AIRCRAFT RADIO

By WHITNEY MATTHEWS, '38

AIR transportation has in a very few years covered the entire United States with a vast network of airlines carrying passengers, mail and freight between the important cities in the most rapid transit ever used by man. Aircraft radio has contributed greatly to the safety and wellbeing of the modern air passenger. The radio beacon courses provide unmistakable guideposts of the air which a pilot may follow just as a driver of an automobile would follow a well marked highway.

Many uses are being made of radio for aircraft. Radio service provides the pilot with two way communication with airports as well as government weather reports and other information necessary for the safety of his passengers. A ruling which was put into effect in January, 1935, requires each radio range station to maintain continuous listening posts for planes on the aircraft to ground channel (3105 kc.) which assures a pilot that a message which he may send will be given proper attention.

Air travel between the important cities of the country may now be made entirely by the use of radio courses maintained by the U. S. Department of Commerce. Stations are located at close intervals so that the pilot is assured of ample signals under all weather conditions and the courses are so arranged that the routes followed are the least hazardous in that particular region.

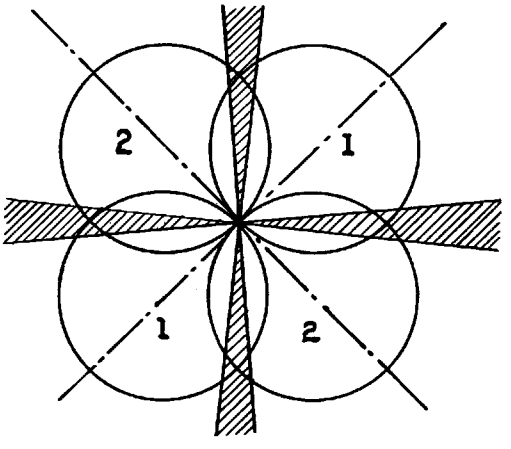
Radio beacons are provided by the use of a directional antenna system used in conjunction with a transmitter system known as a *Radio Range Transmitter*. If a simple loop antenna is used a receiving characteristic is approximately a *figure eight*.[1] Thus, when a receiver is at a point along an axis perpendicular to the plane of the loop the signal is a maximum, and if the point of reception is in the plane of the loop, the signal strength is zero (or in actual practice, it is a minimum). Thus, by the use of two loop antennae a field pattern similar to that shown in figure will be obtained.[2] The broken lines represent the planes of the antennae and the circles show the receiver characteristic or *field pattern* due to this combination of two antennae. From this simple diagram it will be seen that a receiver within one of the shaded areas will receive with equal intensity a signal sent from the two antennae. However, a receiver located outside this shaded area will receive one or the other of the two signals stronger.

The original system used an aural indication. Upon one of the loops a carrier was impressed which was keyed by a motor driven key to give the code letter A (dot-dash) and upon the other the code letter N (dash-dot) so synchronized as to be interlocking. Thus, if the output of the receiver were fed into a sound reproducer a continuous sound would be heard as long as the plane was on the course (in the shaded area). However, going out of

[1]Fowle, *Standard Handbook for Electrical Engineers*, McGraw Hill Book Company, New York, Sixth Edition, 1933, p. 2538.

[2]Mabry, Radio-Range Transmitters Guide Traffic of the Air, *The Electric Journal*, Vol. 30, No. 8, p. 334.

FIELD PATTERN OF TWO LOOP ANTENNA



this beacon range in one direction the letter A would be given by the sound reproducer, or in the other direction the letter N. This system of radio range transmitter is for obvious reasons called the "AN" type.

In most cases the loops for antennae have been replaced by two vertical antennae for each loop. The effect in the operation of the system is the same but a higher efficiency is obtained with the towers than with loops.

A visual indication system was later developed to replace this "AN" system. Instead of keying the input to the two antennae systems with the letters A and N, one antenna has the carrier modulated with a frequency of 86.7 cycles and the other antenna system has the carrier modulated with a frequency of 65 cycles. The output of the receiving equipment is then applied to two tuned reeds, one tuned to 65 cycles and the other to 86.7 cycles. The amplitude of vibration of each reed is proportional to the amplitude of that frequency present in the receiver output. Then as long as the amplitude of vibration of these two vibrating reeds are equal the plane is on course, but as the pilot leaves the course one signal becomes stronger than the other and causes one set of the vibrating reeds to *fan out* showing that the pilot is off course. The direction in which the plane must go is indicated by the reed which has the greatest amplitude of vibration. Another type of receiving equipment for the visual signal uses a center zero instrument in which an indication on one side of zero indicates that the plane is on one side of the radio range and an indication on the other side of zero indicates that the plane is on the other side of the course. Such instruments are marked *O* (on course), *L* (left) and *R* (right).

By the use of audio frequency filters in the output the same receiving equipment may be used to receive the radio beacon and serve in the two way communication with the airport. In this case, both the radio range signal and the voice are broadcast in the same transmitter equipment.[3]

Another important feature of radio in the safety of the airlanes is the use of special transmitting equipment slightly off the radio range frequency which over a short distance will give a signal on the radio range channel. These are used to warn pilots of the high obstructions in the airlane. A typical example of this is the beacon marker transmitter used by radio station WBNS in Columbus in warning pilots of the 379 ft. vertical antenna. This beacon marker is licensed as station WOEX and has an output of 30 watts. It has a range of about 15 miles and will give warning to pilots within that distance on the Columbus-Cincinnati radio beacon range.

The major airlines of this country are using an automatic *giro* pilot which is controlled by impulses from the beacon transmitters which will automatically fly the plane on the radio range course.

[3]Jackson and Stuart, Simultaneous Radio Range and Telephone Transmission, *Proceedings of Institute of Radio Engineers,* Vol. 25, No. 3, Part 1, p. 314.

Aircraft radio has made exacting requirements upon the radio designer. The equipment must be entirely trustworthy but the weight must be limited. For example, a typical set of equipment including a 30-watt transmitter, a three-band receiver, a dynamotor and other equipment necessary weight but 24 pounds. This transmitter has a range of about 300 miles in daytime and about 500 miles at night. It is popular priced equipment which is suitable for the operator of a private plane.[4]

Airplane transmitters generally use a trailing antenna which is wound upon a reel within the ship, and is let out when the airplane is off the ground. The receiving antenna may take the form of a short vertical mast, an L, V, or T or a trailing antenna as used by the transmitter.

Aircraft receivers for privately owned planes are also made which use ordinary broadcast stations as the beacon transmitter. In this case a loop antenna is used in the plane and a center zero instrument indicates the course toward that station as in the case of the visual indication for the radio range equipment.

A recent entrant into the field of aircraft radio is a device for the blind landing of a plane. A directional beam similar to the radio range is used in conjunction with a second beam transmitter which provides a *landing beam.* This second transmitter is arranged so that the horizontal field pattern is uniform, but the vertical distribution follows an exponential curve beginning upon the field and rising through the space above the field. The pilot then follows both of the beams simultaneously, one of which determines the elevation and the other the compass direction.[5] This equipment is also used with a giro pilot which will automatically land the plane[6] in the most dense fog. This equipment is not yet in use. Landing directions are now supplied by a two-way radio communication between the pilot and the airport officials.

Trully, radio is coming to take a very important part in the air transportation of tomorrow. The planes will be automatically flown along a radio range beacon to the airport and landed automatically by means of the landing equipment. It will provide warning of approaching storms and will give the pilot warning of tall buildings or radio transmitter antennas which may lie in his path. Radio has come to play an indispensible part in the maintainance of scheduled transport flying.

[4]Learadio equipment, R-3 receiver, T-30 transmitter and G-30 dynamotor with auxiliary equipment.

[5]Diamond, Performance Tests of Radio System of Landing Aids, *Bureau of Standards Journal of Research,* Vol. 11, No. 4, p. 463.

[6]Thomis, Landing Planes in Dense Fog, *Science Digest,* Vol. 1, No. 1, p. 45.

Frosh—"What do you do when you get tired of hearing a girl's empty chatter."

Soph—"I give in and take her to a restaurant."

A man who has a face that would stop a clock, can never be a girl's big moment.