Radio Problems in Aviation

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THE day is not far distant when all airplanes used in long distance flights will be required to carry standard *wireless equipment*, permitting of communication over distances equal, if not greater, than the ranges of sets required on passenger steamship liners. The reason is obvious. An airplane in distress is far more helpless than a ship and in case of forced landing, relief is almost always an immediate necessity.

Even in cross-country flying a good radio outfit is a necessity in holding a true course and in signaling ahead for special parts or supplies to save time at intermediate landing points *en route*.

The requirements for a reliable radio apparatus on airplanes bring up certain problems which are still unsolved and subject to considerable experiment at this date, when American ingenuity has been able to advertise its achievements in airplane radio. These intensive problems will attract the highest radio engineering skill in their solution.

The problems may be considered as:

1. Directional control of transmitted signals.

2. Wave length adjustment of incoming and outgoing signals.

3. Transmitting ranges and sensitivity of receiving apparatus.

Under the first item, that of directional control, the engineer faces a very difficult task. The design of the aërial has always been the critical factor in directional control, and it is greatly limited by the facilities which an airplane offers for setting up the antenna.

The most effective control has been secured by the single trailing wire antenna. (See Fig. 1.)

A length of about 300 feet of wire is allowed to swing in the air held down partly by a weighted "fish." Thus the metallic parts of the airplane form the counterpoise and as the trailing wire swings backward in a characteristic curve the major electrostatic field is projected downward ahead of the airplane at about 45 degrees.

This gives a directional effect directly ahead of the airplane. Signals behind the plane or to the side of the lateral axis are greatly weakened. Even when the plane banks on a turn, the signals ahead die down rapidly. Hence to transmit in any given direction the plane must be pointed in the direction of the receiving station and to find that direction by compass is not as easy as it seems.

Furthermore, an airplane might have to reverse its direction every time it desired to communicate with a given station, and on long flights this lack of control would be extremely inefficient, in view of the fuel thus lost and the time consumed.

In land radio for long distance transmission the towers supporting the aërial are built for a given directional effect. Where non-directional effect is desired an umbrella type of antenna is used. However, since the airplane must get the maximum efficiency in range from the least amount of aërial weight, an umbrella type antenna, even if practicable, would not be suited to the airplane.

When it is attempted to arrange a fixt antenna (as opposed to the trailing type, which is free to sway) on an airplane the limiting conditions of aërial capacity and structural areas impose very harsh conditions on the designer. Consider the capacity of a wire equal to the wing span of an airplane, seldom more than 30 feet, and with no means of suspending the aërial over a foot above the wing surface, and with comparatively little metal in the wing itself to give the desired field its maximum capacity. Wing spread is the longest overall dimension of the airplane in any case.

Fixt wire antennæ on airplanes have never attained results commensurate to their cost in installation and in reduced flying efficiency; for every wire that is thus exposed to the air means increased *head resistance* and a few wires can multiply head resistance to a very serious extent.

One design of fixt wire antenna which was used in the army combined the fixt type with the trailing type. (See Fig. 2.)

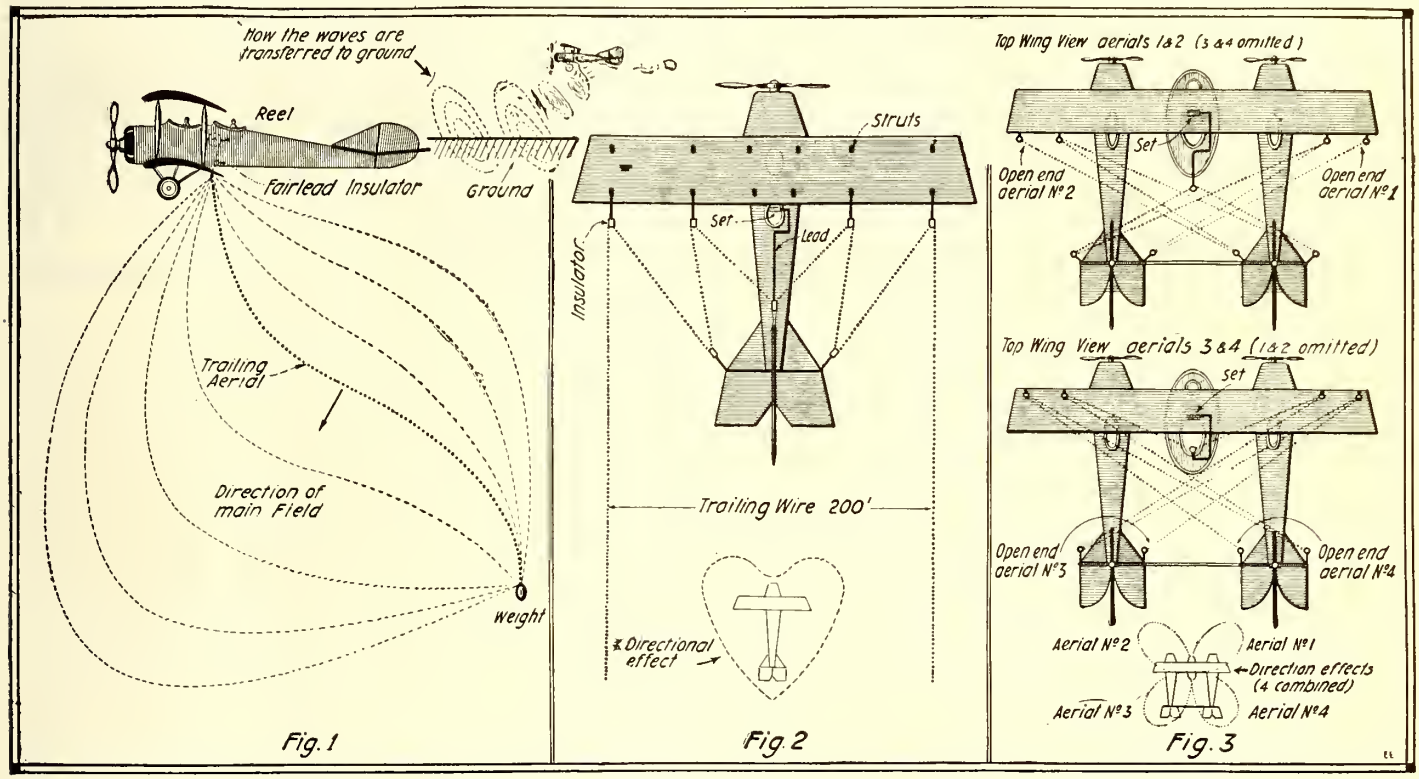

Fig. 1—This Illustrates the Simple Trailing Type of Airplane Radio Antenna, Used to a Great Extent During the War. It Can Be Reeled Up Quickly But Possesses Several Disadvantages. Fig. 2—A "W" Type, Combined Fixt and Trailing Radio Antenna, Successfully Used for Inter-plane Communication. Top View. Fig. 3—Radio Antenna Rig-up Proposed By the Author, for Double Fuselage Biplane. The Quadruple Antenna and Its Directional Effects Are Clearly Illustrated.

Here the ends of the wire were not weighted and as they were constantly liable to become tangled in the controls such fine wire had to be used that their effective capacity, low enough with any practicable airplane antenna, was further reduced. Furthermore, the trailing wires were awkward in landing and in taking off, since they could not be reeled and the fixt wire system was an added menace, due to the fire hazard which they involved.

This "rig-up," however, was effective for *interplane communication* over short distances, not exceeding a mile, using a 200 watt fan-driven generator. Communication to the ground was easily establisht, but receiving from the ground was difficult. The directional effect was low ahead and strong to the rear of the airplane.

The results obtained in army aviation radio were generally satisfactory for their purpose, but in the broad field of commercial aviation, the *directional control* must be far more highly developed before the radio apparatus can be relied upon.

The same structural conditions which impose so many difficulties on directional control also affect selectivity of wave lengths. As is well known, a long wave length is more efficient for long distance transmission. To get long wave lengths a great deal of inductance and capacity are needed. The land radio operator little considers the

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ment is confronted with conditions which make it imperative to ask for this monopoly.

Obviously the United States can not own radio stations in other countries. These countries fall into certain groups: (1) Those in which the Government itself maintains a radio monopoly; (2) those in which the Government permits its own nationals, but not foreigners, to own and operate stations; (3) those in which any authorized individual or corporation can erect s ations.

Obviously every encouragement should be given American companies to manufacture and sell radio equipment abroad and to own and operate stations abroad. The American Government-owned stations should exchange traffic with such stations and assist them in any legitimate way. Especially should any patents or improvement controlled by the Government be made available to such American companies under proper safeguards and guaranties.

In conclusion this department recommends that Congress immediately enact legislation regarding radio communication along the following lines:

(1) Either by a committee of Congress or by special designated commission, authorize a comprehensive study of the problems in connection with radio within the United States. This, however, is not of immediate concern to this department. Of course, the department stands ready to give the benefits of its experience and technical knowledge.

(2) Authorization to the President to set aside by proclamation certain bands of wave lengths for ship-to-shore work, for shore to aircraft, and for transocean services in accordance with international conventions and demonstrated needs from time to time.

(3) Constituting ship-to-shore radio service a Government monopoly under the Navy.

(4) Constituting transocean and international radio service a Government monopoly under the Navy.

(5) Authorization for Navy Department to utilize immediately all Navy radio stations for commercial and press business.

(6) Authorize the Navy and other departments to assist American enterprise in the sale of radio apparatus and the development of American-owned radio stations abroad, and especially to authorize the Secretary of the Navy to authorize the use by American companies under proper conditions of Government-owned patents and improvements, to be paid for either in exchange of patent rights or in other suitable ways.

Sincerely, yours,

JOSEPHUS DANIELS.

THE SPEAKER OF THE HOUSE OF REPRESENTATIVES.

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factors of capacity on an airplane, since he is used to the high building and tower aërials and the solid capacity of Mother Earth. But the airplane must give its capacity effects with little more than the engine and tank metals for counterpoise. And to build up any additional capacity with lengthened aërial means increased weight and lowered flying efficiency. These considerations have therefor held the aviation radio sets to wave lengths of 300 meters or less. And if any radio engineer was asked to design a transmitting set with a minimum range of 500 miles with 300 meters to work with he would think you had asked the impossible.

It is not so difficult to use loading coils to permit of reception by the radio set in an airplane of longer wave lengths than 300 meters, but the added resistance is always undesirable and for transmission it is impracticable.

And in addition to the head resistance and structural limitations on the radio sets for airplanes we have a number of other complications peculiar to aviation radio, to wit:

The engine noises are always present during flight and make accurate message reading difficult even with "noise-proof" receivers. The army practically never attempted to require aviators to receive messages in the air. All signals to the airplane were visual.

The engine magneto sets up a field which has a marked effect in reducing the transmitting range of the airplane set ahead.

Effective power generation for transmitting means a sacrifice of speed. If coupled