Radio Beams Guide the Planes in Flight

by ALBION R. LA FARGE

Just how the commercial planes are enabled to fly in soupy weather by flying along radio lanes directed from stations at the ends of the airlane, and how communication is maintained between the ships and stations.

WHEN the first primitive man fastened sails to his crude boat, there were the usual crowd of well wishers and "can't be dones" on hand. He would be drowned, seized by a monster or stricken by fire from the Gods for his insolence!

He dared something new and was therefore deserving of ridicule and criticism for departing from an established custom. But his jumping eventually extended to steamships and trains, and finally aviation, which now bears the oft assigned burder of progress and pioneering.

To those associated with aviation over the development period the progress of this utility is unbelievable. Pipe dreams are now condensing to hard cold facts. Watch the traffic, both mail and passenger, at any large air terminal where good dollars are riding those air carriers to prove it.

We think back over a short span of twenty years when a few pioneering companies dared offer a low powered plane for the private owner or small operator. It was lauged at. Who had the money to buy one and who would? A visit to any field today will give another answer.

TOP—This transport plane is flying along a radio "track" that guides it to its destination. IN CIRCLE—Pilot talking to the supervisor. LEFT CENTER—The supervisor directs the planes and provides them data from the weather maps. BOTTOM—The station transmitter.

Then another pipe dream comes true — the airmail spans the country—smooth, efficient and on time. The airmail is here to stay and it is important enough to figure in governmental economies and supervision.

In its early days, the airmail was a crude system compared to the present organization. The pilot went as far as possible—sometimes making the trip and sometimes not—depending on weather and motor. When bad weather set in he sat down or went back. "Waiting on the weather" was a familiar phrase around the mail fields.

And so it seems that weather was and is yet to be the stumbling block of aviation—the bugaboo, the bad boy for transport aviation to chew on. Weather, good, bad, or indifferent. Good sunshine, tail winds and unlimited ceiling are to be balanced against the black sheep of rain, fog and low ceiling. And how these black sheep can combine to make soupy weather. The war is on, a specialized war of attack and defence with a general staff and with men behind the lines. Instruments, trained pilots, radio, beacons, motors and planes, each to play a part for the common cause of schedule flight.

In what way has progress been made thus far?

Early forms of navigating instruments gave broad readings. The altimeter read in thousands of feet, with its lowest division reading 200 feet. For the pilot flying low and partly blinded by poor visibility, it was not sufficiently accurate. The pilot needed an instrument giving a ten-foot reading or even a one-foot reading. Now, on the "dash" of modern planes is such instrument, an altimeter so accurate that it registers when raised from the ground to arm's height.

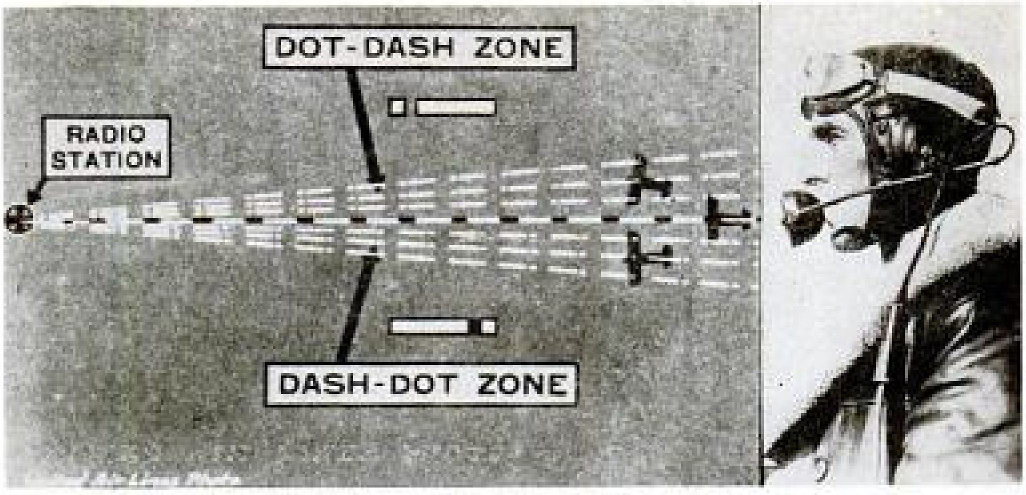
The old belief that a pilot's sense of balance and direction could be developed to certainty in blind flying has been dropped into the basket of discarded beliefs. The turn-and-bank indicator, the rate-of-climb-meter and the Sperry Horizon have convinced the pilots that our sense of balance is a false friend. Needless to say the work of improving still goes on.

Another complaint was made against the magnetic compass. In rough air, the magnetic compass with its pitching, tossing and swinging, made it difficult to check courses and headings. The Sperry Gyro Compass was then converted into aviation use. This type of compass, when set for the desired heading, neither pitched nor tossed, changing its reading only when the heading actually changed. In technical terms, it eliminated the "turning error."

Ability to pierce blinding weather came by way of radio. Flying through low or zero visibility, or riding over it, the pilot keeps his course on the radio beam. The beam described in this achievement acts like a beam of light from a searchlight. Starting from a created source, it can be directed and concentrated on the desired target.

A radio beam at Newark aimed at Washington, hits Washington and vice versa. Although narrow at its source, say some fifty feet, it broadens with distance, making it necessary for Washington to shoot another beam at Newark. These two beams overlap, producing a continuous beam, although the two divisions are transmitted at different frequencies to avoid interference.

For example, a pilot leaving Newark for Washington (Fig. 1) tunes in with his beam receiver. He tunes in the Newark beam, not yet near the overlap. When tuned, he is informed by signal where he is in relation to the beam course. A dot-dash—the "A" of International Morse—informs him he is to the right of the course. Should



Simple diagram of a radio beam showing how the ships can fly on their course by staying within the beam. If to the right they get the "dot-dash" signal, if too far to the left they receive the "dash-dot" note. Communication can also be carried out between station and pilot so long as the latter is within the beam.

he be to the left, he receives a dash-dot—the "N" signal.

A series of dashes, caused by "A" and "N" meeting at the center of the course is the "on course" signal. These signals are interlaced with the identity of the transmitting station, also given in code letters as by an "H", "J", "W", etc. This signal is necessary where beams meet—such as at Washington. Proceeding along the Newark Beam until the overlap is reached, the pilot then tunes in the Washington Beam. This beam narrows as it nears Washington —"drawing in" as it is called.

This method of using overlapping beams eliminates the evil of beam broadening, overcoming the danger of the beam covering too much territory at the destination. The beam is allowed a broadening of from ten to fifteen miles before the overlap steps in.

Soon, this overlap and broadening will be eliminated as well as the "Skips" or points on the course where the beam leaves the true course and wanders around the country, eventually returning to the true course. "Skip" locations are known as they are constant and pilots continually using the beam grow accustomed to making allowance for these deviations.

Now, let's make an air mail reading of the beam. Let us continue on from Newark to Washington. The pilot tunes in the Newark Beam on leaving Newark. He receives an "A" signal. Desiring, on account of the weather to stick close to the true course, he must go to the left to catch the "on course" signal. An amateur turns sharply to the left, the experienced pilot slides over.

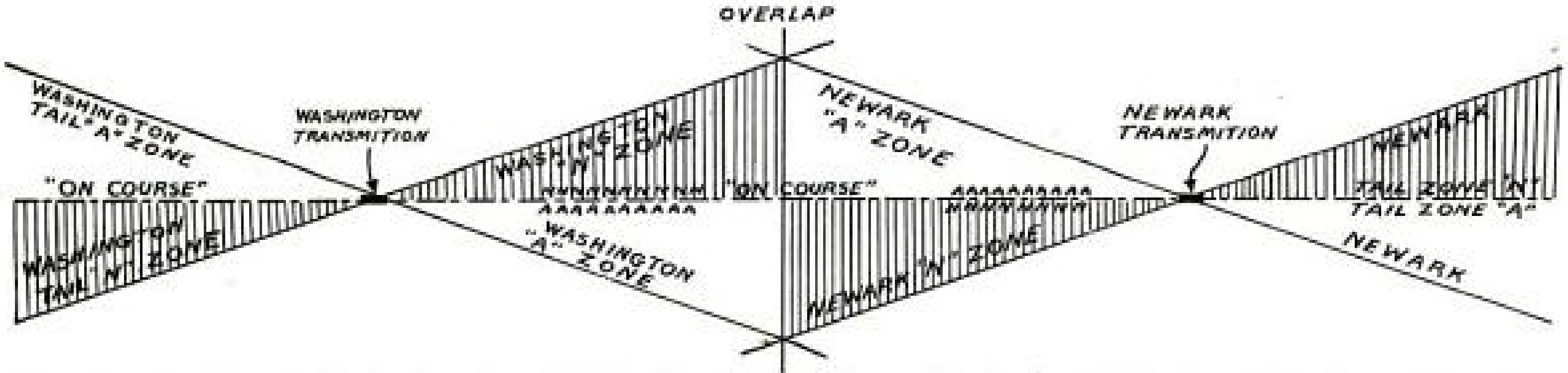


Fig. 1. Graphical diagram showing how the radio beams diverge and overlap so that the "N" and "A" tones reverse their position at the center of the line and at points beyond the stations. These points of reversal in the nature of the signal tell the pilot whether he is in the center of his run or whether he has passed either of the two terminal stations.

The angle of approach to "on course" is important. A sharp angle, one of 80 or 90 degrees across the beam, usually results in overrunning the "on course" signal and lands the pilot in the "N" zone. A like turn to the right brings him back into "A" zone. Thus, his course is somewhat like a corkscrew in appearance.

It has been noticed that the signals are weak on the outskirts of the beam. By listening to the volume of the signal, the pilot can determine his distance from the course center and governs his approach accordingly.

A gradual, flat angle approach does the trick. Once on course, only a slight change of heading is needed and he "rides the beam". Approach to "on course" from "A" or "N" zones is heralded by receiving the steady dashes of that position as an underbeat of the zone signal. When on course, any tendency to slide off results in receiving the "A" or "N" as an underbeat—becoming louder as the error in direction increases.

At the overlap, the Washington beam is tuned in and the zones are reversed, "A" for "N", or "N" for "A". This serves to identify the pilot's position. On the new beam the narrowing takes effect. The "drawing-in" has begun.

As the plane nears the Washington transmitting station, the slightest deviation from the "on course" cannot be made without receiving the signal of the zone favored. Over the station all signals cease, for the beam is completed. Should the station be overrun, the beam is again heard, this time as at Newark—"A" for the right side zone and "N" for the left.

This is why the original Washington beam was reversed. The searchlight has its reflector back of the source of light, but the radio—having none—shoots in both directions like the recoil of a gun. This back part is known as the "tail" of the beam.

As a pilot nears the beam transmitting station, a new note or beat is heard—somewhat like the sound of the propeller of a boat. This is the noise caused by the transmitting machinery and serves as a warning to the beam wise pilot that the end of the beam is being reached.

This procedure reads so easy that we must slip in the inevitable joker. After arriving at the beam end, the pilot must find the landing field. In clear weather it is a simple matter, even in weather of poor visibility, as he knows the location of the field from the transmitting station signals. In weather of zero visibility, he has a job on his hands. Stations located to lay on the beam course make the job much easier. The "drawing-in" and "field finding" calls for experience and clear thinking.

I have known pilots to spend hours searching for the landing field after arriving at the beam end, waiting for a break to get down and losing it when the fog remains solid. Then back to the beam at the transmitting station to make a fresh start. To land, the pilot must see. Obstacles such as telephone poles, buildings and trees are poor companions of an airplane in flight. When we have wide open fields, low surroundings and landing beams, this trouble will vanish.

The variation of the beam station signals from the landing field location is this. When the Department of Commerce installed the beams, they failed to take into account the zeal and aptitude of the pilots who were to use them. It was intended that the beam was to be used for "coming through" rather than for "coming in". The "coming through" expression is used for the following conditions.

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Floats

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compiled, a complete set of lines should be faired on a half-size layout. This is done to eliminate any irregularities in the contours of the float, as offsets taken from small scale layouts will involve surprisingly large errors. The half-size lines should be faired by means of full length wooden splines or battens.

Parts involving complicated curves should be faired by the system of water lines and buttocks, which is simply projecting the curves where the water lines or the buttocks intersect the surface into a right angle view. Any irregularities of the surface will become immediately apparent.

The spacing of the frames and floors should be undertaken next. This will depend upon the gross weight of the seaplane, the type of construction and material used. The spacing can best be determined by making a brief loading analysis, using required loading as specified by the Department of Commerce in Bulletin 7-A or by the Military Services. The position of the frames and floors should be located on the half-size layout and offsets for detail design measured from them.

There are several types of construction which may be followed with confidence and the designer should have no trouble on this score.

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Radio Beams

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Say that a patch of bad weather exists on the course—the departure point and destination being sufficiently clear to take-off and land. As most bad weather comes in low with a limiting ceiling, the pilot can climb over or go through the low ceiling as he will. He keeps course by means of the beam.

Formerly, a bad stretch of weather meant the cancellation of the flight, especially if passengers were concerned. This occurred when the bad spot was large in area. By use of the beam, a flight can be made over a course 80 percent. bad weather, the only requirement being a clear landing area. Department of Commerce rulings on this bad weather flying forbade flying through under a 500-foot ceiling. This rule is to be waived. The decision for the flight rests on the pilot, unless impossible flying weather exists. In these extreme cases the flight is cancelled from the operation's office of the line. In general, passenger pilots are required to use more discretion in bad weather flights than are the pilots of the mail planes.

They, the mail pilots, were the ones that caused the upset. They flew the beam in weather that was fit to be called "pea soup", inventing the process of "drawing-in". With their parachute as an ace in the hole, they dared the weather to do its best to force them down.

Now comes the training of the pilots to fly this beam through the "soup". Radio keeps him going in the right direction. As to how he goes depends upon himself. His ability to fly by instrument needs be highly developed. When the natural check point, the ground, disappears in scud, fog or mist, he must turn to these instruments and believe what they tell him.

That is the secret of instrument flying—believing in the instruments against his own sense of balance. The interpretation of the instruments is easily learned, but the belief comes hard. Once the lesson of faith is digested, instrument flying becomes a matter of experience. Blind flying becomes instrument flying, the plane goes through and the schedule is kept.

So many articles have been written on the subject of flying by instrument that it will not be discussed or expounded here. For those who wish to learn more of this subject, Howard Stark, veteran mail flyer and instructor of the pilots on the Eastern Air Transport, has a book on the subject.

Let it be known that it requires no super-pilot to do this work. Pilots have taken off blind from a runway in bad weather with 200 and 300-foot ceilings all along the course. With their skill at instrument flying and the Radio Beam, they made the flight under conditions that formerly were impossible.

The installation of beacons has made night flights a much easier matter. The beacon acts as a lighthouse and the flying is no more difficult than flying from one light to the next. The more experienced pilots fly a course parallel to the beacons.

The safe axiom of beacon flying was "a beacon ahead", meaning that the flight continued as long as the next beacon was visible from the one underneath. As the beacons are sometimes flown when the visibility is so poor that the beacon cannot be seen until directly over it, perhaps the axiom—not the ruling—may go the way of the 500-foot ruling. Bad weather calls for a combination of the beacons and beam.

One-way communication is made possible by means of the beam. At stated intervals, the beam signals are shut-off and the weather is broadcasted to the pilots enroute. This gives the course weather, the local weather and any special features or local conditions of interest to the pilots. The pilot can determine from these reports, also with the reports given him at his last stop, just what the weather is going to do. It is equally important for him to know the conditions behind him for he may have to retreat or seek landing fields to the right or left of him.

Having this continuous weather data, he can plan his flight and navigation according to conditions. This beam information is called "One Way Communication." On planes where space and weight carrying ability permit, the "Two way Radio" is installed. With this the pilot can communicate with the ground stations of his line. He gives his position, weather dope for other pilots, company business, etc. The stations in return give him weather conditions, local conditions, such as smoke, haze, new obstacles, etc.

So the weather observation may be termed the "Spy system" of the pilot's army. The Intelligence Corps watches the weather for the slight change, passing it on for the information of those concerned. They can now make preparations for the battle it may give. The Beam gives the weather, two-way gives the weather and the stations furnish a written weather report to the pilot, all of which are concerned with weather.

On the pilot's shoulders rests the burden of condensing the information furnished. He must perfect himself in the use of the mechanical aids made for his use. Radio, Weather Man, Pilot, Navigator—his schooling is not yet ended.

To the many knowing the obstacles, the marvel of a printed schedule of operation is still a miracle. To run an established schedule over a nine hundred mile run was a dream disbelieved by even the most optimistic. But it was done. Now the transatlantic run is next.

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