (also regarded as an elevation), the vertical gusts are lacking at the Biesdorf shed, whose height corresponds better to that of the airship.

The Zeppelin airship shed reminds one of the Lakehurst shed, chiefly on account of the big doors. One might imagine that in an oblique wind the same sort of eddies would be formed at the entrance of this Zeppelin shed, as are shown in Figure 18, so that, with the narrow leeway allowed the Zeppelin entering the shed, collision with the latter would be inevitable. Such an idea evidently influenced the builders of the American shed in choosing such an extraordinary size, which indeed, mitigates the danger of the airship striking the shed, but on the other hand, makes the shed much more dangerous as an obstruction to the wind.

One point in favor of the Lakehurst shed is that it stands out free on a wide plain, away from all other buildings, so that at least at the moment when the wind is in the direction of the

axis of the shed, symmetrical eddies may be expected. In this respect the arrangement of the stationary sheds in Friedrichshafen (Figure 53), is very unfavorable, for a symmetrical formation of the wind current on the longitudinal axis of the left-hand main building cannot be expected, no matter what direction the wind is in, on account of the neighboring sheds. The conditions here would be very similar to those obtaining at the double revolving shed at Nordholz. Here is where the most experience has been had with veering winds, since with gusts, even when coming from the same direction, different eddies are formed each time. With a shed standing free on an open field, far enough from the seacoast (for example, on the Lueneburg Heath), one would wait in vain for a veering wind, unless a whirlwind or tornado happened to be passing over the field.

In an article by Walter Scherz entitled "Harbors for Transatlantic Airships," which appeared in Luftfahrt, No. 21, November 5, 1926, one reads: "Every airship pilot will always long for a more or less natural harbor, i.e., a field which offers a certain protection from the wind, either through surrounding hills or forests (like Friedrichshafen), or through nearness to the seacoast (Haage), or a wide river valley assuring a wind in one direction (Dresden)."

One does not need to be a sailor to know that this "certain protection from the wind" can be very unreliable, and that the wind through a river valley is not always a steady even wind.

On the contrary, such a terrain is precisely the cause of altogether irregular wind conditions. Thus the elevations and forests surrounding the "Havelsee" have been the undoing of many a sailor when the "certain protection from the wind" suddenly gave free rein to a gust which capsized his boat.

It would be altogether useless to incur the great expense of a revolving shed unless it could be situated in the open, on a wide, unobstructed plain. Even if the winds were stronger, this would not outweigh the advantage of steadiness of direction, even with gusty winds. In Friedrichshafen, for example, the advantages of a revolving shed would count for nothing, on account of the nearness of the hills, and the advocates of the revolving shed should be thankful that no "test" of such a shed was made there.

A terrain that has a natural wind screen should be avoided as an airship station, on account of the irregularity of the direction of the wind. In any event, there would be no advantage for a revolving shed where there was such a natural screen, because the direction of the wind changes so suddenly that the shed could not be revolved fast enough to keep up with the wind.

The greater or lesser danger of the landing does not depend entirely on the more or less suitable installation of the airship station. It depends a great deal also on the type of airship to be landed. Among the three types (the nonrigid, semi-rigid and rigid), the nonrigid is the least sensitive to the

shock of a hard landing. For example, I may mention an incident in the history of the nonrigid Siemens-Schuckert airship. It was in connection with the landing after a flight on which Graf Zeppelin was present in the control cabin. The weather was favorable. With consideration for the distinguished guests on board, the commander was anxious to make a particularly elegant power landing, but stopped the engines too late, and the bottom of the forward engine car ran into a ditch, so that the airship, whose weight was at least 15 tons, found itself in the position shown in Figure 22, arching its back like a cat. But it righted itself immediately, with a metallic clang, and the only harm done was the breaking of three steel tubes in the forward car, which were replaced within 24 hours. Although the constructors of the Siemens-Schuckert airship had, naturally, taken the greatest care in securing the front of the forward car to the envelope fabric, they were astonished to see how well the attachment to the fabric at the forward end met this extraordinary stress. A semirigid airship in such an accident would have received very severe injury to its stiffening truss, and a rigid airship would have fared even worse.

The sensitiveness of the semirigid airship is evidenced in the collapsed stiffening truss of the Nobile airship "Norge" after her flight over the North Pole with Amundsen (Figure 23). The picture gives the impression of a catastrophe, whereas in reality, it is only the sickle-shaped stiffening frame under the airship envelope which, hardly able to bear its own weight, was broken by the weight of the empty, falling airship envelope when the airship was deflated. A picture of the bow-stiffening frame of the same airship gave less the impression of a wreck, even though by close scrutiny quite important distortions in the frame could be seen.

As for the rigid airships, we may conclude from the next pictures (Figures 24 to 27) that the Zeppelin airships, probably on account of greater practical experience, are much lighter than the American or English airships. Figure 25 shows the Zeppelin which was stranded at Weilburg, the framework, almost up to the somewhat sturdier bow, being altogether crushed. Figure 24 shows the ruins of the SHENANDOAH, and the comparatively well-preserved shape indicates that the construction was heavier than that of the Zeppelins.

A very unusual accident to a rigid airship is shown in Figure 26, in which the bow of an airship was smashed in by a wind gust. Such an accident can be explained only by an extraordinarily light construction and the effect of the inertia of the airship. Pictures showing the framework of the LZ-127, leave the impression of a construction that is very light in comparisom with the great size of the structure.

The wreck of the R-34 (Figure 27) indicates a heavier construction of this English airship. The fact that it broke in

the air does not in any way contradict the supposition of a heavier construction, for it is not sufficient to make the framework heavier, since the distribution of the weight of the material must also be right. Another picture of the wreck of the SHENANDOAH showed the main girders in comparatively good condition and only the wire netting was badly damaged. The diagram of the main transverse frame of the R-101 (Figure 28) shows that the English have become independent of the German prototype and are now standing on their own feet. With a very gradual development, it is difficult to grasp the right moment in which hitherto valued practices are no longer applicable and must be replaced by others. Therefore, a great increase in the size is usually less dangerous than it would at first seem, because the designer is then less liable to be tied down to former practices and precedents or to look for inadmissible analogies. For this reason, the builders of the Siemens-Schuckert airships had no fear of the 13,500 m^3 gas capacity, although, at the outset of their work, the other airships, except Zeppelins (12,200 m^3), were mostly only in the order of about 3,600 m^3.

In speaking of mistaken shed installations - some only proposed, others carried out - the stranding of the Delag airship "Deutschland" on the Düsseldorf shed should not be omitted (Figures 29 and 30). In Figure 29, the screen in front of the shed can be seen in its full extent. This "protection," however, seems to have been the cause of the stranding of the airship. A gust of wind drove the airship up over the screen and landed it on the front edge of the screen with its bow over the entrance to the shed. All these accidents to airships with stiffening frames, in addition to those later shown, should lead to the abandonment of the expression "rigid airship" for, aside from the fragility of the framework, the airship body is subject to considerable elastic distortion, which is not compatible with the meaning of the word "rigid." It would therefore be more correct to speak of "frame airships."

An undeniable defect of revolving sheds is that, as already shown, they can be built for only one airship each, if they are to retain the unique advantages which distinguish them. An idea for solving this problem, which is often advanced but which shows the general lack of understanding of the unique features of the revolving shed, consists of the proposition to arrange stationary sheds radiating around the revolving or pivot shed, thereby combining the ability to house several airships with the present advantages of a revolving shed. The persistence with which this proposal recurs, led me to include such a combination of sheds in the towing experiments made in Hamburg (Figure 31). The experiments should have been made for all 16 points of the compass, and further, for each wind direction with various positions of the pivot shed. Considering, however, that the northeast and southeast quadrants could be considered as reflections of the northwest and southwest quadrants, it was possible

to cut down the 16 main experiments to only 9. Besides, from the various possible positions of the pivot shed, I chose for the experiments the one which showed the most favorable flow conditions about this shed. In this way, the photographs (Figures 32 to 47) were obtained. In all these photographs the wind is to be considered as blowing from left to right. For some wind directions I am showing several photographs, in order to explain how very insignificant incidents can change the picture entirely and how impossible it would be for an airship commander to know before landing what eddy formations he would find around the shed.

Although it would be very agreeable to talk about each of these pictures, still, for the purposes of this article, it will be sufficient, if a general examination of the pictures leaves the impression that such an arrangement of sheds around a revolving shed would entail unforeseen air-flow phenomena, and that the valuable regularity of the flow around the free-standing, revolving shed would be entirely lost. I hope that the persuasive power of these flow photographs will do more than any mere words can do to bury this persistent idea.

On the evidence of these flow pictures, such an idea as illustrated by Figure 48 must be abandoned. The idea of a separate pivoting shed on an open field for receiving the airship has led to numerous applications for patents. The Deutsche Maschinenfabrik A.G. (Demag) proposed radiating underground

sheds with a revolving elevator platform in the center (Figure 49). After taking on the airship, the platform is lowered to the level of the subterranean airship sheds, so that the airship can be transferred to one of the sheds. This idea is as theoretically correct as it is in fact impracticable, at least for airships of the dimensions that must be reckoned with in the future, i.e., 250 to 300 meters long and 50 meters high and wide for airship sheds. For the same reason, the writer's proposal of a revolving shed on the level of the ground (Figure 50), with radiating sinkable elevator sheds, is only of theoretical interest.

Another proposition that is always being made, and which even received First Prize in a contest, is the idea of a round shed for housing a large number of airships of different sizes. The proposal is based on the erroneous assumptions that it would be possible for all the airships to be walked out through the leeward side of the shed, if only the entire circumference of the shed were furnished with doors which could be opened as desired. Figure 51, another remarkable photograph, produced in Dr. Ahlborn's laboratory, shows us the flow around a cylinder and that the exit from the shed would not be safe even for the central airship, because it would have to proceed against the backwash, while any of the other airships would be caught by side currents and flung against the wall of the shed. It is also apparent from this flow picture that all the airships in the shed would have to be turned in whatever direction the wind turned,

even to allow a single airship to be taken out. For efficient operation, this continual swinging of the airships would be a great hindrance, especially as the sheds are intended also for overhaul of the airships, which work would necessitate the installation of structural supports and the like.

The Biesdorf shed, as already mentioned, has housed airships of all the different types. Among these were the army airship M IV, the Schütte-Lanz SL-1, which occupied the shed for two months, during a thorough overhaul, and the Zeppelin Hansa. This last was too long to get completely inside the shed. However, there was no danger in allowing the airship to extend out beyond the shed because, during the 4.5 years of operation of the Biesdorf shed, the rate of turn of 360° per hour proved fully sufficient to follow with ease all changes in wind direction. During this time no veering winds were ever experienced. The P.L. 6 also occupied the Biesdorf shed for awhile. Figure 52 shows the Siemens-Schuckert airship lying in the correct position for landing and taking off, namely, with its axis parallel with the shed axis and heading into the wind, which was taken from the Parseval airship P.L. 6. Still other representatives of the Parseval type have been guests in the Biesdorf shed.

The crews of these various airships were unanimous in their recognition of the exceptionally great advantages of the Biesdorf revolving shed, of which they had become convinced during their visits to the shed. In all this time there were no operating disadvantages found in this shed, so that the disadvantage of high initial cost is the only one which has been brought seriously against the revolving type of airship shed. For this reason, the idea of revolving sheds has never been entirely given up but has, instead, been the basis of the most varied proposals.

In an article in the Scientific American, June, 1924, three inventions of J. Mason were favorably mentioned as solutions of the problem of airship handling. The proposals of Mason are chiefly theoretical, although much is said of experience. However, since the same ideas often appear in other places, they may be described here (Figures 54 to 57). It is true that, when an airship is moored to the mast, the resistance of the airship and the forces on its frame are the least when its bow is headed into the wind. Otherwise his ideas must be considered as of rather doubtful value. That Mason also entertained the idea of protecting screens, of which our figures 29 and 30 show the doubtful value, need only be mentioned incidentally. Noteworthy, however, is the great care with which Mason tries to protect the bow of the airship, whereas the bow of an airship, on account of the dome-shaped framework, is the very strongest part. Consequently, the hood must be intended as a wind screen for the whole airship. For this purpose, the protecting cap does not reach back far enough, for not the wind flowing along the sides of the airship, but only the oblique currents are dangerous.

The airship fastened to the pivoting platform (Figure 54) is too heavy and will not swing of itself with changing wind direction. It would have to be moved by machinery. If the wind should suddenly come in a gust from an unforeseen direction and strike the airship amidships, no mooring would be strong enough to keep it from being wrecked, because the heavy platform on which it is mounted would prevent the airship from moving with the wind as it would if it were moored to a mast

It appears from the illustrations that there is no provision for keeping the airship from rising and falling. It rests on the platform like a heavy body without any buoyancy. In the same article an airship shed is often compared to a dock, which is altogether wrong, because in a shed the airship remains in its own element and retains its buoyancy, whereas, in docking a surface ship, it is taken out of its element, loses its buoyancy and is subjected to entirely different stresses than when it is in the water. An airship shed may at most be compared to a sheltered harbor. The pivoting dock with bow cap shown in Figure 55, assuming that it is located in a lake without heavy seas, can be disposed of with the statement that, in the event of a sudden strong gust coming from an unexpected direction, the device would not be able to accommodate its position quickly enough to the direction of the wind, so that, with the first blast, if strong enough, as it might easily be, the airship would be wrecked. Until such mooring methods have been tested successfully in a strong side wind, it cannot be said that they have proved their worth. Otherwise, the constructor is receiving credit for something that is due to a considerate wind.

The author of the above-mentioned article, and presumably also the inventor, is very proud of the idea illustrated in Figure 56, namely, a transport for large airships which is meant to operate with the fleet. The proposal is doubtless for modern airships, i.e., of about 150 tons. Even without high seas, and with very little rolling and pitching of the transport, the first contact of the airship with any part of the transport would wreck the airship. But even if one were to assume that the airship had been securely fastened to the transport, as shown in the picture, so as to be immobile, and then the transport should steam away with the fleet into storm and wind, the whole mass of the airship, 150 tons, would be continually accelerated and retarded by the motion of the rolling transport, causing enormous local stresses. It does not seem to have occurred to the inventor that the mass of the airship must be accelerated, not only upward but downward, if it is not to be separated from the steamship, for its weight is more than offset by its buoyancy. When ship and airship are still, the airship rests in the slings without putting any load into them. The slings work only when the airship is tossed upward. There must be the same arrangement of slings over the top of the airship to fasten it down to the transport; otherwise, in pitching downward, the transport will sink away from the airship and, on its next upward motion, strike against the airship and break it in two. The method of securing the airship with lines like mooring lines, as shown in the picture, would not be able to withstand the accelerating forces. The conditions would be altogether untenable, if the transport had to proceed in a direction across the wind, which could not be avoided at times by a ship accompanying a fleet, for a fleet cannot let its course be determined by the wind. Here, however, the reporter himself, in his article, calls attention to the formidable forces that would be exerted by even a slight cross wind, and reckons that this force in a "moderate summer breeze" even, would be more than 20 tons. To this, in most cases, must be added the forces caused by the rolling and pitching of the transport. We see that it is always a lack of appreciation of the inertia forces of the masses and of the correct evaluation of the wind pressures which allow the putting forward of such impracticable proposals.

I felt it necessary to go into some detail here in regard to Mason's inventions, not only on account of their being sponsored by the Scientific American, but also because they are being seriously considered by the American Patent Office, and because otherwise the impression might find support that a revolving platform on a circular track could take the place of an airship shed. Against an installation such as that pictured in Figure 54, too strong a warning cannot be given, especially for localities that have to reckon with sudden changes in the direction of the wind. The method of supporting the bow of the airship in a sack-shaped net, as shown in Figure 57, was taken from the patent. It shows a detail of the arrangement in Figure 56.

For translation of Part II, see Technical Memorandum No. 513, which follows.

Translation by Mrs. Elizabeth T. Cedergren,
Bureau of Aeronautics,
Navy Department.


Fig.1 Smooth landing of a free balloon.

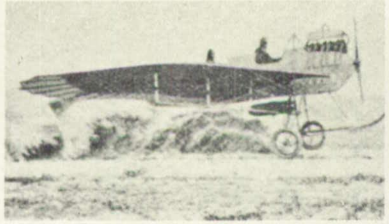
Fig.2 Effect of a braking device for shortening the land run.

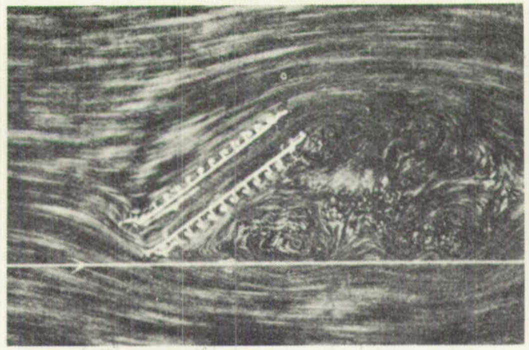
Fig.3 Flow past an airship shed open at both ends in an oblique wind.

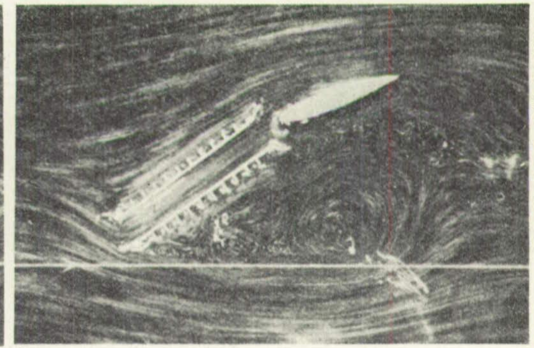
Fig.4 Flow past an airship shed open at both ends in an oblique wind,with airship entering.

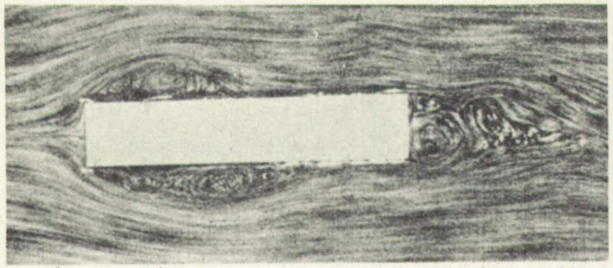
Fig.5 Flow about a revolving shed with a square head,extending in the direction of the wind.

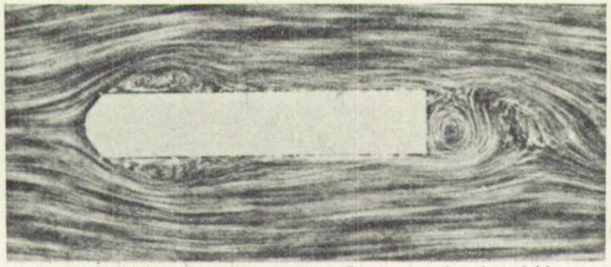
Fig.6 Flow about a revolving shed with a a pyramidal head,pointing in the direction of the wind.

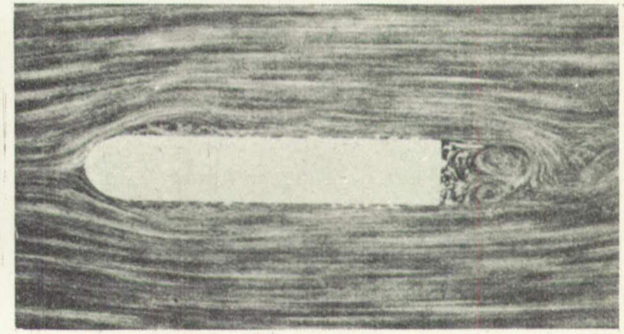
Fig.7 Flow about a revolving shed with rounded head.

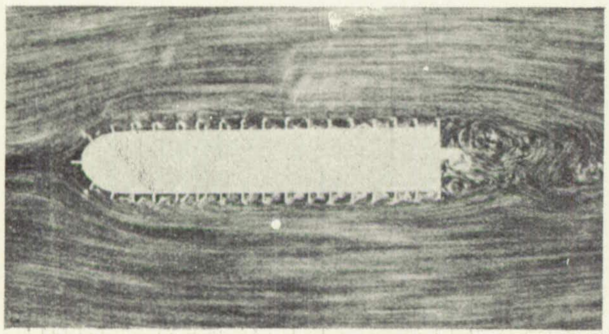
Fig.8 Flow about a revolving shed with uncovered steel structure.

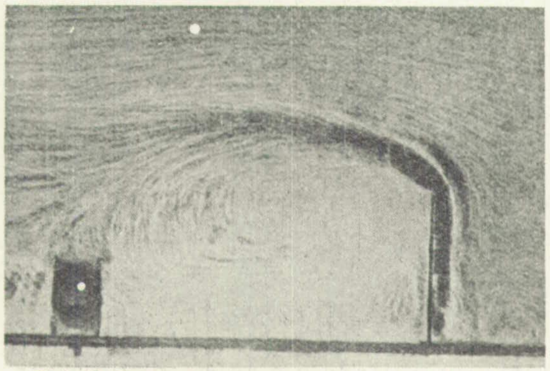
Fig.9 Formation of eddies behind an obstructing screen.

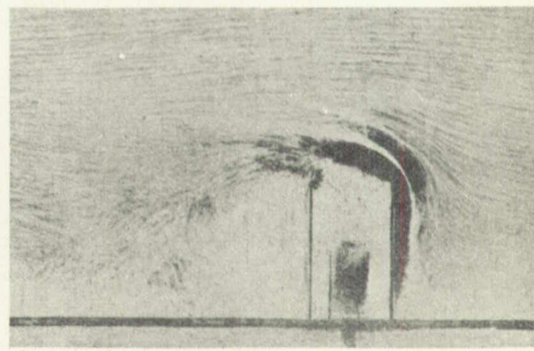
Fig.10 Flow about a pair of screens.

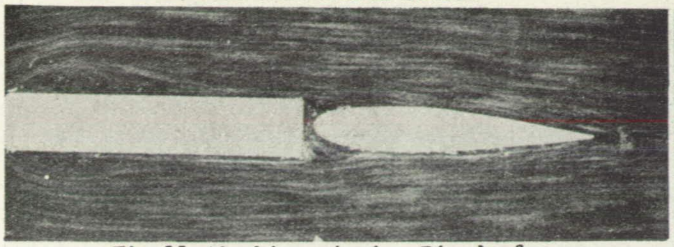

Fig.11 Airship entering Biesdorfer revolving shed.

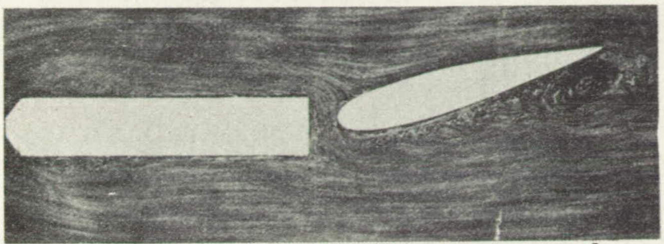

Fig.12 Effect of placing airship at an angle with the axis of the shed.

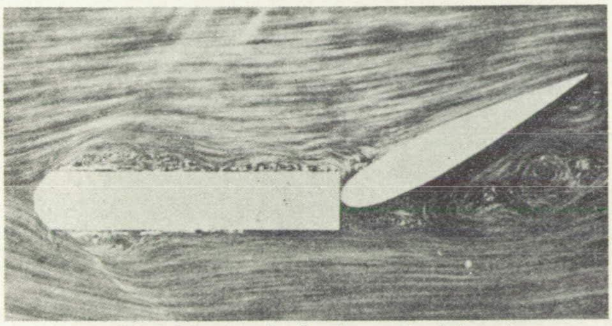

Fig.13 Effect of placing airship at a greater angle with the axis of the shed.

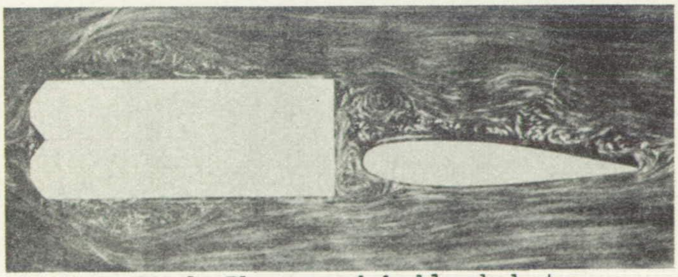

Fig.14 Flow around double shed at Nordholz with airship entering one side.

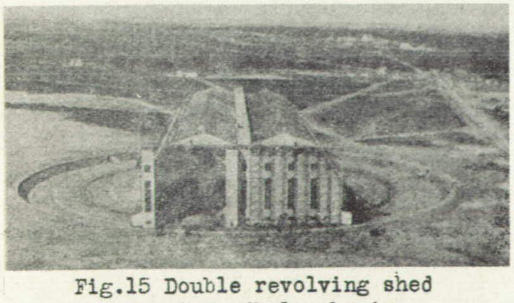

Fig.15 Double revolving shed at Nordholz, showing doors.

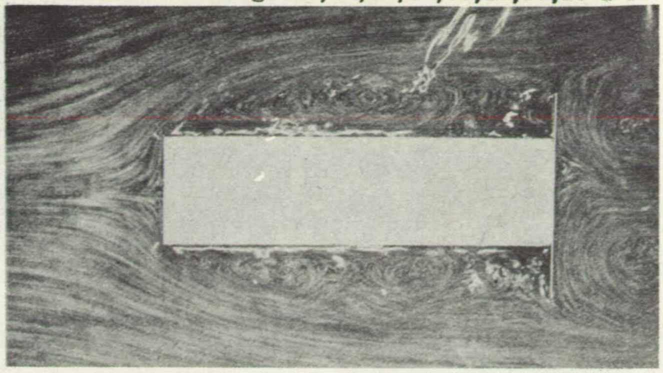

Fig.16 Flow about the Lakehurst airship shed with the wind in the direction of the shed's axis with the doors open.

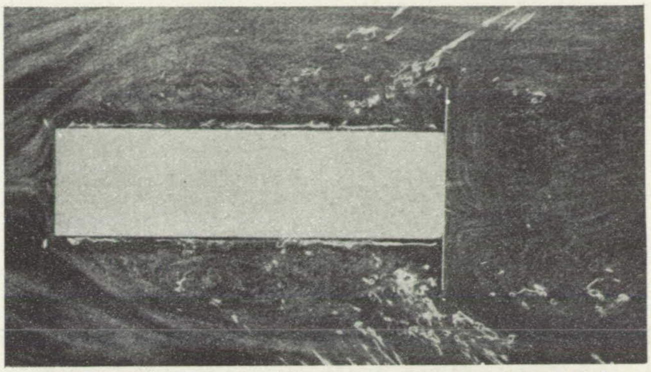

Fig.17 Flow about the Lakehurst airship shed with the wind in the direction of the sheds axis with doors open, showing unsymmetrical eddies in the lee.

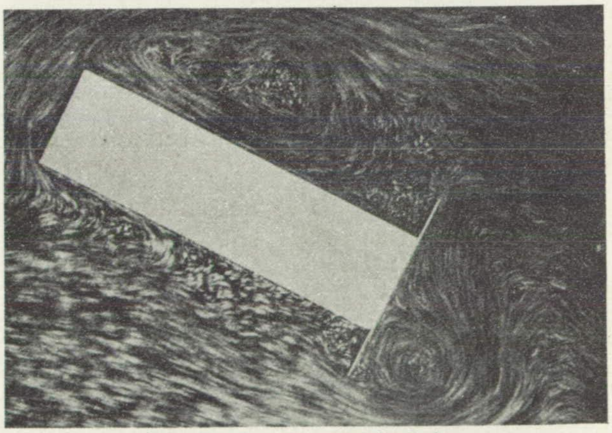

Fig.18 Lakehurst shed in an oblique wind.

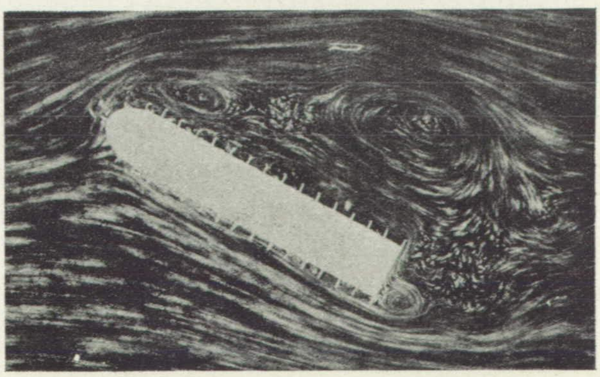

Fig.19 Biesdorf shed in oblique wind.

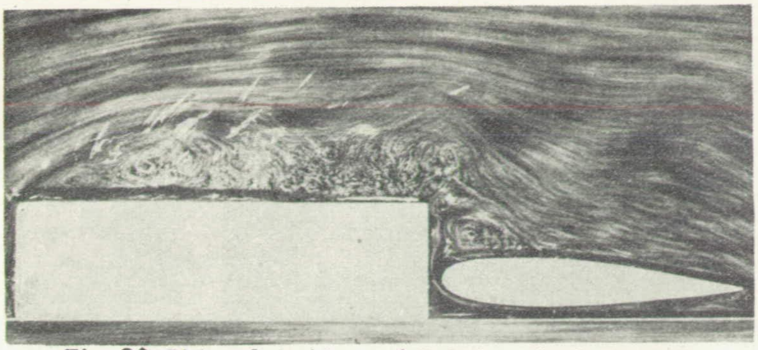

Fig.20 Side elevation of Lakehurst shed with airship entering.

Fig.25 Zeppelin stranded at Weilburg.

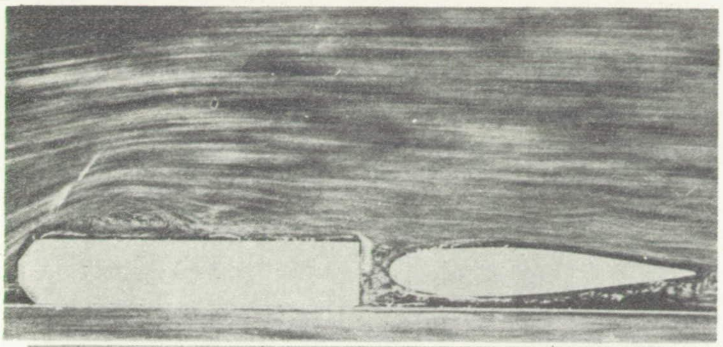

Fig.21 Flow about Biesdorf shed and entering airship. (Elevation)

Fig.23 Truss of the "Norge" while being dismantled in Alaska.

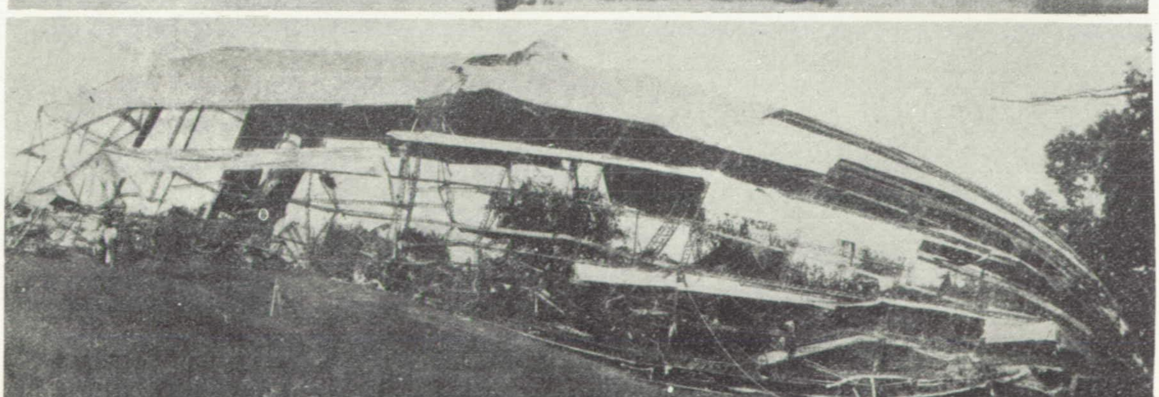

Fig.24 Ruins of the "Shenandoah" Sept.3 1925

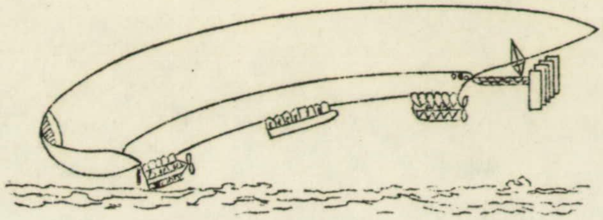

Fig.22 Landing of Siemens-Schuckert airship,
Feb. 28, 1912.

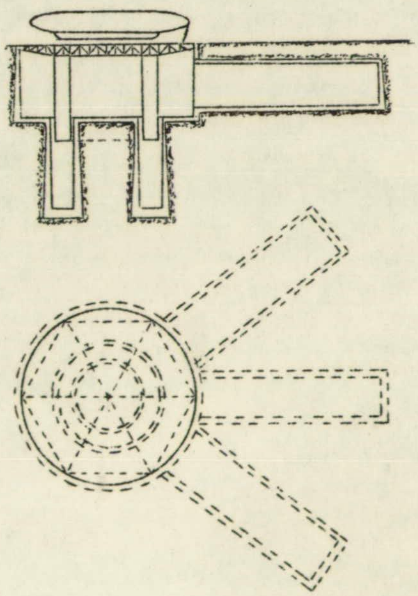

Fig.49 Underground sheds with revolving
elevator platform.

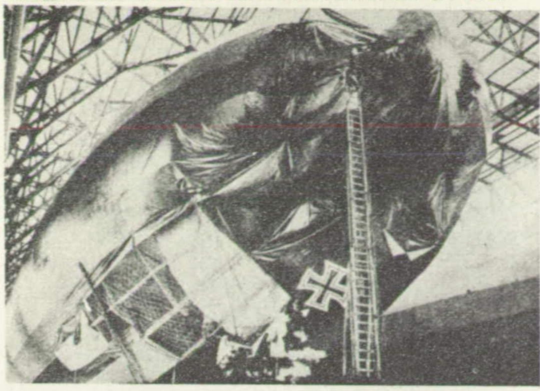

Fig.26 Nose of Zeppelin damaged by a gust while in flight.

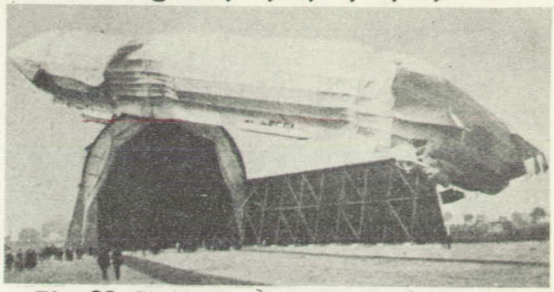

Fig.29 Stranding of the Deutschland on the Düsseldorf shed.

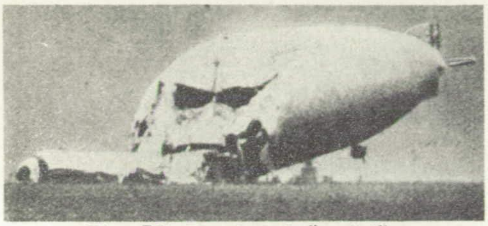

Fig.27 Wreck of "R-34".

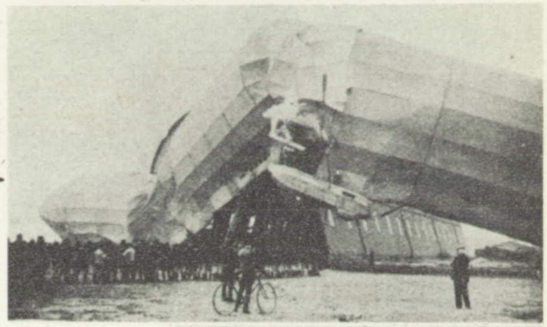

Fig.30 Dismantling of the Deutschland.

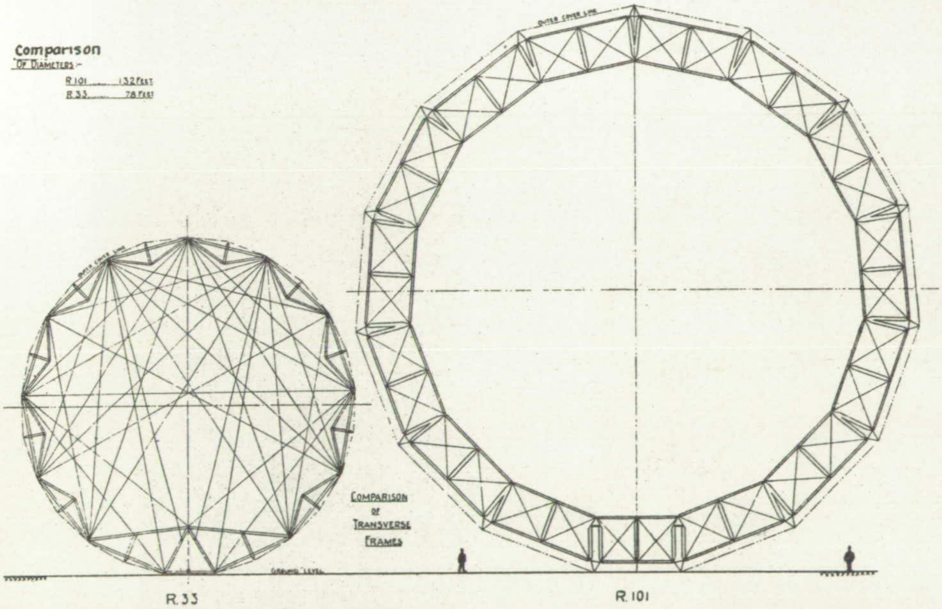

Fig.28 Comparison of cross sections of "R-33" and "R-101".

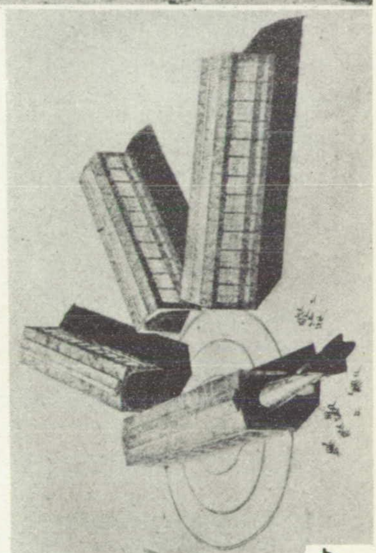

Fig.31 Revolving shed with radially arranged stationary sheds.

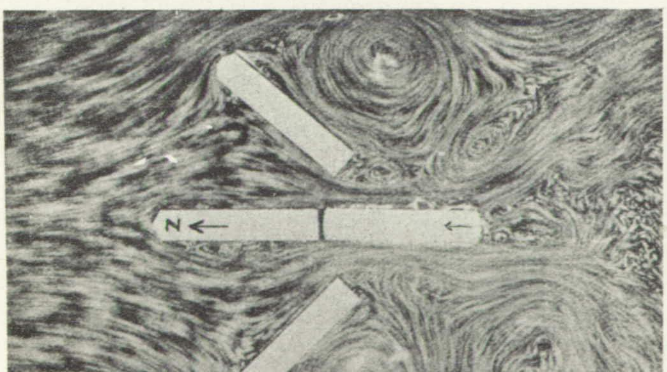

Fig.32 Flow with north wind.

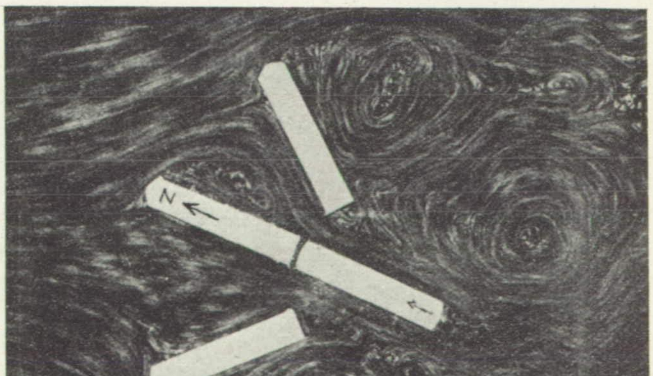

Fig.33 Flow with N.N.W. wind.

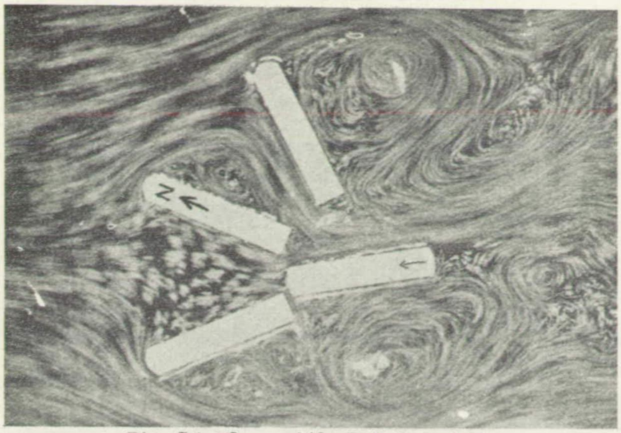

Fig.34 Flow with N.N.W. wind.

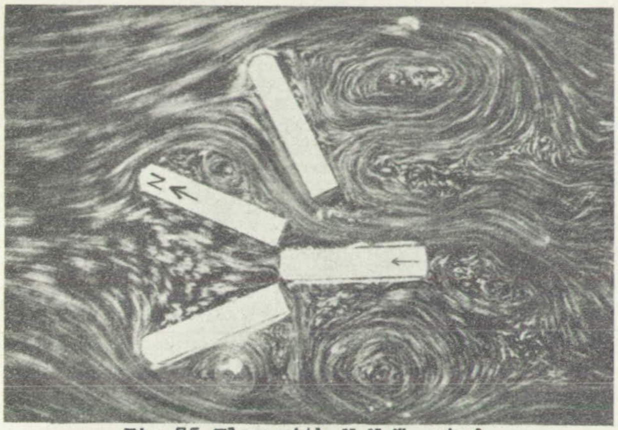

Fig.35 Flow with N.N.W. wind.

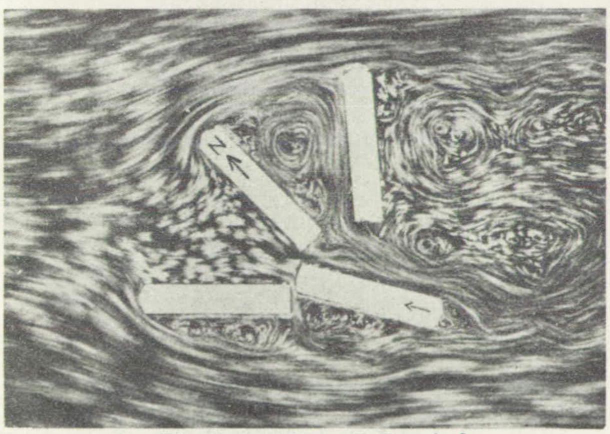

Fig.36 Flow with N.W. wind

Fig.37 Flow with N.W. wind.

Fig.38 Flow with N.W. wind.

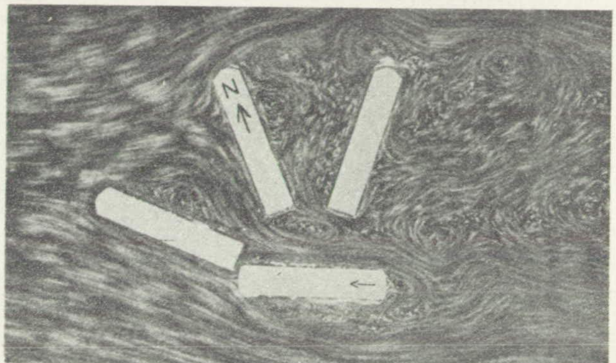

Fig.39 Flow with W.N.W. wind.

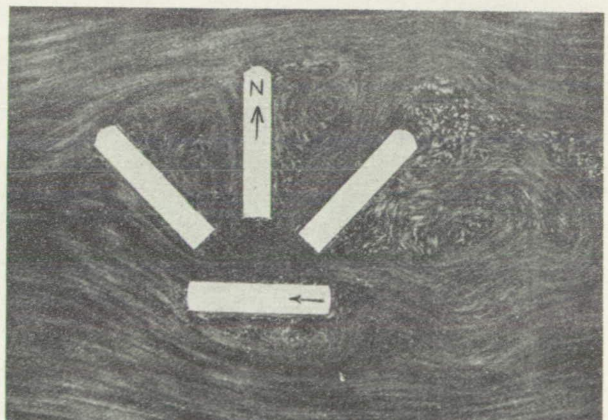

Fig.40 Flow with west wind.

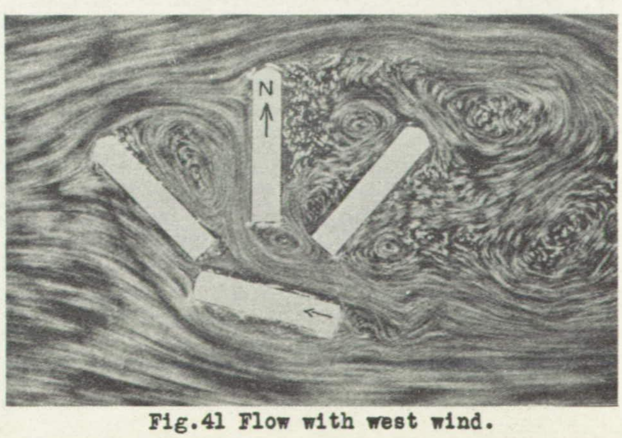

Fig.41 Flow with west wind.

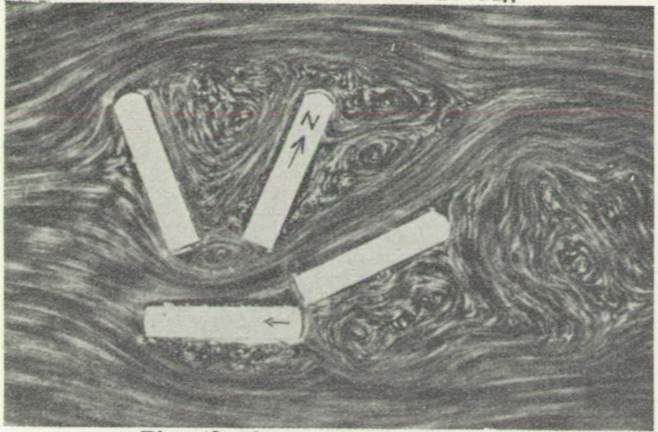

Fig.42 Flow with W.S.W. wind.

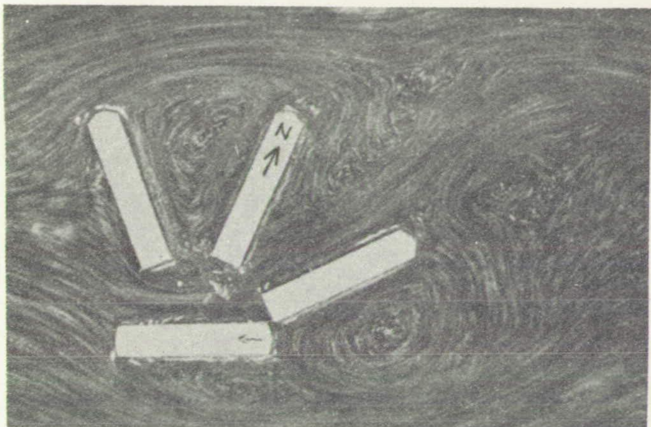

Fig.43 Flow with W.S.W. wind.

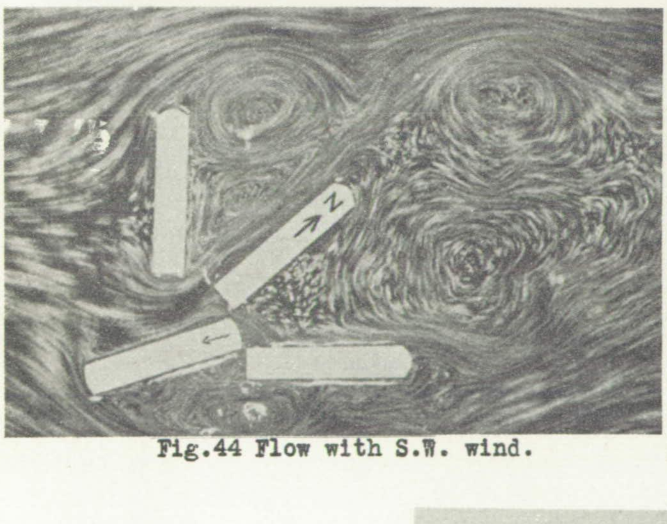

Fig.44 Flow with S.W. wind.

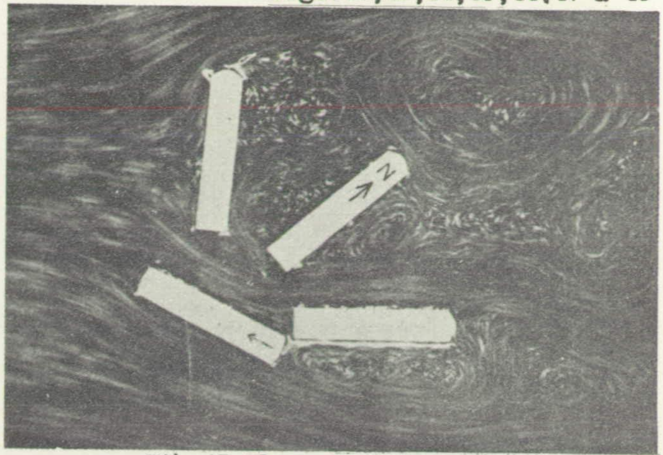

Fig.45 Flow with S.W. wind.

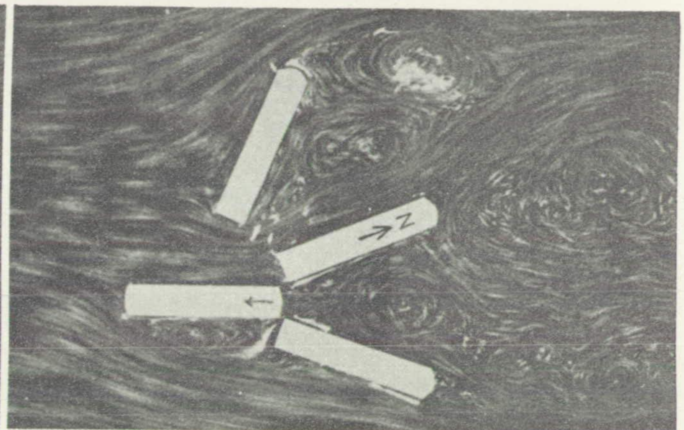

Fig.46 Flow with S.S.W. wind.

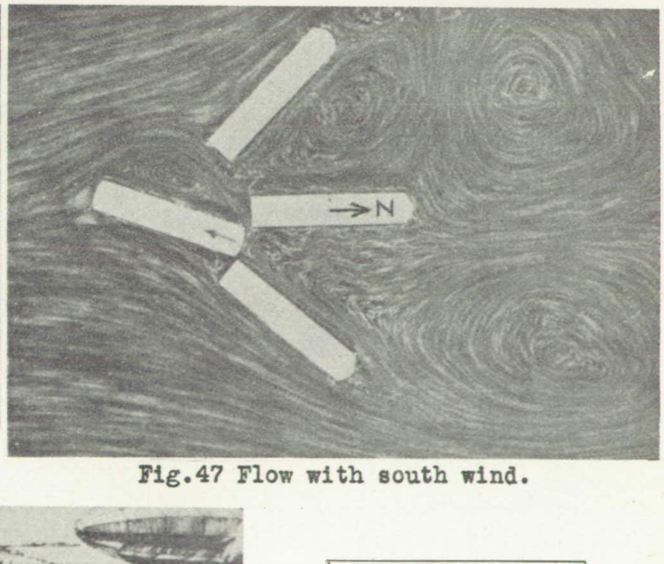

Fig.47 Flow with south wind.

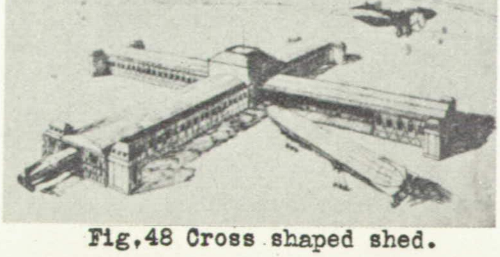
Fig.48 Cross shaped shed.

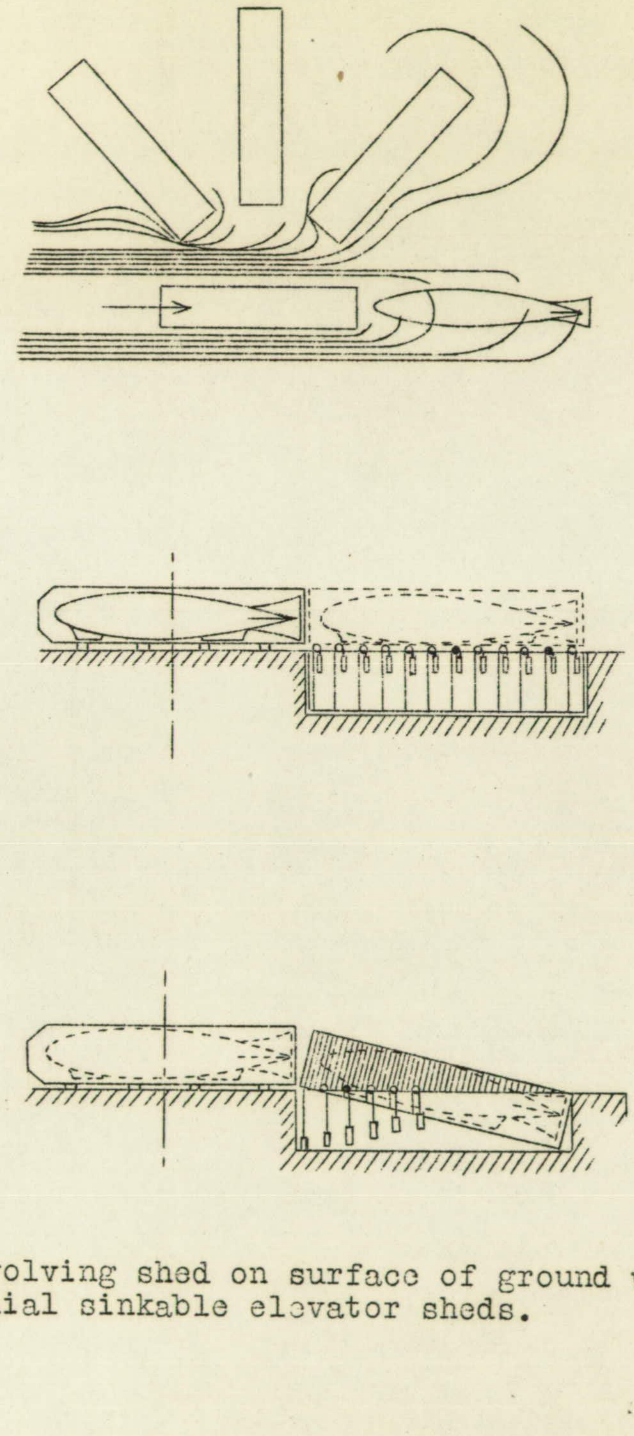

Fig.50 Revolving shed on surface of ground with radial sinkable elevator sheds.

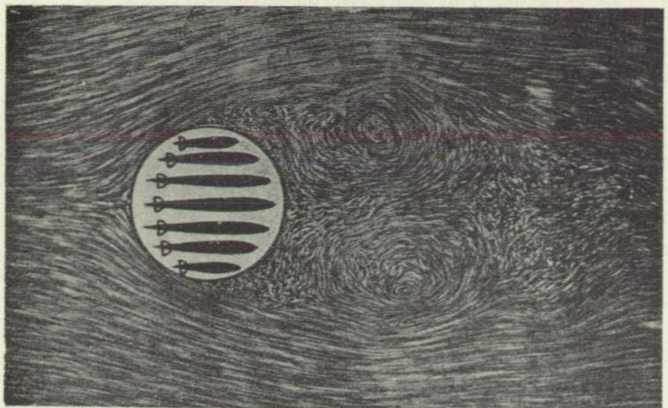

Fig.51 Flow about a cylinder (round shed).

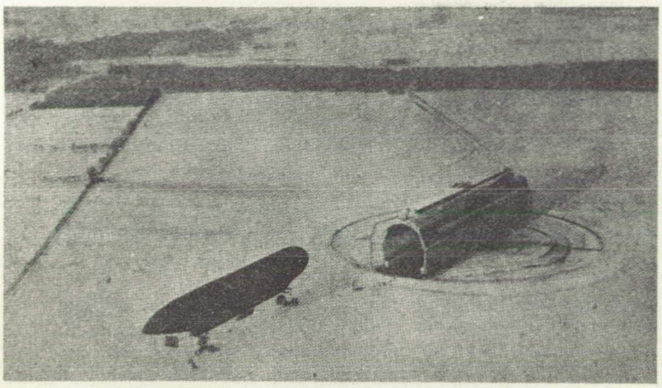

Fig.52 Siemens-Schukert airship in front of its shed.

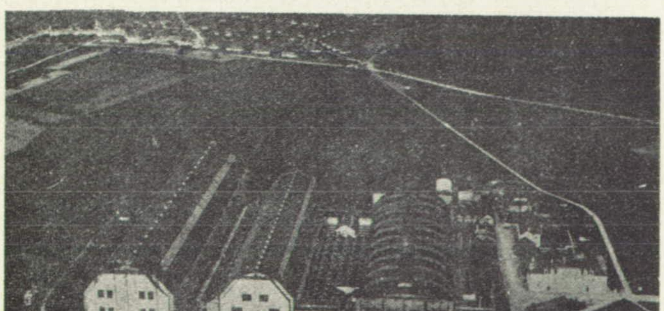

Fig.53 Friedrichshafen airship sheds.

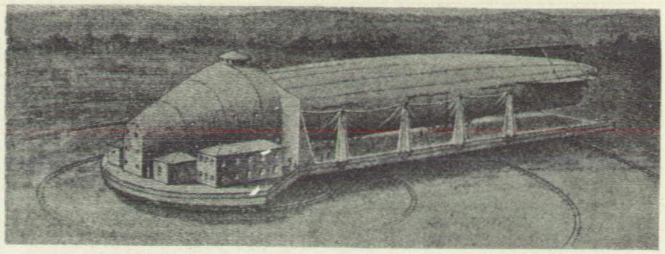

Fig.54 J.Mason's revolving platform.

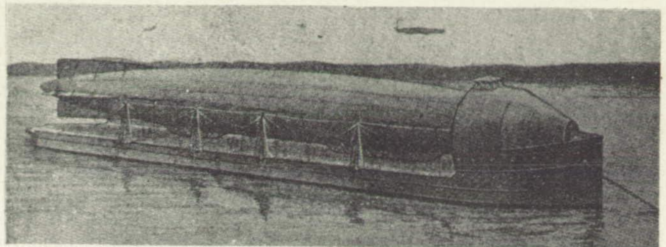

Fig.55 J.Mason's floating platform.

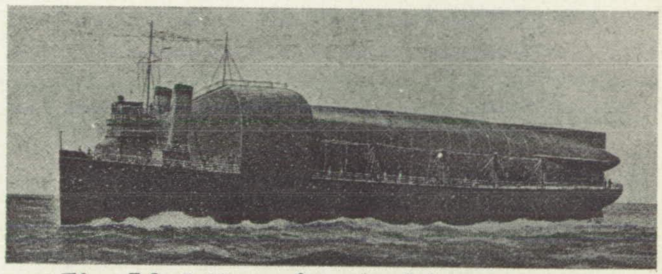

Fig.56 J.Mason's airship carrier.

Nov. 25, 1924. 1,516,541

J. MASON

MOORING STATION FOR DIRIGIBLES

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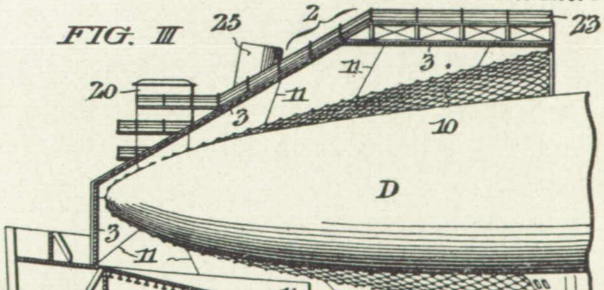

Fig.57 Bow of airship in carrier.