Department of Transportation

FEDERAL AVIATION ADMINISTRATION

VFR PILOT EXAM-O-GRAM* NO. 39

SIMPLE ADF FOR VFR NAVIGATION

To test the applicant's knowledge of the practical aspects of cross-country flying, FAA written examinations contain test items on the use of radio aids to VFR navigation. In analyzing applicant performance on written examinations, it is apparent that a high percentage of applicants lack an adequate understanding of Automatic Direction Finding (ADF) procedures. Since a large number of modern aircraft are ADF equipped, it is essential that VFR pilots have a reasonable knowledge of the use that can be made of this important navigational aid. Since there is very little instructional material available to the VFR pilot in this area of knowledge, the material which follows is pertinent, timely, and promotes aviation safety.

The methods presented here are only the basic and more common uses of ADF suitable for VFR flights where "pin point" precision is not a vital factor. These methods include how to (1) fly to the station, (2) determine the direction of your position from the station, and (3) determine the ADF indication that signifies arrival at a desired direction from the station.

WHAT TYPE OF RADIO STATIONS CAN BE USED FOR ADF? Most ADF receivers receive signals in the frequency spectrum of 190 KHz (Kilo Hertz) to 1750 KHz, which includes LF (low frequency) and MF (medium frequency) navigation facilities, and the AM (amplitude modulation) commercial broadcast stations. Primarily for air navigation, the LF/MF stations are FAA and private non-directional radio beacons (Rbn), ILS compass locators (LOM), and four-course radio ranges (MRA). Marine radio beacons can be used but present difficulties in air navigation because they transmit only at brief scheduled periods and are arranged in groups of three or more along the coast, with each in the group transmitting on the same frequency. AM stations, or standard broadcast stations, are useful for air navigation; but remember that they can be identified only when the broadcast is interrupted for "station identification," some operate only during daylight hours, and many of the low-powered stations transmit on identical frequencies causing erratic ADF indications.

HOW DOES AN ADF INSTRUMENT INDICATE DIRECTION TO THE STATION? As implied by its nickname "Bird Dog," the ADF has automatic direction qualities which result in the indicator always pointing to the station to which it is tuned. This action is presented to the pilot on the vertically mounted face of the instrument (Fig. 1 and 2); that is, when the pointer is straight up (nose position), the station is ahead of the aircraft; when the pointer is straight down (tail position), the station is behind the aircraft; and when pointing 90° to either side (wing tip position), the station is off the respective wing tip.

WHAT DOES THE ADF INDICATION MEAN IN TERMS OF BEARINGS TO THE STATION? The more commonly used ADF instrument (sometimes termed Radio Compass), to which this Exam-O-Gram relates, has a stationary azimuth dial graduated up to 360° (with 360 or 0 at the top of the instrument representing the aircraft nose). The bearing pointer shows only the relative bearing, or angle from the nose of the aircraft to the station; i.e., the Relative Bearing in Fig. 1 is 060°. A more sophisticated instrument called a Radio Magnetic Indicator (RMI) uses a 360° azimuth dial which, being slaved to a gyro compass, turns with the aircraft to continually show the Magnetic Heading of the aircraft at the top of the instrument. With this rotating azimuth thus referenced to a magnetic direction, the bearing pointer superimposed on the azimuth, then indicates the Magnetic Bearing to the station. For example, in Fig. 2, the Magnetic Heading is 240°; the Magnetic Bearing to the station shown by the No. 1 needle, is 104°. The No. 2 needle shows a Magnetic Bearing of 040° to another station.

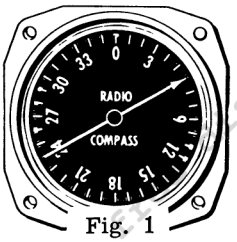

Fig. 1

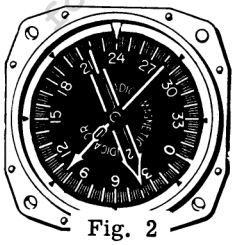
Fig. 2

* Exam-O-Grams are non-directive in nature and are issued solely as an information service to individuals interested in Airman Written Examinations.

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HOW CAN ADF BE USED TO FLY TO THE STATION? The easiest, and perhaps the most common method, is to "home" to the station. Since the ADF pointer always points to the station, simply head the aircraft so that the pointer is on the 0° or nose position. The station, then, will be directly ahead of the aircraft. With a crosswind, however, the aircraft would continually drift and, unless a change in heading is made, would no longer be headed straight to the station. This would be indicated by the pointer moving to the windward side of the nose position. By turning into the wind (toward the pointer) so as to continually return the pointer to the 0° position, the aircraft is flown to the station, although in a curving flight path, as shown in Fig. 3 inbound. (As this curving flight path deviates from the direct course, use caution to avoid drifting into unanticipated obstructions or terrain.) The lighter the crosswind and the shorter the distance, the less the flight path curves. Upon arrival at and passing the station, the pointer will swing from a nose position to a tail position.

IS IT POSSIBLE TO "HOME" AWAY FROM THE STATION? For all practical purposes--NO! "Homing" away from the station can be accomplished only if there is no crosswind. Attempting to keep the station directly behind the aircraft in a crosswind by turning to keep the pointer on the tail or 180° position, requires that the aircraft be turned more and more to a downwind heading. This, of course, results in the aircraft getting further and further from the desired course (Fig. 3 outbound).

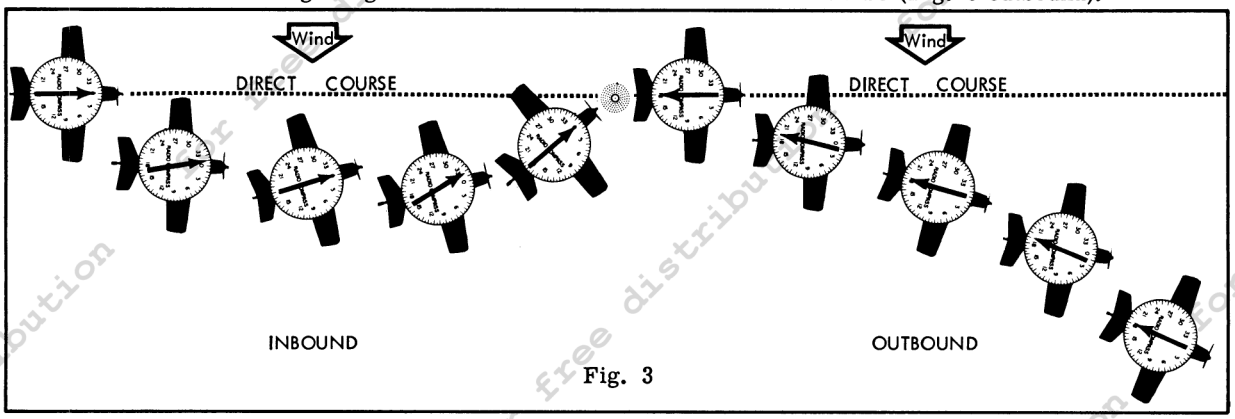

Fig. 3

OF WHAT IMPORTANCE IS THE MAGNETIC HEADING OF THE AIRCRAFT WHEN USING ADF? ADF should be considered as a moving, "fluid" thing. The number to which the indicator points on the fixed azimuth dial does not mean anything directionally until it is related to the aircraft's heading. Due to this relationship, the heading must be observed carefully when reading the Relative Bearing-to-the-station. Anytime the heading is changed, the Relative Bearing will be changed an equal number of degrees.

HOW CAN THE MAGNETIC BEARING TO A STATION BE DETERMINED ON A FIXED ADF AZIMUTH DIAL? Looking at the ADF instrument, imagine yourself as being in the center of the fixed azimuth, with the nose of the aircraft at the 0° position, the tail at the 180° position, and the left and right wing tips at the 270° and 090° positions respectively. When the pointer is on the nose position you are heading to the station and the Magnetic Bearing can be read directly from your compass (plus or minus deviation). If the pointer is left or right of the nose, note the direction and number of degrees of turn that would (if you were to head to the station) move the pointer to the nose position, and mentally apply this to your heading. For example, in Figure 4, a turn 60° to the left would place the pointer on the nose position. 60° left of the 090° Magnetic Heading is a Magnetic Bearing of 030° to the station. Your location, then, is southwest of the station, and if you were to head to the station, your heading would be 030°.

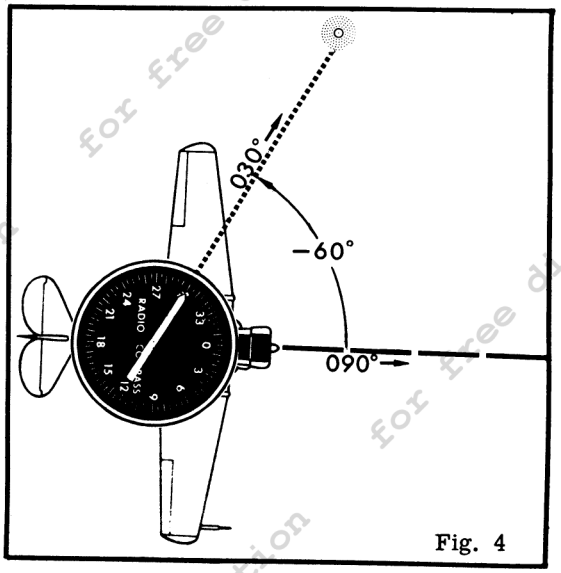

Fig. 4

HOW CAN THE MAGNETIC BEARING FROM THE STATION BE DETERMINED? Since the direction from the station is the opposite of the direction to the station, it can be determined by following the steps discussed in the preceding paragraph and add or subtract 180°, as appropriate, to the aircraft-to-station bearing. In other words, find the reciprocal of that bearing. If the ADF pointer happens to be behind the wing-tip position (flying away from the station), an alternate method is to note the number of degrees and the direction of turn that would move the pointer to the tail position, and apply to the heading. For example, in Figure 5, a turn 45° to the right would place the pointer on the tail position. 45° to the right of the 030° Magnetic Heading is a Magnetic Bearing of 075° from the station (east-northeast of the station). Just as "radials" always extend outward from a VOR station in a magnetic direction, the Magnetic Bearings from an ADF station should be thought of as "radials" of that ADF station. It is important to determine the radial (bearing from the station) because to locate your position, the line of position must be plotted from the known station location, as similarly done in VOR orientation.

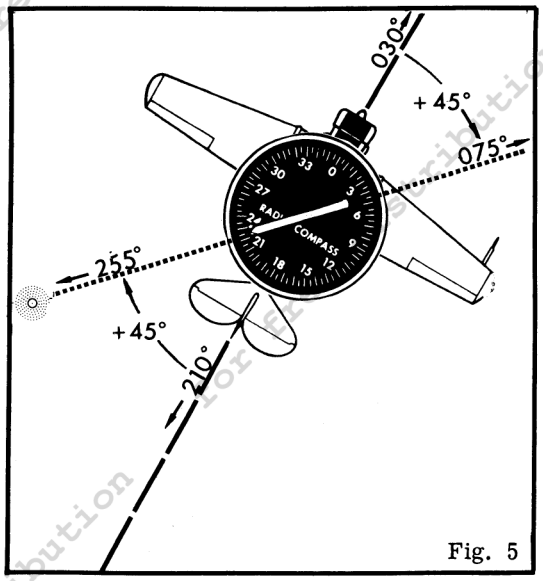

Fig. 5

CAN THE ADF INDICATION WHICH SIGNIFIES ARRIVAL AT A SPECIFIC BEARING-TO-THE-STATION BE PREDETERMINED? YES! From the aeronautical chart, first ascertain whether the station is left or right of the course being flown. Then, after selecting the Magnetic Bearing-to-the-station that you desire to intercept, determine the angular difference between that bearing and your Magnetic Heading (angle of intercept). With the aircraft headed to the 0° position of the ADF azimuth, the bearing indicator, in pointing to the station, will show the relative angle between the aircraft's nose and the station. As you continue on course this angle will gradually change, since the position of the aircraft relative to the station is changing. Arrival at the preselected bearing-to-the-station will be indicated when the pointer shows the difference between the heading and that bearing (angle of intercept). For example, as shown in Figure 6, if your Magnetic Heading is to be 315° and the selected bearing-to-the-station is 225°, the angular difference is 90° left. Arrival on this bearing then, will be indicated when the pointer is 90° left of the nose position. If the station is to the right of the course on a bearing of 045°, the 90° angle between the heading and the bearing would be shown to the right of the nose position, as in Figure 7.

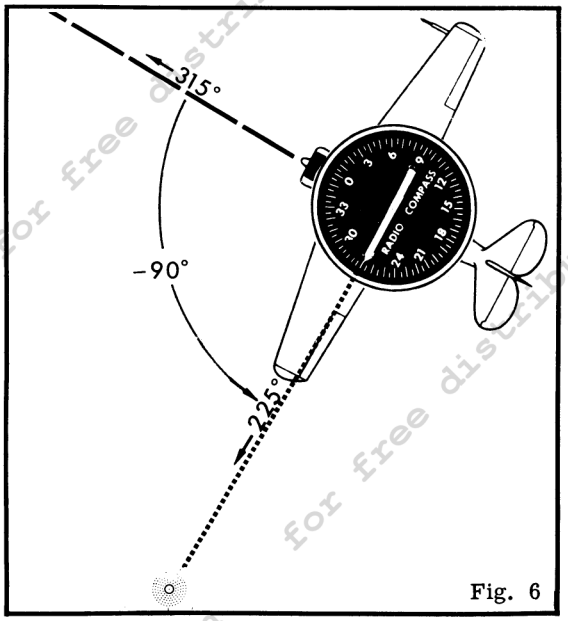

Fig. 6

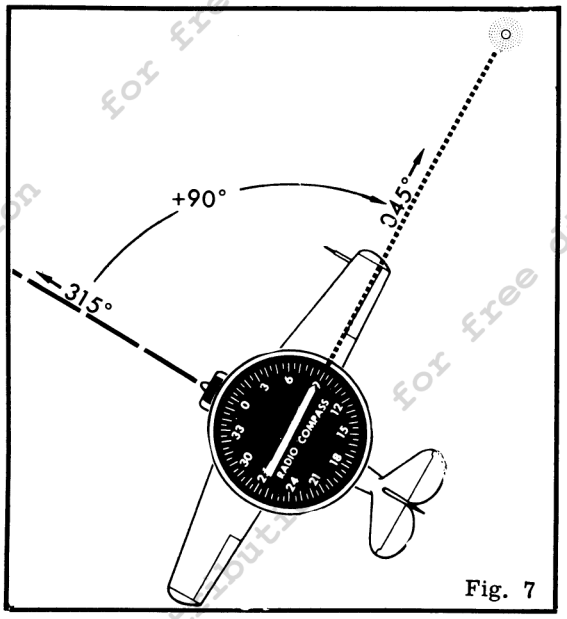

Fig. 7

HOW CAN MAGNETIC BEARINGS TO OR FROM A STATION BE DETERMINED ON AERONAUTICAL CHARTS? Since a compass rose or azimuth is not shown at LF/MF or AM stations on VFR-type charts, the most accurate way to obtain a Magnetic Bearing is to measure the direction with a plotter, taking into account the local magnetic variation. However, the many VOR azimuths and airway courses (already oriented to magnetic direction) printed on the chart can be used satisfactorily for approximation of ADF bearings on VFR flights. This approximation can be made on the basis of the direction of the nearest VOR radial or airway that most closely parallels the bearing of the ADF station. Remember, though, that the VOR radial or printed airway direction is outbound from the station. To find the bearing to the station, simply determine the reciprocal of the parallel radial or airway.

HOW CAN ADF BE USED TO SUPPLEMENT VOR NAVIGATION? One of the most valuable uses of ADF is the determination of your position along the course being flown. Even though you are following a course along a VOR radial, obtaining an ADF bearing that crosses the course will establish your "fix" or position along that course. This is particularly advantageous when an off-course VOR is not available for a cross bearing or when the only VOR receiver must be used as the primary tracking system.

WHAT CAN CAUSE AN ERRONEOUS ADF INDICATION? As mentioned earlier in this Exam-O-Gram, two or more standard broadcast stations may transmit on the same (or close to the same) frequency and interfere with each other's signal. This causes the ADF pointer to oscillate in an attempt to discriminate between stations. Whenever possible, choose stations of higher power and lower frequencies or wait until you are closer to the station before using it. Another source of erroneous bearings is improper tuning, or tuning in the fringes of a signal. Always tune to the center of the signal, which may be a few KHz (Kilo Hertz) on either side of the published frequency. And, of course, always make an absolute identification of the station before using it for navigation purposes. In the vicinity of electrical storms, the ADF pointer tends to swing from the radio station to the center of the storm at every flash of lightning. This makes it difficult to obtain reliable bearings. Erroneous or fluctuating bearings may also result from the deflection of radio waves from the surface of mountains. Use caution when taking bearings over mountainous terrain.

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