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AERIAL NAVIGATION

On the Problem of Guiding Aircraft in a Fog or by Night When There is No Visibility.

By

William Loth.

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Translated from
"Comptes Rendus des Seances de l'Academie des Sciences," No. 23, December 5, 1931, by Paris Office, N.A.C.A.

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## On the Problem of Guiding Aircraft in a Fog or by Night When There is No Visibility.

By

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Last year the Under Secretary of State for Aeronautics asked me whether it would not be possible to solve the problem of guiding airplanes and airships under conditions of very poor visibility, or total lack of visibility, by a method similar to that which I invented for ships. Having accepted the proposition, a former line of transmission of energy enveloping part of the Aviation Field at Villacoublay was repaired so that it might be used for the experiments.

I began by making a study of the magnetic field of the wire to a sufficiently great distance. The wire was traversed by an alternating current with a frequency of 600 and grounded at each end.

This field may be considered to be derived from a double lemniscate, considered in the particular case where the origin is a double point formed from the magnetic field of the slack wire, from the field produced by the return currents and from the field due to the currents induced in the conducting mass. These fields are dephased in two ways, one in the direction of the wire, the other in a direction perpendicular to it.

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* Presented to the Académie des Sciences by Admiral Fournier.
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The conducting apparatus for locating and following the wire consists of three frames, two vertical, perpendicular to each other, and the third horizontal.

Receiving is by sound, with the help of a telephone connected successively to the three frames or to a combination of two of them. It may be done by sight. It appeared at once that the receiving was considerably hampered by the noises from the magnetos, which were sometimes so loud as to stop all receiving. This brought out a new problem. In order to solve it, we first determined the exact forms of the magnetic fields. From this we found that by grouping the magnetos in a certain way and creating a special magneto, the receiving was much less affected.

At the present time the noises from the magnetos are almost wholly suppressed. This is managed as follows: Near the magnetos is placed a small receiving set, the characteristics of which (area, impedance, induction coil) are calculated so that when this set is put in series with the main receiving set further away from the magnetos, and taking into account the ratio of the distances of these two receiving sets from the group of magnetos, the currents induced in these two receiving sets by the magnetic fluids of the magnetos nullify each other. I may point out that this device, in connection with discontinuous receiving, obtained by interrupting all reception at the instant of sparking, would clear Wireless Telegraph and Wireless Telephone receiving of all parasite noises arising from the magnetos.

In order to perfect the receiving, a low frequency amplifier is added, tuned with the variable current in the guiding wire, the current in which is also tuned. The device weighs a few kilograms and cannot be seen from the outside.

Control.- A vertical frame is placed in the direction of the longitudinal axis of the airplane. It receives best when the airplane (or airship) is parallel to the guiding wire. The strength of receiving weakens as the airplane departs from the route traced by the wire. It becomes zero when the airplane is flying perpendicular to the direction of the wire.

The receiving power of the transverse frame is exactly the opposite.

Moreover, these frames may be placed, always perpendicular to one another, at an angle of 45° with the axis of the airplane. They may be attached to a goniometer giving the angle of inclination to the route.

The horizontal frame receives from both sides of the line. When the airplane passes above the guiding wire, it receives nothing. The direction of the inclination to the right or left is obtained by putting the two vertical frames in series one after the other and in opposite directions. Instead of utilizing the lateral frames, single or grouped in series, we may become aware of the passage from one side to the other of the guiding wire by putting the longitudinal and horizontal frames in series one after the other and in opposite directions.

Landing is accomplished by putting the transverse and horizontal frames in series one after the other and in opposite directions. This putting into series indicates also the ascent or descent of the guiding wire on a mountain side.

The following results have been obtained:

Contact was established with the horizontal frame at an altitude of 3000 m. and with the vertical frames at 2500 m. At a height of 2000 m. the sounds are clearly heard in the whole of the control apparatus and we can begin to steer the airplane without being hampered by sounds proceeding either from the airplane or from the magnetos. At 1500 m. receiving is fairly clear; at 1000 m. very clear. At an altitude of 2000 m. contact is established at a distance of about 2000 m. from the wire; at 1500 m., at a still greater distance. On the ground the distance reached on each side of the wire is 15 km.

These are the minimum results and were obtained with a sinuous line of 2990 m. with eight sharp bends. The longest straight portion was only 565 m. The results would be much improved with a straight line of great length, but even now, it is the opinion of experts that the results obtained are amply sufficient for controlling aircraft. The intensity of the current in the wire varies from 4.2 to 2.8 amperes. On airdromes, the wires would be placed in such a way as to enable the airplanes to land facing the wind.

Such are the results obtained which I have the honor to submit to the Academy. With such results, the problem may be consid-

erei to be solved. The utilization of this new method will, in the opinion of experts, render the greatest services to aerial navigation since, by its help, the aerial service need not be interrupted either by fog or by darkness.

These conclusive results have been obtained, thanks to the support given by the Under Secretary of State for Aeronautics and the Aeronautical Technical Service.