

A VFR pilot with a single omni receiver can do more than track inbound and outbound from a VOR station. Think in terms of time, distance and magnetic bearings when flying the omnirange

A typical VOR (omni) station operated by the FAA

## Get The Most From Your Omni

Don't lament because you do not have dual omni receivers in your airplane to take as full advantage of the virtually static-free omnirange navigational system as does the pilot flying IFR. With one properly functioning omni receiver and a little know-how, the VFR pilot can enjoy the advantages of:

Tracking with a practical course accuracy of plus or minus 2°, which is possible with most VOR receivers.
Locating airports which are sit-

uated off airways.

• Conducting "running fixes."

• Navigating off airways between omni stations.

• Determining flying time to the station when groundspeed or exact location along the radial is not known.

• Using the localizer portion of an ILS system to track to the runway of an airport of destination.

In order to achieve some professional proficiency with the omni receiver, the VFR pilot can shorten the learning time by thinking in terms of time, distance and magnetic bearings when flying the omnirange, rather than in terms of "just flying the needle."

For example, if a track of  $90^{\circ}$  is to be followed into a station, the usual way for the novice pilot is to set up his receiver, and then turn the airplane in the direction indicated by the left-right needle. When the needle is centered, he continues to



FIGURE 1 Locating off-airway airports

keep it there by turning the airplane one way or the other. Here it can be seen that he is using the left-right needle as a primary source of information, and perhaps regarding the magnetic heading of the airplane in a secondary manner.

This method of flying the omni radial will, of course, guide the airplane to the station, but has the following disadvantages:

1. Should the omni receiver become inoperative or the omni station go off the air, the pilot may become confused as to what heading to hold in order to make good his track to the station without the aid of the omni signal.

2. If he continues to "fly the needle" when approaching the cone of confusion near the station, he will experience some wild needle chasing until he spots the omni station.

3. The pilot is not conditioning his mind to the concept that magnetic bearings are the basis for accurate radio navigation, and therefore, can experience mental confusion when he attempts to work out an orientation problem, or apply other services of the omni receiver which go beyond tracking on a radial.

The recommended way to fly the omnirange (or any other radio facility) is to think of it as a "navigational aid," and its role is to indicate whether the aircraft's heading is the proper one to steer it to the desired destination, or to supply data in the form of magnetic or relative bearings to be used for plotting an aircraft's position, and for determining groundspeed, drift, wind direction and velocity, etc.

Referring again to the example of tracking into a station on a 90° radial

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-the proficient pilot sets up his receiver, determines the amount of "cut" (number of degrees of change to be added or subtracted from the aircraft's present magnetic heading) and then flies the new heading to intercept the desired radial. Depending upon the turning radius of the airplane, he will turn to the magnetic bearing of 90° a few seconds before the left-right needle centers, or immediately after it centers.

Upon completing the turn, he holds the 90° magnetic heading to determine the amount of drift. This is manifested by the left-right needle, which will move off center and indicate the direction of the drift correction. To determine the amount of drift when VFR, the course selector can be adjusted to bring the L-R needle back to center (with a "to" indication), and the difference between the original 90° radial and new reading of the course selector will (Continued on page 52)



FIGURE 2 Conducting 'running fixes'

FIGURE 3 Navigating off airways between omni stations

## Most From Your Omni

(Continued from page 35)

indicate the approximate amount of drift in degrees.

Or, if the pilot does not wish to disturb the course selector as when IFR, he can approximate the amount of drift from the amount of deflection of the L-R needle. By consulting the operating manual for the omni receiver used, the number of degrees reflected by a deflection from the center line to the outside limit can be found. Once this is known, it is relatively easy to interpolate the drift.

(If the full deflection of the L-R needle represents  $10^\circ$ , then one-half scale deflection would represent  $5^\circ$  of drift; a quarter-way deflection would represent  $2\frac{1}{2}^\circ$  of drift.)

With the drift angle approximated, the pilot takes another cut to get the airplane back on the  $90^{\circ}$  radial. However, this time when the airplane is on the  $90^{\circ}$  radial, the drift correction is applied to the aircraft's heading, and the pilot holds the corrected heading. Usually after one or two corrections for drift, the pilot can determine a magnetic heading which virtually will lock the aircraft onto the desired radial. Now let's look at some other uses for

the omni receiver, such as:

Locating airports which are not on an airway nor served primarily by a VOR station — Referring to Figure 1 on page 34, a pilot plans to fly from Welcome Airport to Lost Nation Airport, and he desires to use the Chardon omni (CXR) to locate Lost Nation. On his chart he draws a line from Lost Nation to Chardon omni, and finds that Lost Nation is 317° "from" the station. This distance from the omni station to Lost Nation measures only 16 miles, so he knows that he can depend upon a good signal strength over Lost Nation at a relatively low altitude of 1,500 feet. The next step is to draw a course line of  $30^{\circ}$  or so from Welcome Airport to where it intersects the bearing line from the Chardon VOR to Lost Nation. With this accomplished, he takes off and flies the 30° heading. As he proceeds northeast he tunes his omni receiver to the Chardon frequency, setting the course selector to 317°. Immediately the to-from indicator shows "from" and the L-R needle deflects fully to one side.

From the pilot's view, the navigation is quite a breeze. He just sits there and holds the 30° heading until the L-R needle creeps down the scale and centers. At that moment the pilot turns his airplane to a magnetic heading of 317°, corrects for drift, and sets up a heading which will take him outbound (from) on the 317° radial. In a matter of a few minutes time, Lost Nation Airport appears right beyond the nose of his airplane.

This example illustrates just one of the several ways an omni station can be used to locate an off-airways airport. This same idea also can be applied to a situation where the track is inbound to the airport and the omni station. Just remember: (1) to draw a course line from the omni station to the desired airport; (2) fly a course to intercept the radial course line; and (3) turn and follow the radial to the airport.

Conducting "running fixes"—If the course of an airplane coincides with a turnpike, railroad track, shore line, or the like, the ground track can be maintained with reference to same and a general heading, and any position along this line can be verified if an omni station can be received. In the situation shown in Figure 2 (page 35), a pilot was flying in a westerly direction along the south shore of Lake Erie, and wished to verify several check points.

In looking at his sectional chart he observed that the nearby Jefferson omni would serve as a base station for the running fixes. By extending the  $40^{\circ}$ "from" radial, he saw that it would pass through the middle of the town of Conneaut, and establish a fix on the check point coming up.

Quickly he tuned in the Jefferson omni, verified it, and set the course selector on  $40^{\circ}$ . The to-from indicator showed "from" and the L-R needle swung far to one side.

As the flight progressed to the west, the L-R needle moved slowly down the scale until at position A (Figure 2), it centered. This position of the L-R needle verified that the town located at 10 o'clock (with reference to the nose of the aircraft) was Conneaut. For the second running fix the course

For the second running fix the course selector was set to  $0^{\circ}$  (see Figure 2), and when the L-R needle centered, the city of Ashtabula was verified.

city of Ashtabula was verified. For the third fix off the Jefferson omni, the 300° "from" radial was used to verify the aircraft's position just north of the two towns of Madison and Geneva.

If additional running fixes are to be made as the flight progresses, the sequence can be set up again on another omni station which may be found to be within good reception distance of the aircraft, and located in a direction generally ahead of the aircraft position.

Navigating off VOR airways between omni stations—To learn this technique will pay off twofold, since the basic theory is position finding by triangulation. So it is that (1) a pilot can navigate "between omni stations" where no VOR airway exists, and (2) he will become proficient at "finding" the position of the aircraft at any time desired, as long as it is within reception of two omni stations.

To perform the tuning of the omni receiver and plotting on the chart while flying the aircraft—is quite a task for one man. It works out quite well when there are two pilots aboard, one to fly the aircraft and hold the heading, while the other completes the navigation chores.

Here is how this "off VOR airways" navigation can be conducted. Referring to Figure 3 (page 35), a pilot and a friend planned a flight from Airport "A" to Airport "B," and the direct airline course was found to run "between" the Cleveland and the Mansfield omni stations. The pilot drew a course line on the chart, and figured out a heading to make good the course.

About five or eight minutes after reaching their cruising altitude, the copilot took the first fix. He tuned in the CLE omni and adjusted the course selector until the L-R needle centered with a "from" reading—the course selector read 182°. He jotted down this figure and then quickly retuned the receiver to the MFD omni for the "from" bearing. With the L-R needle again centered, the course selector read 98°. This reading was jotted down, as was the time of 13:00.

Now possessing the two magnetic "from" bearings, the copilot placed a small ruler on the chart and drew a line from the center of the CLE omni out through the 182° mark on the compass rose, and continued it slightly beyond the course line.

He repeated the line drawing, this time connecting the center of the MFD omni with the 98° mark on the compass rose, and extended the bearing line until it intersected the first bearing line. Where the two lines crossed was the location of the aircraft at the time the fix was taken.

If the crossing of the two bearing lines had fallen on the course line between Airports "A" and "B," it would have indicated that the heading was correct. If the "fix point" had fallen to one side or the other of the course line, then a correction to the heading would be required to put the aircraft back on its general course.

It can be observed that with this method, the fix pinpoints the exact location of the aircraft, and the amount of drift off course can be estimated rather closely.

During the flight depicted in Figure 3, the copilot took two other fixes, following the same procedure as with the first. Each fix verified the position of the aircraft as it proceeded along the course, which was between omni stations where no VOR airway exists.

Determining flying time to the omni station when groundspeed or exact location along the radial is not known— When inbound to an omni station, it is desirable to know an estimated time at which the aircraft will pass over the station. To figure an ETA is a simple matter of setting up groundspeed against distance-to-station on the computer. But when the pilot is unsure of the aircraft's position along a radial, and unaware of the groundspeed, the problem may appear somewhat more confusing.

However, it need not be, for the problem can be solved in about 2<sup>1</sup>/<sub>4</sub> minutes.

Proceed this way: take note of the radial on which the aircraft is tracking (bearing #1), turn 90° either way, and fly the gyro compass for two minutes on a right-angle heading from the

original inbound radial. At the end of two minutes, turn the aircraft toward the station and determine the new radial (bearing #2).

Subtract bearing #1 from bearing #2 (or vice versa if #1 is larger) to obtain the differences. Divide the difference into 120 (two minutes) and the result is the number of minutes flying time to the station.

Example: track into the omni station is 240° (bearing #1); after flying two minutes to the left at a right angle (gyro heading of  $330^\circ$ ), turn toward the station and determine the new radial (bearing #2). Let's say it turns out to be  $250^\circ$  then

Bearing #1	240
Bearing #2	250
Difference or change	10

120 divided by 10 equals 12 minutes approximately to station.

(Note: When the wind at cruising altitude is below 10 knots, the estimated time is rather close to the actual time; when the wind is between 10 to 25 knots, the estimated time usually falls within plus or minus three minutes.)

Using the localizer portion of an ILS (Instrument Landing System) to track into an airport — If the omni receiver used can receive "localizer" signals (refer to the manual for the type receiver), another navigational aid can be used to locate an airport with an ILS. The localizer is similar to a "single radial omni station," and the radial is

lined up with the instrument approach runway. Hence, an aircraft can track inbound on the localizer radial and be led to the runway.

Since the localizer is also within the VHF spectrum, the distance of reception varies with altitude. At 2,500 feet (MSL) reception is about 25 miles maximum from the airport; at 5,000 feet about 40 miles; and at 10,000 feet the range is about 80 miles.

When inbound on the localizer to the approach end of the instrument runway, this is referred to as the "front course" and the L-R needle acts in its normal omni fashion (i. e., turn toward the needle to stay on course.)

Since the localizer also radiates a radial in an opposite direction to the "front course," this is logically called the "back course," and can be used in the same fashion for tracking inbound or outbound from the airport. The point here to remember is, when flying the back course of the localizer, the action of the L-R needle is reversed. To bring the needle to the center line, the aircraft must be turned *away* from the needle rather than toward it as in the front course.

Localizer signals are usually found

in the lower end of the aircraft VHF band. Their identifications are preceded by the letter I (two dots.) Frequencies for the various localizer signals at airports, and their magnetic bearings, can be found in the Airman's Guide or approach plates used for IFR work.

So it can be seen that a single omni receiver in an aircraft can be used for a number of services, in addition to tracking inbound or outbound from an omni station. Remember to fly the aircraft by establishing a heading to hold the track, and use the omni to check and verify positions—don't rely on "flying the needle" as the primary reference. By combining the factors of heading, time and distance with omni flying, a single omni receiver will pay a good return in service for the investment.

## THE AUTHOR

END

Ted Durosko, author of "Get the Most From Your Omni," is well known to PILOT readers. His last article, "A Natural Approach to Instruments," appeared in the December 1961 issue.