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LOSS OF THE DIXMUDE.

By Hugo Eckener.

From "Luftfahrt," January 23, 1924.

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

TECHNICAL MEMORANDUM NO. 256.

LOSS OF THE DIXMUDE.\*

By Hugo Eckener.

The mystery concerning the loss of the "Dixmude" (formerly the Zeppelin airship "L-72") has not yet, four weeks after its occurrence, been cleared up. We know indeed today, if the newspaper reports can be trusted, that the airship was burned. Charred remains of the airship and crew have been found, but the conclusion drawn by the press that the airship was struck by lightning is pure guesswork. The recovered parts of the airship and of a corpse indicate, rather, that the airship was not struck by lightning (i.e., that the hydrogen in the gas cells was not set on fire by a flash of lightning, but that the airship was, far more probably, destroyed by the gasoline taking fire. In the cases investigated during the war, when an airship fell in flames after her gas had been ignited, it was found that the bodies of the occupants were not at all or only slightly burned. It often happened, in fact, that individual members of the crew escaped with their lives. The newspapers tell, on the contrary, of burnt fragments of flesh which still clung to portions of a uniform. Such burns can only be sustained in a gasoline fire in the keel corridor and therefore raise the question as to whether such a fire may not have been the origi-

\* From "Luftfahrt," Jan. 23, 1924, pp. 1-3.

nal cause of the burning of the Dixmude. This question will probably never be answered.

The public, however, believes the Dixmude was set on fire by lightning. It considers this the greatest danger for airships and consequently accepts it as the most probable cause, when there is no good reason for such an assumption. In fact, the question as to the magnitude of the danger from lightning is of extraordinary importance in estimating the longevity of commercial airships and we will therefore first endeavor to determine what conditions may have led to the destruction of the Dixmude by lightning.

It may be taken for granted that an airship with a metal frame, like a Zeppelin, is exposed in only a very slight degree to the danger of being set on fire by lightning. This has been demonstrated by both theory and practice. It must be borne in mind, however, that an airship is not proof against being struck by lightning, so much as against being set on fire by lightning. I am of the opinion that an airship with a metal frame, when moving between electrically charged clouds, is not only occasionally, but very frequently, struck by lightning, which is harmlessly received by the mass of metal. Theoretically considered, there are two principal cases in which electrical flashes or sparks may pass from a cloud to an airship. A cloud and the approaching airship may be oppositely charged and thus cause a discharge as soon as they are near enough or, in the other case,

the airship may simply serve as a good metal conductor for discharges between two oppositely charged clouds. The latter case must be by far the more frequent, because the electrical tension of the airship is ordinarily nearly the same as that of the surrounding air, due to the immense radiating surface and to the exhaust gases.

Theoretically considered, the exchange of electricity between the clouds, through the metal frame of the airship, would take place in a harmless manner, because the masses of metal at bow and stern (the probable entrance and exit of the flash) are large enough for the transmission to take place without melting the metal conductor. The correctness of this theory has been demonstrated on numerous occasions which have left noticeable lightning marks on the bow of the airship. In these instances, no damage was done the airship, except, perhaps, the fusing of certain parts of the radio apparatus. These observations naturally give no information concerning the surely much more numerous instances, where the lightning was received directly by the metal girders without leaving any perceptible mark.

It is an established rule in aviation that the antenna must be drawn in on approaching a storm cloud, in order to reduce the vertical exposure and, consequently, the danger of being struck by lightning. It is certainly a wise precaution, for danger should not be incurred unnecessarily. Theoretically, however, this precaution is unnecessary, from the standpoint that

lightning is not dangerous. It seems much more important and, in fact, absolutely necessary, for an airship which finds itself among electrically charged storm clouds, not to ascend high enough for the gas valves to open, because hydrogen when escaping from the ventilating shafts, forms, with the air, an explosive mixture, which passes back along the top of the hull and might be ignited by a lightning flash striking the airship.

From the foregoing, it follows that the assumption that the Dixmude was really set on fire by lightning must raise the question as to whether the gas valves were opened in a thunderstorm. This must then seem at least very probable. There are three possibilities as to how this might happen. Either the commander of the airship, out of ignorance, disregarded the rule not to open the gas valves, or his airship was carried, against his will and in spite of the running engines, above the altitude at which the gas valves opened automatically, or the airship was sailing as a free balloon no longer under control. The first possibility we will drop as improbable, since, from what we know of him, the unfortunate commander seems to have been a good pilot.

The second possibility might rather be the case. It can and should not be assumed (if the use of airships is not to be condemned outright) that it is impossible to keep an airship, with her engines running, below the altitude at which her gas valves open automatically, provided the cruising altitude is far enough below the altitude/<sup>at</sup> which the valves automatically

open. In prudent piloting, it is always possible to fulfill this condition before entering the storm clouds. In the case of the Dixmude, however, the pilot probably did not know her location and did not dare descend far enough below the valve-opening altitude for fear of encountering mountains.

From the whole course of the voyage, so far as it can be made out from newspaper reports, it seems to me most probable that the Dixmude encountered the storm practically as a free balloon and was carried above the valve-opening altitude by vertical currents. I will not here attempt to demonstrate this probability in detail, as I have already done in another place. We must wait till the French publish the authentic reports from the Dixmude. I will only remark that there is an almost absolute lack of information concerning what happened between 8 p.m., December 20, when the airship was sighted near Biskra, and 3 a.m., December 21, when she fell into the sea off the Sicilian coast. Since she was driven during this time from Biskra to Sicily, after the announced intention of the commander to keep away from the coast, it appears probable that the Dixmude was carried away by the storm, as a free balloon. There was the danger of the airship being driven into the high mountains back of Biskra, when perhaps one or the other engine stopped and when, perhaps, it was endeavored to fly as low as possible, in order to escape the stronger winds higher up. In this event there was great danger of being carried against the cloud-enveloped mountains, perhaps

by some descending mountain current. At any rate, it is noteworthy that, early in the evening of December 20, all radio communication with the airship suddenly ceased; also the circumstance that only the body of the commander was found and indeed with serious injuries, which cannot be explained simply by the impact of the car with the water. The falling speed, even of the completely burned airship, for an assumed weight of about 99,000 pounds, could not have exceeded 50 feet per second. What then broke the arms and legs of the commander and what became of the (certainly many) other occupants of the pilot car, which so suddenly became dumb?

First of all, I wish to call attention to the fact that, if the assumption that the airship was damaged in the mountains of Algiers cannot be accepted, then the presumption arises that several engines must have stopped and that the airship thus became the involuntary plaything of the wind.

It cannot be too strongly emphasized that the French Navy was making an entirely unwarrantable and careless use of the Dixmude. It is true that the airship had a carrying capacity of over 100,000 pounds, but this was for the purpose of making raids of one to two days duration and was accordingly designed for carrying as much water ballast as possible, but not for packing full of gasoline in order to make endurance trips of four to five days, as the French Navy employed her. All parts of the airship were made as light as possible, in order to be able to perform her military tasks. This light construction, which introduced

an element of risk from excessive stresses, was justified only by the necessity of flying high in order to avoid the danger of falling a victim to hostile incendiary fire. Under these circumstances, it is almost a miracle and a proof of her good construction that the French had already been able to carry out a series of very long flights with the Dixmude, especially as they lacked the necessary experience in the handling of Zeppelins. What holds true for the airship, as a whole, applies more particularly to the engines. The 260 HP Maybach engine was not built for endurance runs of four to five days, but generally reaches the limit of its efficiency in two days, when it should be overhauled and have certain parts replaced, especially the white-metal bushings, which can hardly stand a longer period of uninterrupted use.

Hence it would not be at all strange, but instead, very probable that the Dixmude began to have engine trouble at about the time when the wind increased to a storm, i.e., after a non-stop flight of over 60 hours. Probably she did not have the use of all six engines at that time and had to run the remaining engines all the harder, in order not to be carried back too far as the wind grew stronger.. This probably soon resulted in putting other engines out of commission, so that the airship no longer had sufficient speed and momentum to respond to the pilot's hand. In other words, she rapidly became a free balloon. The further events would have then taken place in accordance with my previous general remarks.

It would be useless to indulge in further speculations concerning the events of the last hours on board. We believe, however, that, during these hours, notes were dropped overboard by the commander (probably after the failure of the radio), which may yet be found. If this expectation should not be fulfilled, the assumption would be strengthened that some sudden catastrophe occurred which instantly extinguished all life in the pilot car. Before we have the expected explanation, however, we should avoid pronouncing too hasty judgment on the airship.

The "Dixmude" Mystery.

In connection with the preceding article and on account of the great interest in the fate of the former German airship, we are printing the following abstract of an article from the pen of the same author, published January 10, in the "Berliner Zeitung am Mittag," which seeks to explain, on the basis of the then available information and from the standpoint of a technical expert in aviation, the catastrophe so regrettable for its possible effect on the further development of commercial airship transportation. Even though later reports should show differences in the details of the last trip of the Dixmude, we believe that Dr. Eckener's expert opinions will still be of interest to our readers.

The Editor.

For the benefit of the newspaper reader who is compelled to sift doubtful and often absurd reports in search of information, the following is offered as the most probable sequence of events in the loss of the Dixmude.

The Dixmude left Toulon on Tuesday, December 18, with the expectation of reaching In Salah, about 930 miles southwest of Tunis, by 4 p.m. of the following day. Here the airship turned and, at about 9 a.m. Thursday, December 20, reached a point somewhat south of Biskra. She had now been 50 hours in the air. Then, as the west wind was increasing, her course was changed to the northwest, toward the city of Algiers, instead of along the

coast toward Tunis. Her ground-speed diminished as the wind continued to increase. Making an average speed of about 25 miles per hour, she reached Bou Saada at 1.30 p.m. Here she turned toward the south and at 6.30 p.m. was again south of Biskra. She now remained nearly stationary, apparently with the intention of "riding out" the storm. The situation was evidently getting serious. Since the engines were probably no longer in condition to attempt to cross the sea in the face of the storm, the correct course was doubtless to work the airship gradually southward, with her head to the west wind, in order to avoid the storm center and leave more land behind her to the leeward against the danger of being driven back, since the wind at Bou Saada was blowing directly toward the sea. The commander proceeded accordingly and, if nothing had gone wrong on the airship, might have been able, by the next day, to turn north again toward Algiers. According to radio messages, there was still sufficient fuel for two days, though this estimate was probably based on not running all the engines at the same time.

The situation was not reassuring, however, since there were mountains east of Biskra with peaks rising to 7700 feet, into which there was danger of being driven, in case the wind should increase or the engines fail to function. In this event, it would be necessary to attain a higher altitude by discharging ballast, in order to clear the mountains by night and in the clouds. At higher altitudes, however, the velocity of the wind

was doubtless greater, so that the airship would be carried east still more swiftly. Did the Dixmude have enough free ballast for such a case? Hardly, since such an ascent would have necessitated the discharge of 40,000 to 44,000 pounds of ballast at the time of taking off and the fuel thus far consumed was perhaps only 22,000 to 26,000 pounds.

What actually occurred was probably the following: Some seven hours later, around 2 a.m., Friday, December 21, the Dixmude fell into the sea off the coast of Sicily. How did she come to be there? Probably not through the volition of her commander with her engines running, for it is inconceivable that the commander should suddenly abandon his previous correct tactics, in order to go wherever the storm might carry him. There may have been fuel enough at noon to warrant such a course, but not at night, after the supply had been much further reduced. It could hardly have happened unintentionally, with the engines running against the wind, which must have developed an entirely improbable strength, in order to be able to drive the airship backward 500 miles in seven hours. Hence the only reasonable assumption is that the airship was driven by the wind as a free balloon with but little, if any, available engine power. In this event, it is quite probable that the airship could have been carried from the mountains east of Biskra the 435 miles to the coast of Sicily in six to seven hours.

We can imagine two causes, which may have converted the

Dixmude into a free balloon, namely, that she may have come into contact with the ground among the mountains and suffered serious injuries to her stern, or several of her engines may have stopped, thus depriving her of one-half to three-fourths of her normal power. The probability of the latter assumption can be judged from the radio messages during the first part of the voyage.

After the airship was once in the center of the storm, with her steering gear disabled or with little engine power and dynamic lift, her flight as a free balloon could only be of short duration, owing to the precipitation of moisture which would cause her to sink gradually, entirely apart from the danger of vertically descending air currents and electrical phenomena.

When the French newspapers blame the Navy for carelessly exposing the Dixmude to destruction, we are compelled to admit that their reproaches are largely justified. The airship was employed, at a very critical and stormy season of the year, to undertake tasks for which she was not designed. It is true that the Dixmude had a carrying capacity of over 100,000 pounds and that, in case of necessity, she could carry sufficient fuel for a voyage of at least four or five days. For such a long flight, namely, from Toulon to In Salah nearly 1400 miles distant in the Sahara Desert, the possibility that a storm might arise at any time (as demonstrated by the event) should have been taken into account. Moreover, the airship was not de-

signed for long flights, but for military flights of only one or two days. The object of her large relative and absolute carrying capacity was to enable her to ascend to a very high altitude in order to avoid hostile fire. Her engines were not designed for a continuous run of four or five days. The manufacturer of the 260 HP Maybach engines, of which there were six on the Dixmude, always refused most decidedly to guarantee them for more than 48 hours continuous running. Especially, the crankshaft bearings were not designed for longer use. Engines and airship were both made light for high altitude military flights. An entirely new type of engine is being built for the American airship now under construction in the Zeppelin yards, in order to insure the endurance of the engines for the transatlantic flight.

Although we are inclined to assume that some injury to the hull sealed the fate of the Dixmude, we would not deny the possibility of several engines stopping in short order just before the critical hour, notwithstanding their previous apparently good functioning. The Dixmude had already been flying 60 hours, when she encountered the storm, which relentlessly forced her engines to their utmost capacity at a time when they were already suffering from the effects of long continued use.

The future will probably explain why the Dixmude was driven so swiftly to Sicily and there wrecked. We are already convinced, however, that no justifiable conclusions against the

use of airships can be drawn from this deplorable disaster. We are not satisfied by the argument that the storm, in which the Dixmude was lost, was an especially severe one. We would rather acknowledge that airships should not be used for long commercial flights unless they can safely withstand such a storm as the Dixmude encountered on the Tunisian coast.

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