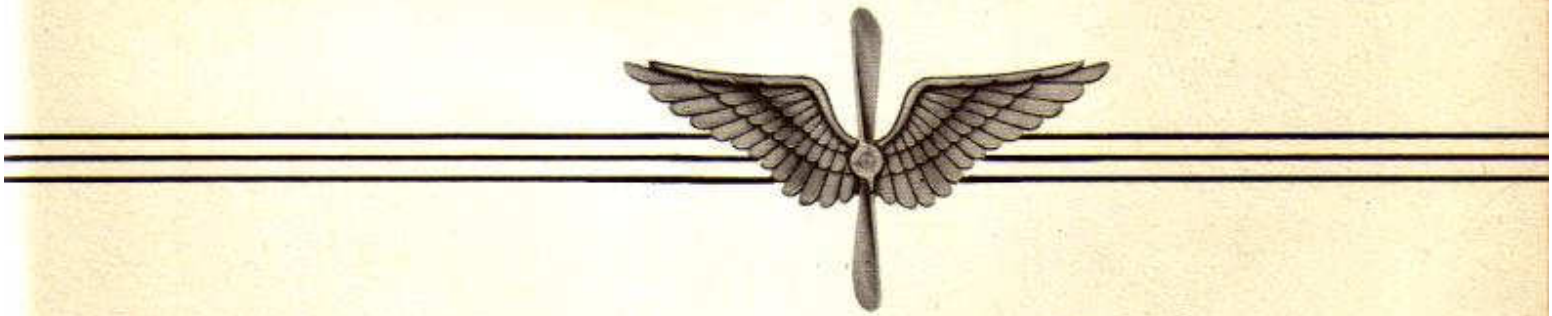
RESTRICTED
DIST: 9
FILE: IR

TECHNICAL ORDER NO. 30-100F-1

INSTRUMENT FLYING

ARMY AIR FORCES

INSTRUMENT APPROACH SYSTEM



NOTICE: *This document contains information affecting the National Defense of the United States within the meaning of the Espionage Act, 50 U.S.C., 31 and 32, as amended. Its transmission or the revelation of its contents in any manner to an unauthorized person is prohibited by law.*

PUBLISHED BY AUTHORITY OF THE COMMANDING GENERAL,
ARMY AIR FORCES

NOVEMBER 10, 1943

THIS PUBLICATION MAY BE USED BY PERSONNEL RENDERING SERVICE TO THE UNITED STATES OR ITS ALLIES

Paragraph 5.*d.* of Army Regulation 380-5 relative to the handling of "restricted" printed matter is quoted below.

> "*d.* Dissemination of restricted matter.—The information contained in restricted documents and the essential characteristics of restricted material may be given to *any person known to be in the service of the United States and to persons of undoubted loyalty and discretion who are cooperating in Government work*, but will not be communicated to the public or to the press except by authorized military public relations agencies."

This permits the issue of "restricted" publications to civilian contract and other accredited schools engaged in training personnel for Government work, to civilian concerns contracting for overhaul and repair of aircraft or aircraft accessories, and to similar commercial organizations.

DISTRIBUTION NOTICE

Under the provision of T. O. No. 00-25-3, dated April 19, 1943, this technical order is assigned distribution symbol 9, "assigned to publications that will receive special distribution . . .", file symbol R, "assigned to publications that will be given special local re-distribution . . . .", and file I, "assigned to publications that will be included in Instrument (Link) Trainer Departments of activities, offices, and organizations."

Copies of this technical order will be furnished in bulk to the Commanding Generals, A. A. F. Western, Central and Eastern Training Commands for distribution within the Flying Training Commands as required.

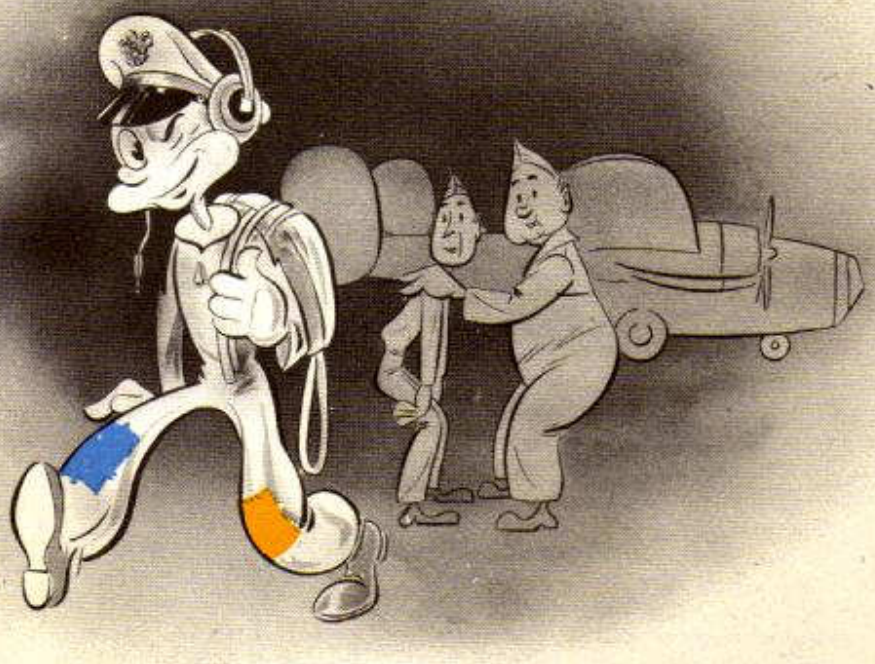
Initial distribution to A. A. F. stations and bases not under the control of the Flying Training Command will be in quantities to permit a local distribution to interested flying personnel. One (1) copy will be included in the files of the Station Technical Inspector

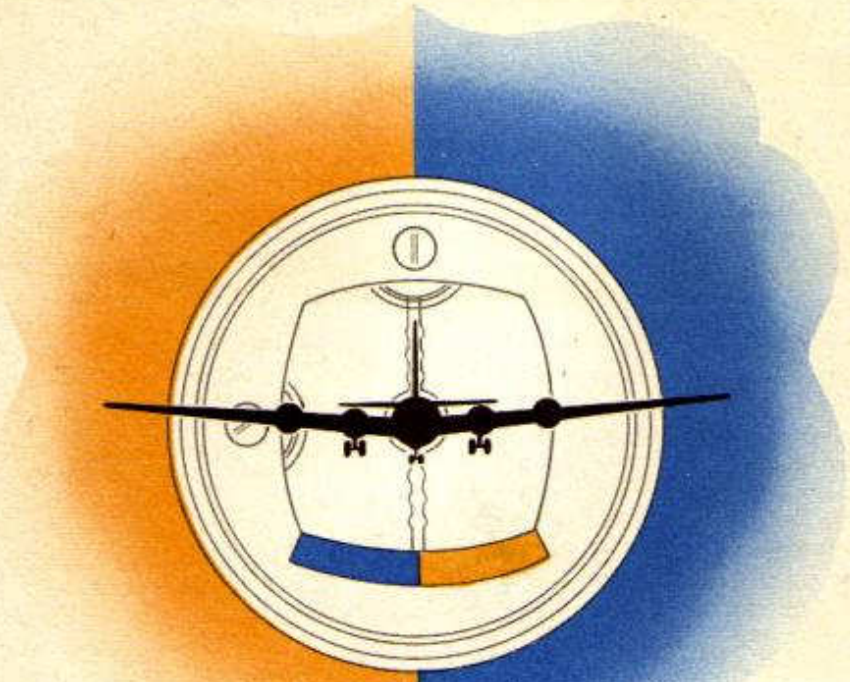
Instrument trainer departments will maintain two (2) copies per trainer.

ADDITIONAL COPIES

Additional copies of this technical order may be secured on requisition Activities will submit requisitions on A. A. F. Form No. 102 in quadruplicate to: Commanding General, Fairfield Air Service Command, Patterson Field, Ohio, Attention: Publications Distribution. For details on distribution of Technical Orders, see T. O. No. 00-25-3.

TABLE OF CONTENTS





FOREWORD

Instrument approach procedures on the radio ranges are limited to let downs through the overcast, provided ceiling and visibility are above a relatively high minimum. The aircraft must proceed to an alternate airport whenever the ceiling and/or visibility is lower than the approved minimum for this type of operation.

Special installations are required to provide the pilot, in flight, with accurate directional guidance along the landing flight path when landing under lower minimums becomes necessary. These radio landing aids must guide the pilot through the overcast on a line of flight which will bring the aircraft to a landing on the near end of the runway under conditions of zero/zero visibility and ceiling.

The original Army Landing System, employing two portable radio transmitters emitting a signal on 201 kilocycles and 219 kilocycles respectively, now known as the Modified A-1 System, can be successfully used to guide the pilot below a 250-foot overcast into a position whence a contact landing straight ahead is practical. The one great advantage of this system is that no equipment need be installed in the aircraft in addition to the Left-Right Radio Compass or the Automatic Radio Compass already available. It is not a true landing system because the flight path of the aircraft cannot be controlled accurately enough to bring the aircraft onto a runway.

The foregoing installations are being currently superseded by the complete "Localizer-Glidepath" installations, which are described in detail under Section III. The earlier equipments are also covered herein, because the Modified A-1 system is still in operation and use, and because the Runway Localizer installation is a component part of the complete system. The Localizer-Glidepath employs the ultra high frequency fan markers, the runway localizer and the glidepath transmitters. The position of the aircraft is shown with respect to the runway approach line by the Blue/Yellow indications of the pilot's localizer indicator (I-101-C) and with respect to the glide path approach by the horizontal needle of the same indicator. This glidepath is projected, from a point a short distance from the approach end of the runway to be used, at an angle 2° to 2.5° above the horizontal.

The British Standard Beam Approach System, also known as the Lorenz, renders let downs to minimum ceilings of 100-foot practical. A detailed discussion of the flight procedures in use with the British Standard Beam Approach System has been published for the information of the Service in T.O. No. 30-100E-1.

SECTION I
THE MODIFIED A-1 SYSTEM

1. GENERAL DESCRIPTION.

a. The Modified A-1 System is essentially the old Air Corps system of instrument landing, modified with respect to the distance from the landing field at which the component parts of the ground equipment are operated. Two definite check points are provided on the prolongation of the runway to be used for landing. Descending on this line to predetermined altitudes over each check point, the aircraft is lined up to permit a straight-in contact landing. The indications of the sensitive altimeter are used to control the altitude at which the check points are passed. Because the flight path of the aircraft cannot be flown precisely, the aircraft must not descend below 200 feet above the level of the airport on instruments.

b. The ground installations for this system consist of a pair of compass locator transmitters, each equipped with a VHF marker beacon transmitter mounted on trucks to provide mobility. Power for operation of the units is provided by generators mounted in the trucks, thus each station is a completely self contained unit. The stations differ only in frequency and tone modulation of the signals emitted by the compass locator transmitters, and in the keying of the marker beacons signals. Thus no doubt of the identity of the station, tuned in and received, can exist.

2. MIDDLE MARKER STATION.

This unit is placed 4500 feet from the down-wind end and on the prolongation of the runway to be used for landing. The compass locator transmitter emits a signal, tone modulated at 700 cycles, on 201 kilocycles. The VHF marker beacon signal on 75 megacycles is keyed to transmit six dashes per second in a vertical fan-shaped pattern.

NOTE

In previous publications this station was designated as the "Inner Station." To avoid confusion with the boundary marker of the localizer system, and to standardize, it is now designated the "Middle Marker."

3. OUTER MARKER STATION.

This unit is placed 3.5 miles from the Middle Marker Station in a straight line with the runway, and Middle Marker Station. The compass locator transmitter emits its signal, tone modulated at 1100 cycles, on 219 kilocycles. The VHF marker beacon signal on 75 megacycles is keyed to transmit two dashes per second in a vertical fan-shaped pattern.

4. AIRCRAFT EQUIPMENT.

This aircraft must be equipped with the Automatic Radio Compass (although the older types of Left-Right indicating radio compasses can also be used for training purposes) and the associated marker beacon receiver. No additional radio equipment is required in the aircraft. It should be noted that the earlier models of marker beacon receivers obtain their power supply from the radio compass, thus, whenever the radio compass is operating the marker beacon receiver is also functioning. Later models of marker beacon receivers obtain their power directly from the aircraft power supply and operate independent of the radio compass. Present type marker beacon receivers provide *only visual* indications. The reception of the keying of the 75 megacycle signals depends upon the type of marker beacon transmitter over which the aircraft is flying. When flying over radio transmitter BC-302, the transmitter used originally with the A-1 system, the light on the instrument panel remains continuously on while the aircraft is in the field of the transmitter. However, when flying over marker beacon transmitters emitting keyed signals, the light flashes in unison with the keying of the signal.

5. AUTOMATIC RADIO COMPASS OPERATION.

a. Radio control box switch to "COMP." (See Figure 1.)

b. Push "Control" switch to operate green light.

c. "Band Switch" to 200-410.

d. Turn "Tuning" crank to 201 or 219 kilocycles and listen for 700 or 1100 cycle tone as the case may be. Rotate crank back and forth for maximum deflection of tuning meter for exact dial setting.

e. Adjust "Audio" for satisfactory head-set level.

NOTE

If desired the radio compass can be operated independently from the other radio equipment and the interphone circuits, by plugging the pilot's head set directly into the jack on the radio control box.

f. The Pilot's Indicator, of the Automatic Radio Compass, (see Figure 2) will indicate "ZERO" whenever the aircraft is headed directly toward the radio transmitting station. If the station is to one side or the

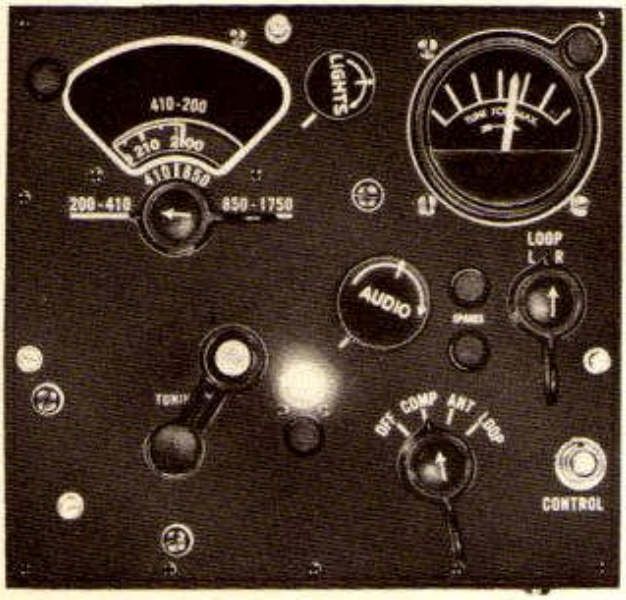


Figure 1—Automatic Radio Compass Control Box.

other the pointer will indicate the number of degrees in relation to the heading of the aircraft. A reading of 33 (330 degrees) indicates the station is 30 degrees to the left of the heading of the aircraft. A correction to the left is necessary (provided drift due to wind is not considered).

Figure 2—Pilot's Bearing Indicator.

6. THE COMPLETE FLIGHT PROCEDURE.

a. (See Figure 3.) The pilot, maintaining flight altitude of the aircraft, will tune the Automatic Radio Compass to 201 kilocycles and listen for the 700 cycle tone of the Middle Marker Station. Before the Middle Marker Station is reached he will call for the altimeter setting and for an approach clearance. After setting the sensitive altimeter, which will then read the surveyed elevation of the airport (plus or minus instrument errors) upon landing, and after he has been cleared for approach, he will pass over the Middle Marker Station. The marker beacon light will flash and the pointer of the Automatic Radio Compass will swing 180 degrees as the aircraft crosses the station.

b. The pilot must immediately tune the radio compass to 219 kilocycles and turn the aircraft until the pointer of the Pilot's Indicator again reads "ZERO". The aircraft will not be homing on the Outer Marker Station. The accuracy at which the remainder of the problem is flown will largely depend upon the rapid tuning to the Outer Marker Station. The pilot must beware of turn tightening which may result if he tries to regain time lost in tuning to the Outer Marker Station.

c. While homing on the Outer Station the directional gyro may now be set on 180 degrees, and a descent to an altitude of 1200 feet above the level of the airport is made.

d. When the Outer Marker Station is crossed as indicated by the 180 degree swing of the Automatic Radio Compass indicator pointer, and by the flashing of the marker beacon light, the gyro heading of the aircraft is maintained for 30 seconds. Then a procedure turn is made by a 45-degree change of heading, either to the right or left depending upon the terrain, held for 40 to 45 seconds followed by a standard rate turn to regain the inbound heading. At the completion of this turn the aircraft will be flying toward the station on the inbound heading. The directional gyro and the pointer of the Automatic Radio Compass indicator should both read "ZERO". If this is not the case, the pointer of the Automatic Radio Compass must be flown toward the Outer Marker Station.

e. After the procedure turn has been completed the landing gear is lowered, flaps are extended if required for the type of aircraft being flown, and power is adjusted for let down as indicated in the applicable operating instructions. A descent is made to 800-900 feet and the Outer Marker Station crossed at that altitude.

f. Immediately upon crossing the Outer Marker Station, the radio compass is again tuned to 201 kilocycles (the Middle Marker Station) and altitude is lost at a constant rate of 400 to 500 feet per minute, holding the air speed well above stalling. The directional gyro is readjusted to zero if necessary. The Middle Marker Station must be crossed at an altitude of between 200 and 250 feet above the level of the airport.

g. After the Middle Marker Station is passed the gyro heading of zero degrees and the rate of descent is held until 200 feet is reached. The airport should now be visible, and the aircraft should be in position to land contact straight ahead. The Gyro Heading, not the indications of the Automatic Radio Compass, must be flown after the Middle Marker Station is passed. If the Middle Marker Station is reached at too high an alti-

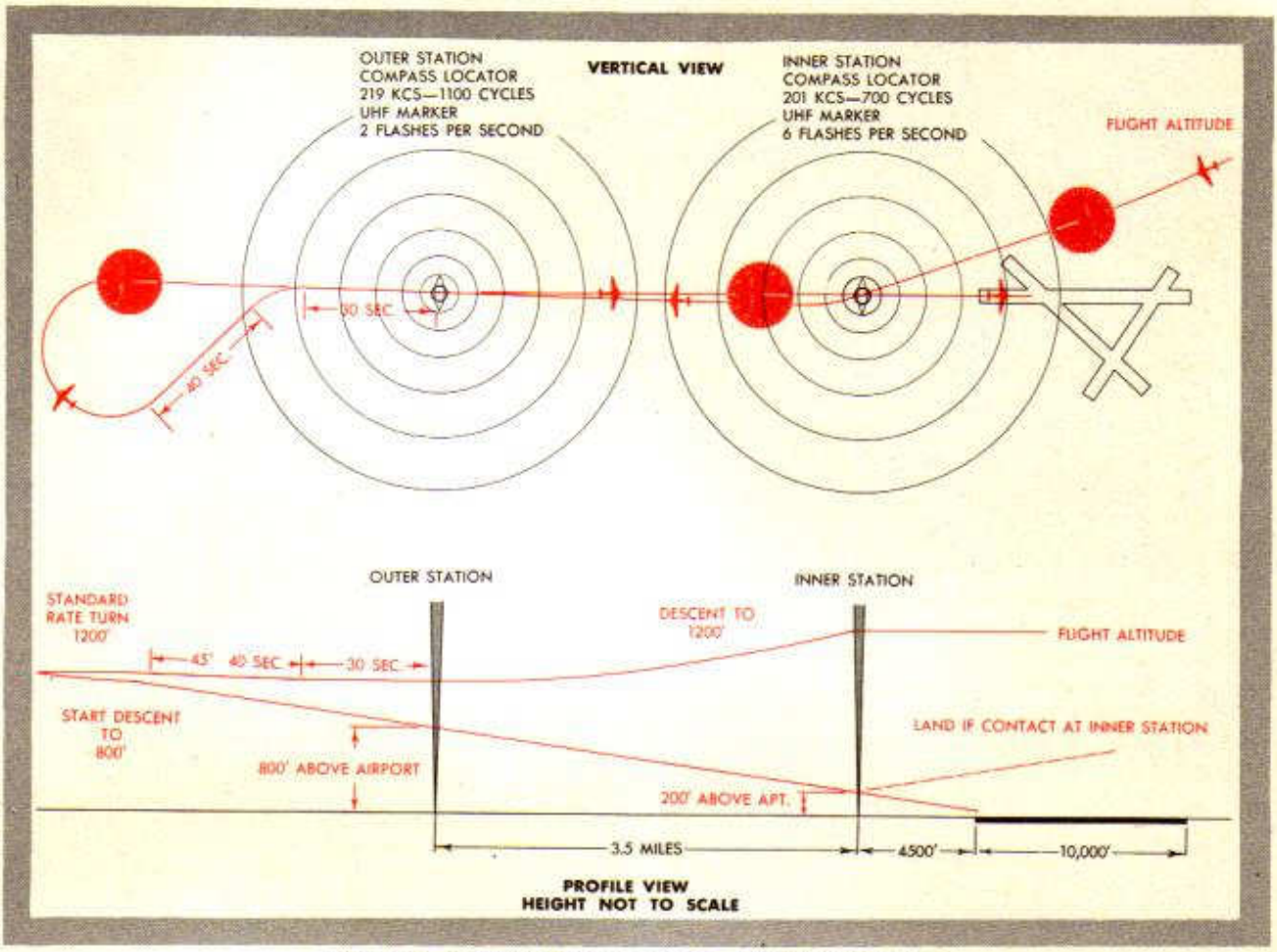


Figure 3—Complete Flight Procedure—Modified A-1 System.

tude, an immediate climb must be made and the entire procedure repeated. A new landing clearance must be obtained from the control tower in this case.

7. ADDITIONAL NOTES.

a. No effort can be made in this Technical Order to specify precise operating instructions for the types of aircraft which may be flown on the Modified A-1 or Localizer Landing Systems. The specific conditions of flaps, propeller pitch, manifold pressure, etc., necessarily differ with the various types of aircraft. It is important that the attitude of the aircraft and the rate of descent be constant throughout the final let down. This condition should be established before the Outer Marker is crossed.

b. With some aircraft it may be desirable to make the turns at one-half standard rate. In this case the off-course heading of the procedure turn must be held for double the normal length of time before the one-half standard rate is started.

c. If, on the initial approach, the Middle Marker Station is reached at a heading close to that to be flown toward the Outer Marker Station, the problem becomes much simpler because no excessive turning will be necessary when tuned to the Outer Marker Station. The initial approach can, with the Automatic Radio Compass, be planned so as to reach the Middle Marker Station on an "easy approach heading."

d. The automatic feature of the radio compass becomes inoperative if the phasing antenna is lost due to icing or other causes. This may be checked by switching to "ANT" and checking the aural signal. If no signal is heard, the loss of the phasing antenna is indicated.

SECTION II
THE RUNWAY LOCALIZER SYSTEM

1. GENERAL DESCRIPTION.

In this system the compass locator stations of the Modified A-1 system are replaced by the Runway Localizer transmitter. The pilot is provided with an accurate indication of the alignment of the flight path of the aircraft with the runway to be used for landing. An additional VHF marker beacon transmitter is installed at the down-wind end of the runway to provide a final "stand by for landing" indication. The installation, see figure 8, then consists of the Localizer, the Boundary Marker, the Middle Marker, (1 mile from the end of the runway) and the Outer Marker (3½ miles from the inner marker). The Middle and the Outer Markers are keyed as in the Modified A-1 System with 6 and 2 flashes per second respectively, while the final clearance marker is unkeyed. The Radio Compass Locator stations, while available in a few of the early installations are not used in the system. However, the Radio Compass Receiving equipment must *not* be switched off, because this action will render the marker beacon receiver inoperative. This is true except in the case of aircraft equipped with the independently operated marker beacon receiver.

2. LOCALIZER.

a. The transmitting equipment is a mobile, self-contained unit mounted in a truck. Approximately ½ hour is required to place the transmitter in operation, if the equipment is not in place. The equipment is operated at a position approximately 1000 feet from the upwind end of the runway

b. The transmitter is crystal controlled to one of six available frequencies between 108.3 and 110.3 megacycles. The signal is modulated at 90 and at 150 cycles; the two fields being considered as blue and yellow colored sectors as a matter of convenience. The pattern produced is similar to a two on-course radio range, and is flown as such by visual indication. The blue sector is transmitted to the right of the beam, right with respect to the inbound aircraft. The yellow sector then is to the left of the inbound aircraft. The normal range of the beam is in excess of 25 miles at an altitude of 2500 feet; this range increases with altitude.

3. AIRCRAFT RECEIVER.

a. The receiver installed in the aircraft for use with the Runway Localizer Transmitter is remotely controlled by a small control box installed near the pilot's seat. (See Figure 4.) The six available frequencies, at one of which the Localizer will be operating, are indicated by the letters U, V, W, X, Y, Z inscribed on the control box. To operate the equipment the main

Figure 4—Runway Localizer Control Box.

switch is turned "ON" and the selector switch turned to the desired frequency. The set is now operative and the Pilot's Localizer Indicator (Figure 5) installed on the instrument panel, will indicate the color area of the transmitter in which the aircraft is then flying by the deflection of the indicator needle. That is, if the aircraft is flying well off-course in the blue area of the transmitter, the needle will indicate a full scale deflection in the blue area of the indicator. The direction toward the beam will not be indicated by this needle deflection. The following should be noted with reference to the needle action.

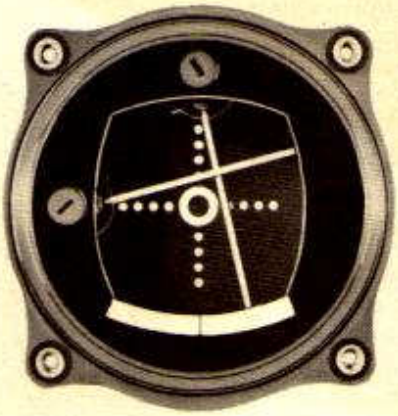


Figure 5—Pilot's Localizer Indicator.

b. When the aircraft is flying on the front beam of the Localizer, headed toward the runway, the action of the needle is directional, that is, when the needle points right, the aircraft must be turned right to regain the center of the Localizer beam. This needle action also applies when flying on the back beam and the aircraft is headed away from the station transmitter.

c. When the aircraft is flying on the Localizer in the reciprocal direction, that is, headed away from the runway when on the front beam, the sensing of the needle will appear reversed. A turn in the direction indicated by the needle will take the aircraft further away from the beam in this case.

d. In either case the needle will correctly be deflected in the color area of the Localizer installation.

e. The blue area is on the right of the aircraft when the aircraft is headed *toward the runway on the front beam.* (See Figure 6.) Since the aircraft flying off-course in the blue area will be to the right of the beam a correction of heading toward the left is necessary to regain the on-course. The indicator shows this correction, and the needle can be followed.

f. The blue area is on the left of the aircraft when the aircraft is headed *away from the runway on the front beam.* Since the aircraft flying off-course in the blue area will now be to the left of the beam, a correction of heading toward the right is necessary to regain the on-course. But the indicator now shows blue and the needle will be pointing toward the left, away from the beam. The relative location of the aircraft to the beam will be correctly indicated, but the sensing will be reversed.

g. The needle is very sensitive and will give a full scale deflection when the aircraft is 3.5 degrees to either side of the on-course. This high degree of sensitivity permits the use of the indicator for accurate runway localization. If the pointer is no farther off-center than one-quarter scale, the aircraft will land on the runway. Five thousand feet from the localizer transmitter a one-third scale deflection indicates a distance of 75 feet from the center of the on-course. It should be noted that for zero/zero landings at least 7000 feet of runway must be available.

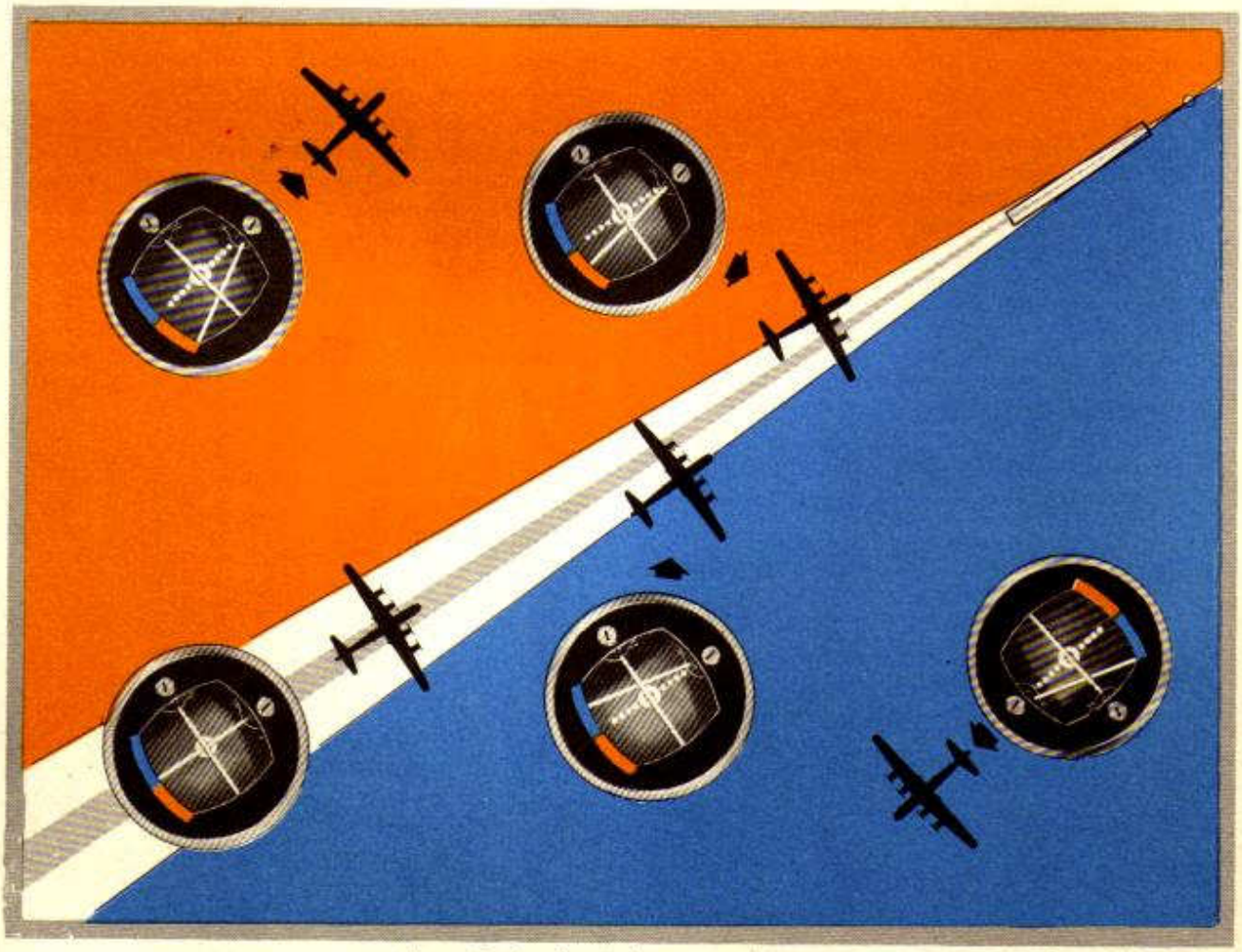


Figure 6—Localizer Indicator Needle Action.

4. THE RUNWAY LOCALIZER PROCEDURE.

a. (See Figure 8.) Permanent installations will be at airports also equipped with radio range stations. In these cases, the aircraft will be flown to the radio range station as in standard airways flying, and the pilot will call for the altimeter setting and his approach clearance. He will switch "ON" the localizer receiver. After having set the altimeter, and being cleared to land, the pilot will set course from the cone of the radio range to the point of intersection of the known radio range leg with the beam of the runway localizer.

b. Thereafter, the system varies from the Modified A-1 system only in that no further reference to the Automatic Radio Compass is made, the Localizer furnishing on-course indications. Flying the leg of the radio range, the pilot will observe the needle of the Localizer indicator. The needle will move from its original full scale deflection toward center as the aircraft approaches the Localizer beam. The pilot now turns the aircraft to intercept the Localizer beam, assuming the outbound heading toward the procedure turn. On the outbound heading the needle will point to the correct color areas, but sensing will appear to be reversed as previously explained. Following the pointer will not return the aircraft to the on-course. Corrections may be made by reference to the directional gyro until the aircraft is on-course and flying in line with and away from the runway. This heading will bring the aircraft over the "Outer Marker." The pilot will be able to check the operation of the "Middle" and "Outer" Marker as well as the operation of the marker beacon receiver as the aircraft passes over these stations. It is to be noted that the signal of the boundary marker may or may not cause the marker beacon indicator light to flash. This marker operates on limited power and consequently will not be received at the initial approach altitude in most cases. If the "Middle" marker is not received the pilot should check the main switch of the Radio Compass. If the marker beacon receiver is operating and either the "Middle" or "Outer" markers are not received the pilot should not continue the procedure until the tower has been requested to check the operation of the equipment.

c. The heading at which the localizer indicator needle remains within one-quarter scale of center should be established. Descent to 1200 feet above the level of the airport is made between the Middle Marker Station and the "Outer Marker," if this altitude was not reached between the radio range and the Middle Marker Station. When the Outer Marker Station Marker Beacon indication is received, course is maintained for 60 seconds. Then the procedure turn is made.

d. After the procedure turn has been completed the landing gear is lowered, flaps are extended if required for the type of aircraft being flown, and power is adjusted for let down as indicated in the applicable operating instructions. A descent is made to 800 feet and the Outer Marker Station crossed at that altitude.

e. When the procedure turn is completed, the needle indications of the localizer indicator become directional. The on-course can now be precisely flown by following the localizer needle. It will be necessary to exercise caution not to overcorrect when the course becomes more difficult to follow as the Middle Marker Station and the runway are approached. All major corrections to course *must* be made before the "Middle Marker" is reached.

f. The altitudes over the "Outer" and "Middle" marker must be 800 to 900 feet and 200 to 250 respectively. The Boundary or Final Clearance Marker, which will cause the Marker Beacon Lamp to light, indicating the safe landing area is just ahead is crossed at 50 feet. If an actual blind landing is necessary, a normal descent is continued all the way to ground contact.

g. It will be found that after a few practice flights drift can be easily established by flying the needle within the center circle of the indicator and that small brackets will be adequate to hold the aircraft on the beam.

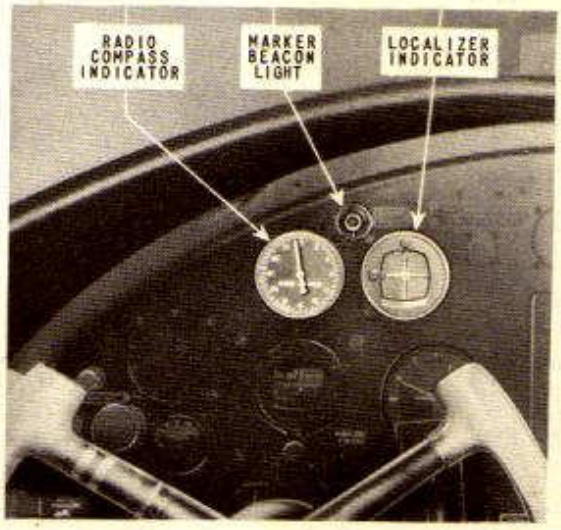


Figure 7—Aircraft Installation.

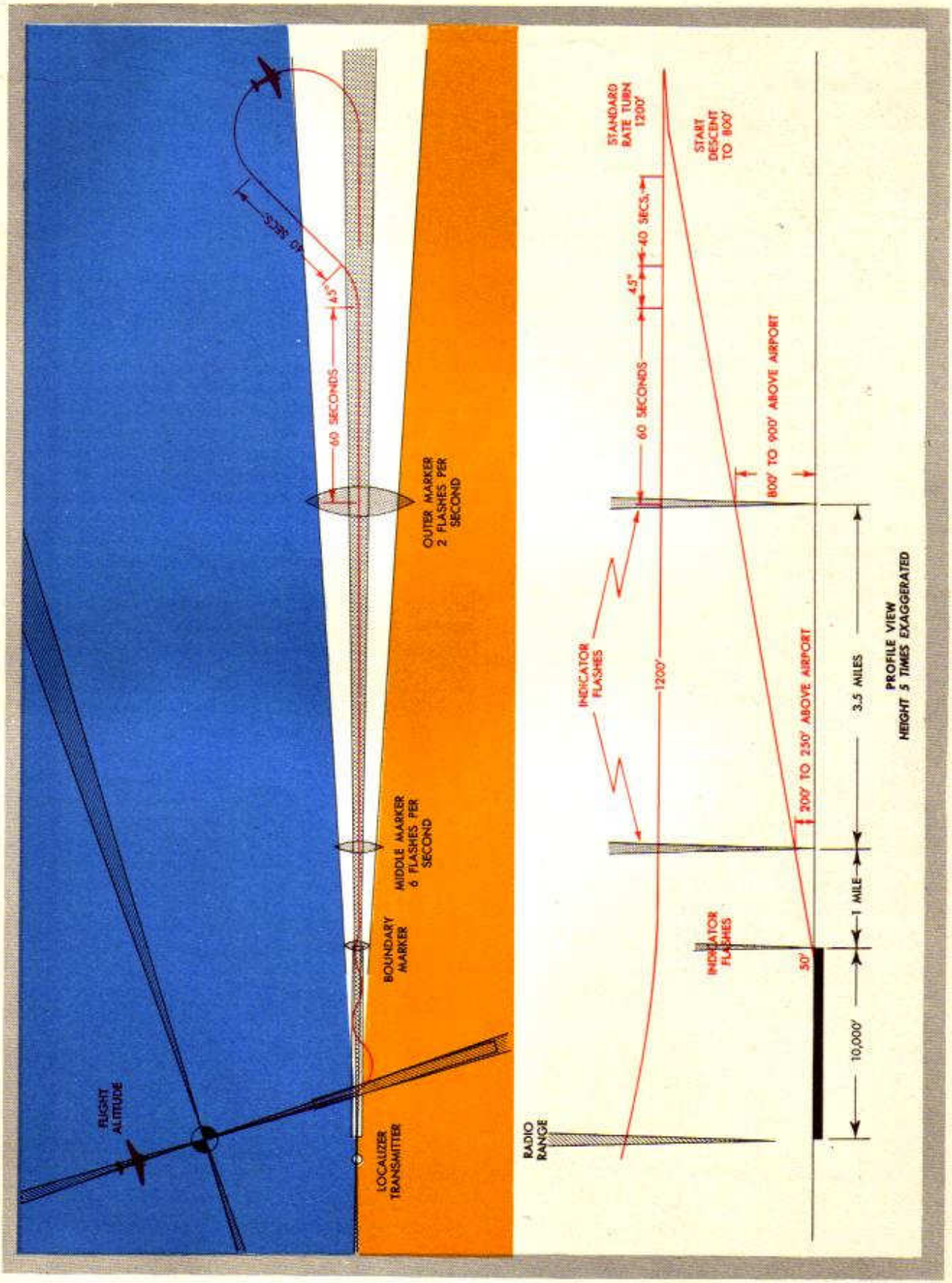


Figure 8—Complete Flight Procedure; Runway Localizer System

SECTION III
ARMY AIR FORCES INSTRUMENT APPROACH SYSTEM

1. GENERAL DESCRIPTION.

a. The present standard equipment (SCS-51) is being installed at Army Air Forces Fields and Bases. This equipment is self contained and is mounted in a truck and a trailer. Air transportable equipment is also being designed and fixed installations are being made by the C.A.A. at various airports throughout the United States. The complete installation consists of:

(1) The Runway Localizer Transmitter.

(2) The Glide Path Transmitter.

(3) The Outer Marker Station Transmitter.

(4) The Middle Marker Station Transmitter.

(5) The Boundary Marker Transmitter.

b. The Army Air Forces Instrument Approach System provides the pilot with a straight line glide path, flown by noting the horizontal needle of the runway localizer indicator. It also provides a visual indication of the lateral alignment of the flight path of the aircraft with the runway. The three markers, when used in connection with the sensitive altimeter, provide a further check. After homing to the airbase by any navigation aid available (that is radio compass or radio range) the aircraft will be flown to intersect the runway localizer path. After reaching the localizer path the flight is conducted by reference to the localizer indications. The A.A.F. Marker Beacon Indicator flashes when the aircraft passes over any of one of the three marker beacons, and on the final approach when the Outer, Middle and Boundary Markers are passed. The Automatic Radio Compass must therefore not be switched off, because this action would render the Marker Beacon Receiver inoperative, unless the aircraft is equipped with the independently operated Marker Beacon Receiver. On the final approach the aircraft being at the desired altitude is flown on the Localizer until the glide path is intersected. The pilot then establishes a uniform rate of descent by reference to the combined indication of the localizer and the glide path.

2. LOCALIZER.

a. The transmitting equipment is a mobile, self contained unit mounted in a truck. Approximately ½ hour is required to place the transmitter in operation, if the equipment is not in place. The equipment is operated at a position approximately 1000 feet from the upwind end of the runway.

b. The transmitter is crystal controlled to one of six available frequencies between 108.3 and 110.3 megacycles. The signal is modulated at 90 and at 150 cycles; the two fields being considered as blue and yellow colored sectors as a matter of convenience. The pattern produced is similar to a two on-course radio range, and is flown as such by visual indication. The blue sector is transmitted to the right of the beam, right with respect to the inbound aircraft. The yellow sector then is to the left of the inbound aircraft. The normal range of the beam is in excess of 25 miles at an altitude of 2500 feet; this range increases with altitude.

3. THE GLIDE PATH.

a. The transmitting equipment is a self-contained unit mounted on a small trailer of a size which makes it possible to load it into large cargo type aircraft such as a C-47. Approximately ½ hour is required to place the transmitter in operation, if the equipment is not in place. The equipment is operated at a position approximately 1000 feet down-wind from the approach end of the runway and 500 feet to one side. Simple adjustments make the equipment operative at either side of the runway. (See Figure 9.)

b. The transmitter is crystal controlled to a frequency of approximately 335 mc. The pattern produced

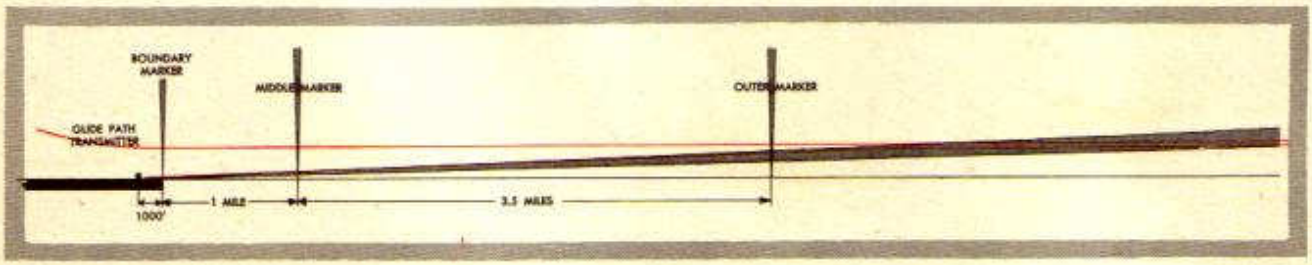


Figure 9—Scale Profile of Glide Path Installation.

is similar to the localizer except the "on-course" lies in a nearly horizontal plane. The glide path makes an angle of approximately 2½ degrees with the horizontal, however, this angle is adjustable over a small range, for use with various types of aircraft.

c. At a vertical angle of 17½ degrees a false course exists but is of reversed sensing and at 22½ degrees a false course of true sensing occurs. It will be realized, however, that the false courses will be unflyable in normal operation because of the high angle, since they would give a rate of descent of 5000 feet per minute or greater.

4. THE MARKER STATIONS.

a. The Outer Marker.—This unit is placed 3.5 miles from the Middle Marker Station. It consists of an ultra high frequency transmitter emitting two dashes per second in a vertical fan shaped pattern.

b. The Middle Marker.—This station is placed 1 mile from the end of the runway, and transmits a signal keyed to six dots per second in an identical pattern.

c. The Boundary Marker.—This station also operates on 75 megacycles but at a lower power output. The signal emitted is unkeyed and, it should be noted, the signal may or may not be received when passing over this station at the initial approach altitude.

5. AIRCRAFT RECEIVER.

a. The receiver installed in the aircraft for use with the glide path transmitter is remotely controlled, either by the localizer control box or by a separate control box installed near the localizer control box in the pilot's compartment. To operate the equipment the main switch is turned "ON". Since the receiver is fixed tuned, no tuning adjustments are necessary. The pilot's combined localizer–glide path indicator will indicate the position of the aircraft with respect to the glide path by the deflection of the horizontal needle.

b. When the aircraft is above the desired glide path the indicator needle is deflected downward and if the aircraft is below the desired path the needle is deflected upward. That is, the needle points in the direction the aircraft must be flown to approach the glide path. *This is true regardless of the heading of the aircraft.* (See Figure 10.)

c. The needle is very sensitive and will give a full scale deflection when the aircraft is 0.3 degrees above the glide path or 0.5 degrees below the glide path. This requires that the aircraft be aligned quite accurately on the glide path at some distance from the field. Only very minor corrections are allowable near the field.

d. The horizontal needle will be normally set to give a fly up indication when no signal is being received. This is done to reassure the pilot; thus he receives an "on-course" indication only when the equipment is working properly and the aircraft is on the desired glide path.

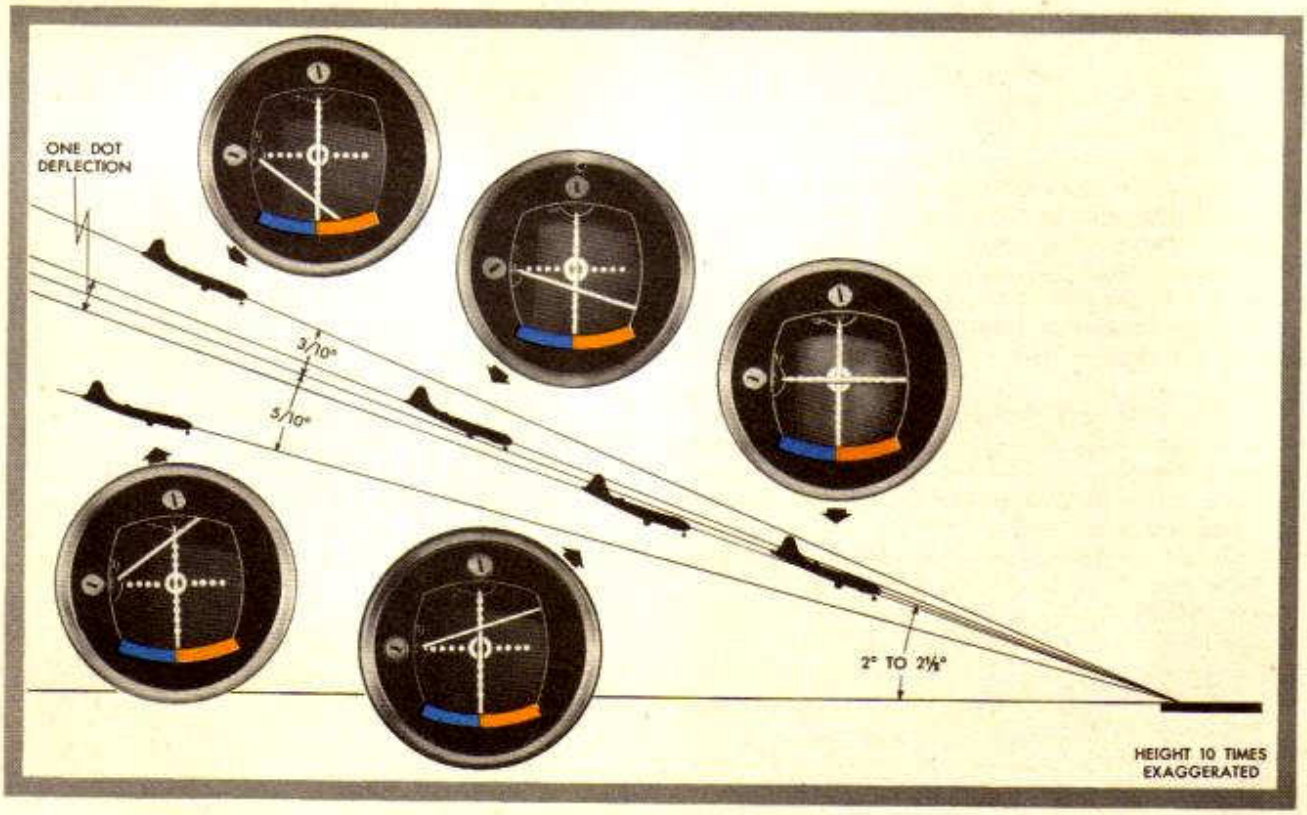


Figure 10—Glide Path Indicator Needle Action.

6. THE RUNWAY LOCALIZER AND GLIDE PATH PROCEDURE.

a. All permanent installations in the United States of the combined localizer and glide path systems will be at airfields also equipped with a radio range station. In these cases, the aircraft will be flown to the radio range station as in standard airways flying, and the pilot, while maintaining flight altitude, will contact the control tower for the altimeter setting and his approach clearance. (Before the range station is reached, the localizer and glide path units in the airplane will be turned *ON* by the single switch located on the localizer control box.) When the units are warmed up the desired localizer frequency is selected by placing the selector switch opposite the frequency number of the airport in question. (See Figure 4.)

b. Descend to 1200 feet over the range station and follow the particular beam leg which intersects the localizer path. (See Figure 11.) Bracket the localizer beam on the outbound heading. If the localizer beam is quickly bracketed the middle and outer markers will be passed on the outbound heading.

c. After the outer marker has been received the course is maintained for a maximum of 60 seconds, then a procedure turn is made either to the left or right depending upon the terrain.

d. After the procedure turn has been completed the landing gear is lowered, flaps are extended if required for the type of aircraft being flown, and power is adjusted for let down as indicated in the applicable operating instructions. As the procedure turn is being completed inbound indications on the glide path may be noted. A descent is made to 800-900 feet along the glide path and the Outer Marker is crossed at that altitude.

e. When the procedure turn has been completed, the needle indications of the localizer and glide path become directional and elevational respectively. The on-course can now be precisely flown by following the localizer in conjunction with the glide path. It will be necessary to exercise caution not to overcorrect when the course becomes narrower as the aircraft approaches the field.

f. The altitudes over the "Outer" and "Middle" Markers must be 800-900 and 200-250. This will be relatively simple if the glide path is followed. If the aircraft is below the glide path at any point *fly straight* until such time as the on-course indication is again received. *Do not attempt an abrupt climb to intersect the beam again.* The Boundary Marker will cause the Marker Beacon Lamp to light indicating the safe landing area just ahead, and a normal descent continued all the way to ground contact.

g. In the event that a *blind landing* is to be made after passing the boundary marker at approximately 50 feet reduce power and continue until ground contact is made and immediately close the throttles.

(1) For nose wheel type aircraft, hold nose wheel off the runway until after initial shock. After the nose wheel is lowered, brake to a normal stop, holding a constant gyro setting and using the localizer as a reference. The localizer is so sensitive on the runway that a needle deflection will be noted if the aircraft is but a few feet off the center of the landing runway.

(2) If a conventionally geared aircraft, upon contact with the runway, the power should be cut and the control column pushed forward enough to prevent the aircraft leaving the runway. As the tail wheel is lowered, the plane must be kept aligned with the runway by brake, rudder, or throttles. The localizer needle is a definite location checker.

7. ITEMS TO KEEP IN MIND WHILE FLYING THE INSTRUMENT APPROACH SYSTEM.

a. Maintain flight altitude until in contact with the tower.

b. Know your landing base either by careful reference to an Army Air Forces Instrument Approach Procedures book or by personal acquaintance with same.

(1) Check heading of the landing runway.

(2) Obstructions to landing.

(3) Altitude of landing runway.

(4) Relation of the radio range legs to the localizer beam.

(5) Turn on your approach equipment well before reaching the radio range.

c. Outbound pattern.

(1) Determine your drift.

(2) Remember that flying the *outbound* heading, *fly away from the needle.*

(3) Cross the outer marker and fly from 45 seconds to one minute before beginning your procedure turn.

d. Inbound pattern.

(1) If the procedure turn is completed before any localizer needle indication is noticed fly as to intersect the localizer beam at 30°.

(2) As the procedure turn is completed, lower gear, and flaps if desired, adjust power setting for a uniform approach.

(3) ***On the inbound heading fly into the needles.***

(4) ***Large corrections are unnecessary.*** Once on the beam, taking the drift into consideration, any turn over 10° either way from the landing heading will usually result in an unsuccessful approach.

(5) ***Do not overcorrect, give the plane time to react to a correction.***

(6) Do not make large corrections near the ground even though the *needle shows a major deflection. From the middle marker on down the localizer needle can be deflected as far off as one dot to the left or right and the aircraft will land on the runway.*

(7) *VERY IMPORTANT!!!* WATCH YOUR *AIRSPEED!!!*

(8) ***Do not be too proud to go around.***

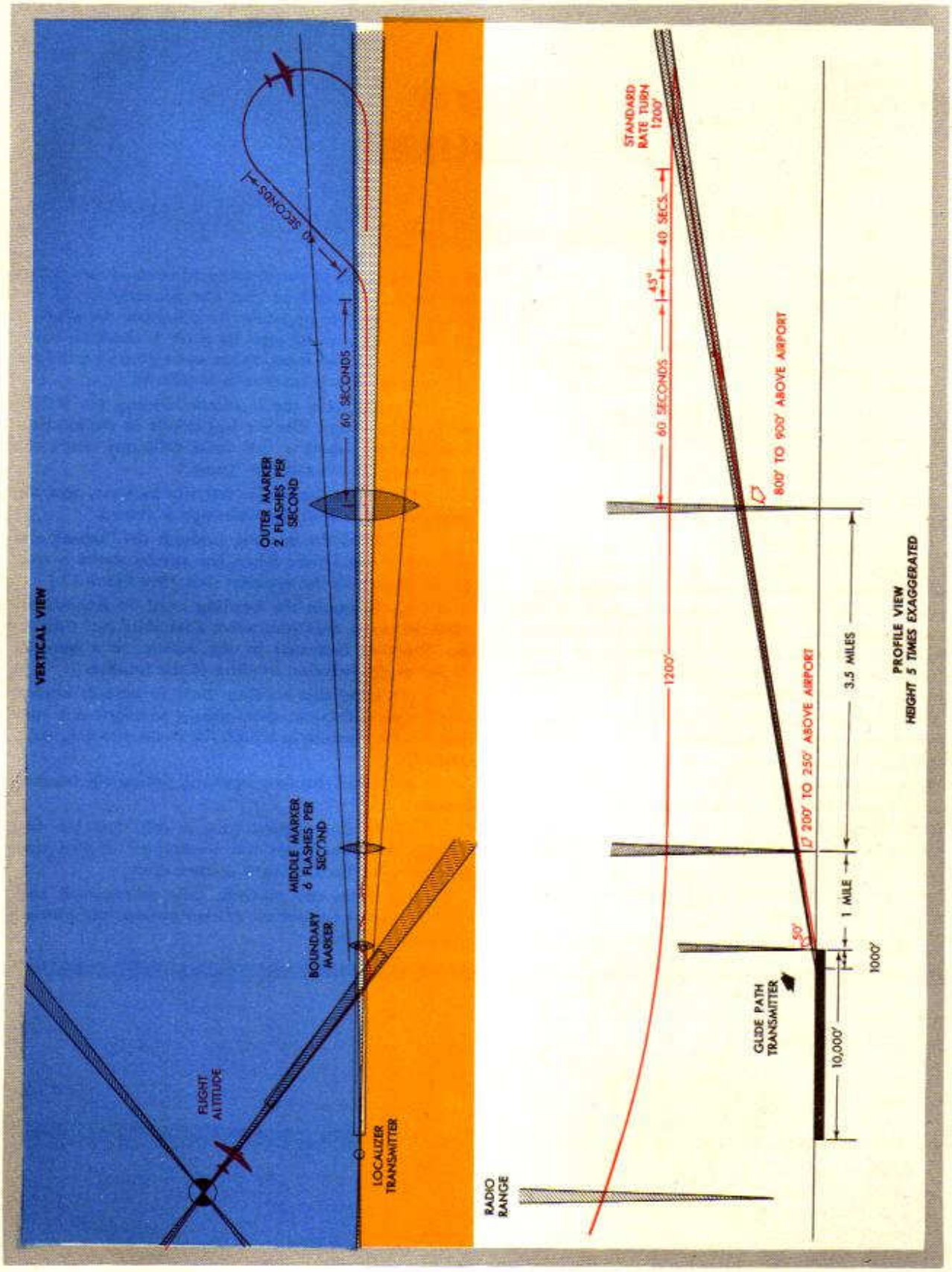


Figure 11—Complete Flight Procedure; A.A.F. Instrument Approach System

SECTION IV
PROCEDURES

1. ORIENTATION.

a. Normally the pilot will home on a radio range or a radio homing station. He will fly to intercept the localizer–glide path course from this known position. It will not be necessary to work an orientation problem on the localizer.

b. Circumstances may arise when the homing station cannot be utilized because it is inoperative or due to mechanical failure of some of the airborne radio equipment. If the localizer-glide path receiver is still operative an orientation problem can be flown and a let-down completed on this installation.

c. The frequency channel on which the localizer is operating will be known to the pilot. He will also know the position of the equipment relative to the runway, and the inbound magnetic bearings of the front and back beams. When the equipment is switched "ON" the indicator needle will be deflected to either side thus showing the position of the aircraft to be in the blue or in the yellow sector.

d. The aircraft must then be flown on a heading which will intercept the localizer beam. This heading will be the inbound bearing of the front beam, plus 90° if the aircraft is in the *yellow* sector; or, the inbound bearing minus 90° if the aircraft is in the *blue* sector. (See Figure 12.)

e. Proceeding on the heading thus determined the beam of the localizer is intercepted. The pilot must now establish which of the beams, either front or back beam, he has intercepted.

f. The front or back beams can be identified by timing the width of the intercepted beam at two points sufficiently separated so that the convergence of the beams will become apparent. To eliminate the effect of the wind, the crossing must be made at the same heading each time, thus insuring the same ground speed for each timing. The procedure is as follows:

(1) Maintain the intercept heading (± 90° to the beam bearing). The vertical needle of the localizer indicator will show a full scale deflection until the aircraft begins to cross the "beam".

(2) When the needle starts to indicate, note the time at which a four dot deflection is shown.

(3) Hold the heading through the "beam" and note the elapsed time when the needle shows a four dot deflection on the opposite side. (See figure 12.)

(4) Maintain the heading until 30 seconds beyond the beam, then commence a standard rate turn, in the direction indicated by the needle, to a heading ± 30° of the inbound heading of the localizer.

(5) Hold this heading until 30 seconds beyond a full scale deflection, then make a standard rate turn back to the heading at which the beam was originally crossed.

(6) Hold this new heading, timing the beam as before.

(7) If this elapsed time is less than the first timing, the front beam was intercepted. If this time is longer, the back beam was intercepted.

(8) From the position thus determined, turn to fly on-course toward the marker stations and proceed with the let-down.

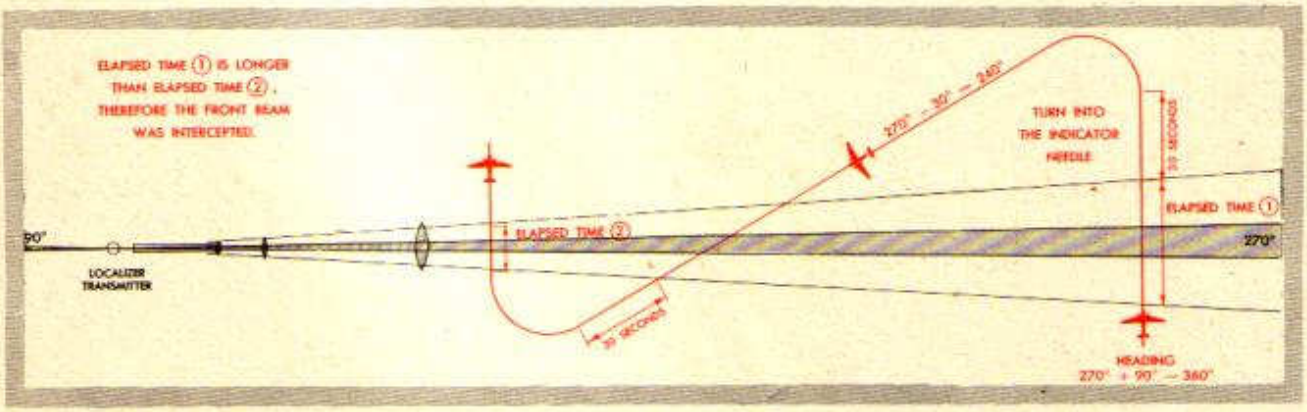


Figure 12—Timing the Beam.