TECHNICAL ORDER NO. 30-100C-1

INSTRUMENT FLYING
Ground Trainer

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TECHNICAL ORDER NO. 30-100C-1

INSTRUMENT FLYING

INSTRUMENT TRAINER

INSTRUCTION GUIDE

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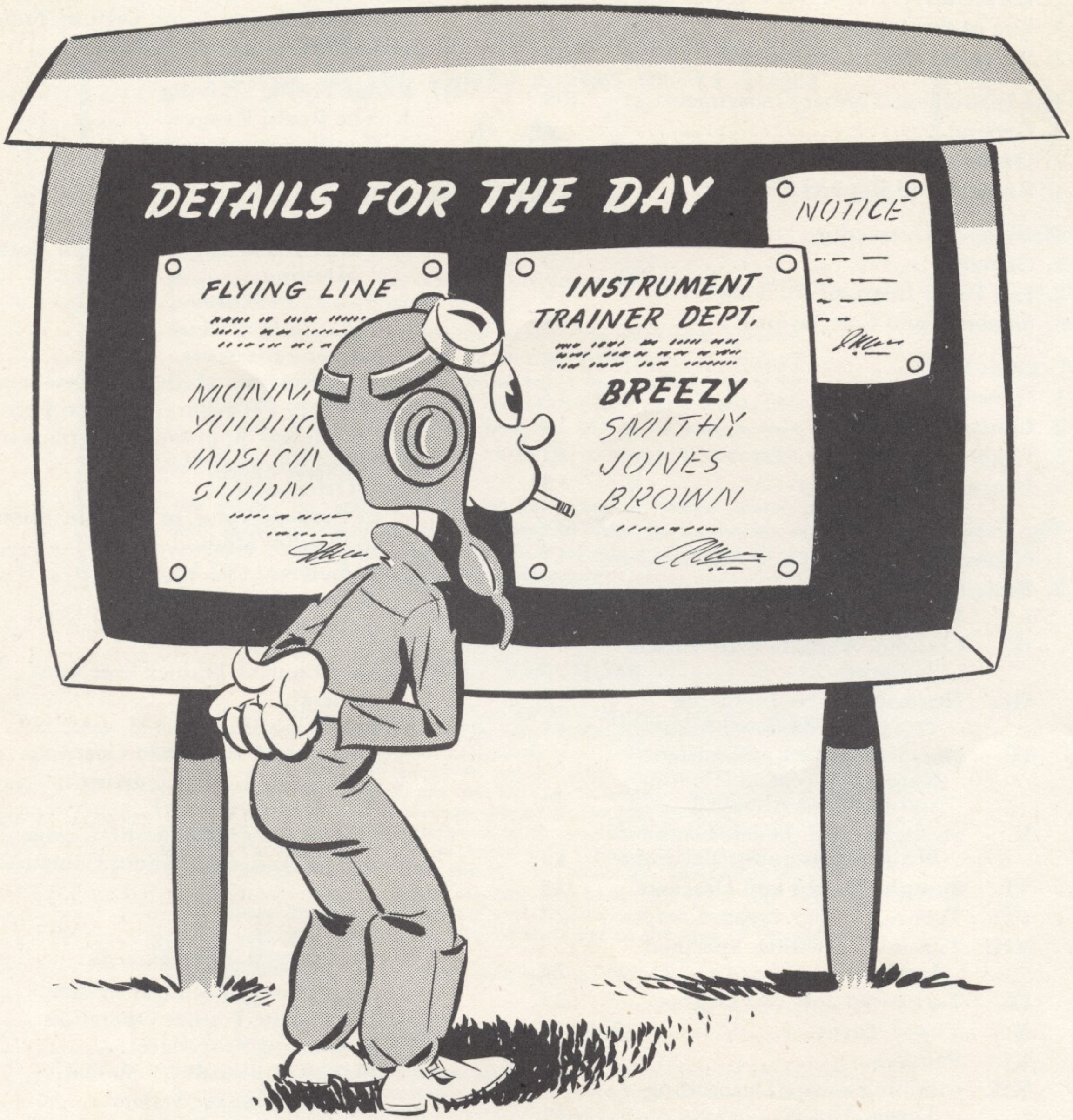
DETAILS FOR THE DAY
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FLYING LINE
INSTRUMENT
TRAINER DEPT.
BREEZY
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JONES
BROWN

SECTION I
THE INSTRUMENT FLYING TRAINER

1. INTRODUCTION.

a. The purpose of this manual is to standardize instruction methods and procedures for all Instrument Trainer activities; to provide the instructor with standard and approved flight procedures; to enable the instructor to make the best possible use of the instrument trainer for both basic instrument flying and advanced radio flying.

b. This manual is a supplement to T.O. 30-100A-1, "Instrument Flying, BASIC, Theory and Practice" and to T.O. No. 30-100B-1, "Instrument Flying, ADVANCED, Theory and Practice."

c. Continuity of instruction must be preserved and the student's progress should not be hampered by change of schools or of instructors. It is particularly important that all instructors use the same approach and methods of teaching to avoid confusion in the student's mind. The causes of remarks often made by students: "One instructor said this, and another said that" must be eliminated by the instructors themselves. This can only be done by careful attention to proper indoctrination of the instructor personnel.

d. Various exercises are described, broken down and analyzed; stress is given to those details which the instructor should bring to the student's attention. It is important that the exercises be given in the proper order and that the student not be advanced to the next exercise until he *understands* the previous exercises. A thorough understanding of the instruments, their indications and reactions is the desired end.

e. It must be admitted that the instrument trainers have in the past gained a very poor reputation in the service. This is traceable directly, as any unbiased study will show, to several related factors.

(1) Due to incomplete understanding of instrument flight and an absence of personal experience, many instructors, lacking any other guide or assistance, pattern their instruction after that received as students in the trainer. This instruction, too, was given by personnel who themselves were similarly handicapped and was most likely not very efficient.

(2) Poor operation caused by improperly trained instructors not being sufficiently aware of the importance of precise and accurate manipulation of the radio controls.

(3) Poor results obtained are also traceable to a lack of coordination and cooperation between the flight line and the Instrument Trainer department. Many flight instructors have imparted to the student their antipathy toward any kind of ground training device before he reports to the trainer department for practice, thus destroying the student's confidence in the value of the practice he might receive in the trainer.

(4) In other cases flight instructors have completely ignored the existence of the trainer department and have permitted the growth of many bad habits to go unchallenged.

2. DIRECTIVE.

a. In view of the necessity for a complete reorganization of the instrument flying program, it has become very important that the instrument trainer situation be radically improved. To that end this publication is directed.

b. It is essential that the closest cooperation and coordination exist between the Instrument Trainer Officer in charge and the Instrument Flight Instructor.

3. USE OF THE TRAINER.

a. The main purpose of the trainer in *basic* instrument flying is to accustom the student to noting and interpreting the instruments and thus to develop an "instrument consciousness" prior to flight instruction. If the student is in the habit of noting and reading instruments prior to instrument flight instruction in the air much of his effort and mental processes will be freed to assimilate flight instruction.

(1) It must be observed, however, that different makes and models of aircraft differ in their characteristics and response to the controls. It is only natural, therefore, that there should be a difference in response to control movement between the trainer and an aircraft. The difference is in the amount and manner in which they are applied. In any case, the student controls the trainer and receives instrument indications similar to the instrument indications in an aircraft.

b. Flight instruction by the "full panel" system teaches the student to fly the *aircraft* under instrument conditions. Basic trainer instruction develops the habit of noting and reading *instruments.*

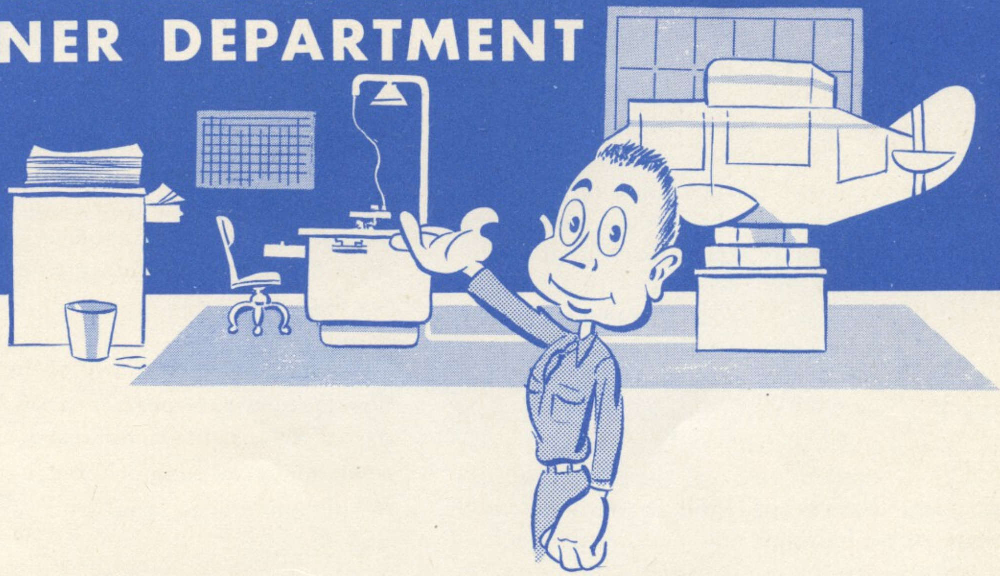
c. All exercises covered in this Technical Order are based upon the limitations of the trainer. The instructor and the student should know that a high degree of proficiency in flying the trainer does not necessarily mean an equal proficiency in an aircraft; however, if the student is unable to develop the smooth technique necessary to fly the trainer, it is possible that he may have similar difficulty in an aircraft. The student's ability to fly the trainer should be developed sufficiently in Basic, so that later in radio exercises, the flying of the trainer will be easy and effortless.

d. That radio navigation can be taught in the trainer is an established fact. The radio techniques which can be taught and learned will make the flying of similar problems in aircraft much easier.

4. RESPONSIBILITY OF INSTRUCTOR.

To indicate the responsibility the instructors have toward the student, it may be well to point out a few pertinent facts. Conditions imposed by the present war dictate the necessity of operating Army aircraft in many different theaters of operation, and under climatic and weather conditions often very different from those prevalent in the United States. Advantage must be taken of available ground installations at these theaters of operation for homing and landing of aircraft whenever they are available. Aircraft are flown in cooperation with those of the Allies of the United States, and operation must be closely coordinated with their effort. These considerations dictate the necessity for training Air Force pilots in the methods of ground to air communications in general use overseas; in the use of radio aids to navigation which are available in order that the time necessarily spent in training upon arrival in a theater may be reduced. The student also must be trained in the methods of air navigation, instrument approach procedures and landings in use in the United States. The scope of this manual does not include coverage of all these methods and radio aids. The instructor is referred to Technical Order No. 30-100E-1 for information on the Standard Beam Approach system. Pilots can be familiarized with the procedures and installations available overseas in the trainer. Before this type of practice can be given, the pilot must be able to control the trainer attitude by reference to all the instruments without intense concentration. In advanced work the greater portion of the students mental processes must be used to learn the fundamental procedures in orientation and instrument landing. For this reason the actual flying of the trainer should be made easy until the student has a sound knowledge of the procedures involved. After the student shows proficiency, his attention may be divided by making the trainer more difficult to fly, i.e., the addition of weather (rough air) and by calling the student's attention to his instruments more frequently.

SECTION II
THE INSTRUMENT TRAINER DEPARTMENT



1. GENERAL.

a. The Instrument Trainer Department should be under the direct charge and supervision of a competent instrument pilot. To assure that qualified personnel are present in the Department at all times, one or more Assistants to the Officer in Charge should be appointed. The assistant will be directly responsible to the Officer in Charge for the Instructor's proficiency and conduct. The Officer in Charge or his assistant will personally check the performance of the instruction being conducted by interviewing students from time to time to determine weak points in the program. The Officer in Charge will also make arrangements for the participation of the instructors in the familiarization flights outlined below. The personnel whose function is the operation of the desk controls of the trainers will be designated Instructors. The official designation of the department will be "Instrument Trainer Department."

b. An orientation lecture will be conducted by the Assistant to the Officer in Charge when a new class of students first reports to the Instrument Trainer Department. The purpose of this lecture will be:

(1) To arouse the student's interest in the program. To accomplish this desired result, the capabilities of the trainer must be carefully and completely explained. The Assistant to the Officer in Charge will point out that, although the trainer is obviously not an aircraft, most of the instrument indications of an aircraft in flight are simulated in the trainer. The voice, radio range, radio compass and other flight procedures can be and are simulated very closely. The assistant will also explain to the students that the trainer is easily flown and that, therefore, the student will be able to devote his full attention to the instruments, or radio procedures as the course progresses. Air time available for instrument flight instruction must be supplemented by time spent in the trainer, and the practice had by the student will materially assist him later when he must rely upon his instruments to control the flight of an aircraft.

(2) To assure that the student will retain interest in the course, the Assistant to the Officer in Charge will also, in a general outline, cover the complete program as it will be given to the student. Basic instrument work in the trainer will familiarize the student with the instruments and their indications. (Additional material for this part of the lecture will be found in Technical Orders No. 30-100A-1 and 30-100B-1.) During advanced instrument trainer instruction the student will be taught radio navigation; including orientation, instrument approaches and instrument landings.

(3) Pilots returning from combat areas stress the great importance of instrument flying. The assistant will in his lecture point out that the student will be amply repaid for the time and attention he will devote to problems flown in the trainer.

c. The Assistant to the Officer in Charge will be aided by the Chief Instructor (s) who will supervise a group of trainers and the instructors assigned thereto.

d. Standard radio telephone procedures will be used by the Instructors in so far as applicable, when speaking to the student over the trainer interphone. Neatness and courtesy on the part of the instructors will be required of them at all times. Devoting his full attention to the task at hand, the instructor will operate the desk controls in such a manner that actual radio installations are simulated. Exaggeration of signals to make the problem easier for the student will not be permitted. Another serious fault found in many instructors is leading of the recorder with the radio signals, resulting in a pretty track. This technique may flatter the student, or under certain conditions may shorten the problem, but no useful purpose is accomplished by this kind of performance. In fact, such technique is extremely detrimental to real progress because when the student gets into the air, the signals will be so unlike those heard in the trainer that he will have to start all over again.

e. The Officer in Charge should make arrangements for each instructor to be flown on actual range installations in order that the instructor may become acquainted with the sound of the signals received by the pilot on instruments. A suggested flight is shown in figure 1. Flights of this type will be repeated from time to time as opportunity permits, in order that the instructor may perfect his technique. A demonstrational flight, with the instructor listening to the signals, and including beam bracketing as it is done in the air, will dispel some erroneous ideas held by many instructors. The voluntary participation in additional flights will be encouraged. Flying officers should cooperate in these flights by scheduling rides for the personnel of the department.

f. Because the operation of the desk controls, when done properly, requires intense concentration on the part of the instructor, no instructor will be required to operate continuously without a rest period. Schedules for personnel should be arranged to comply with this policy.

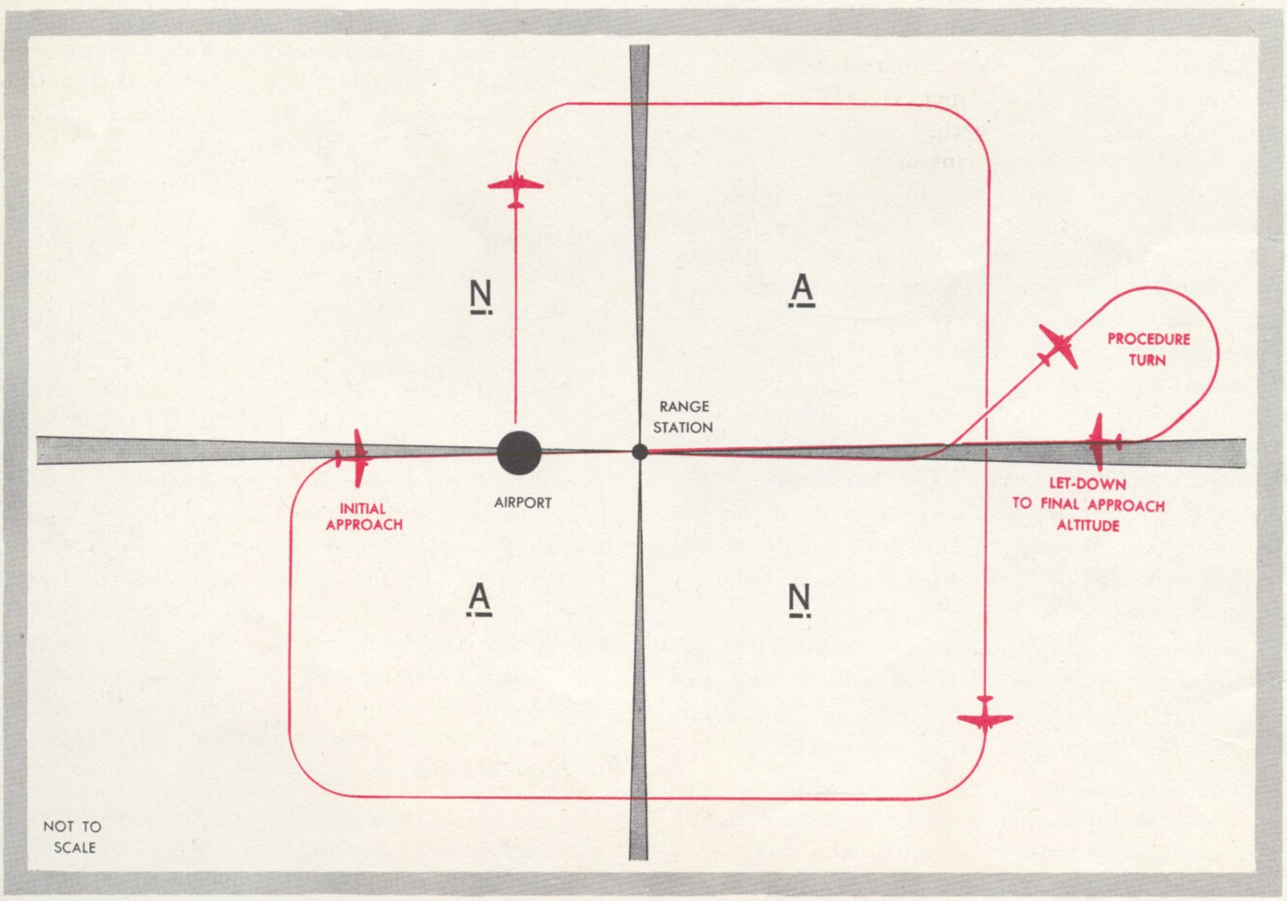


Figure 1—Suggested Flight

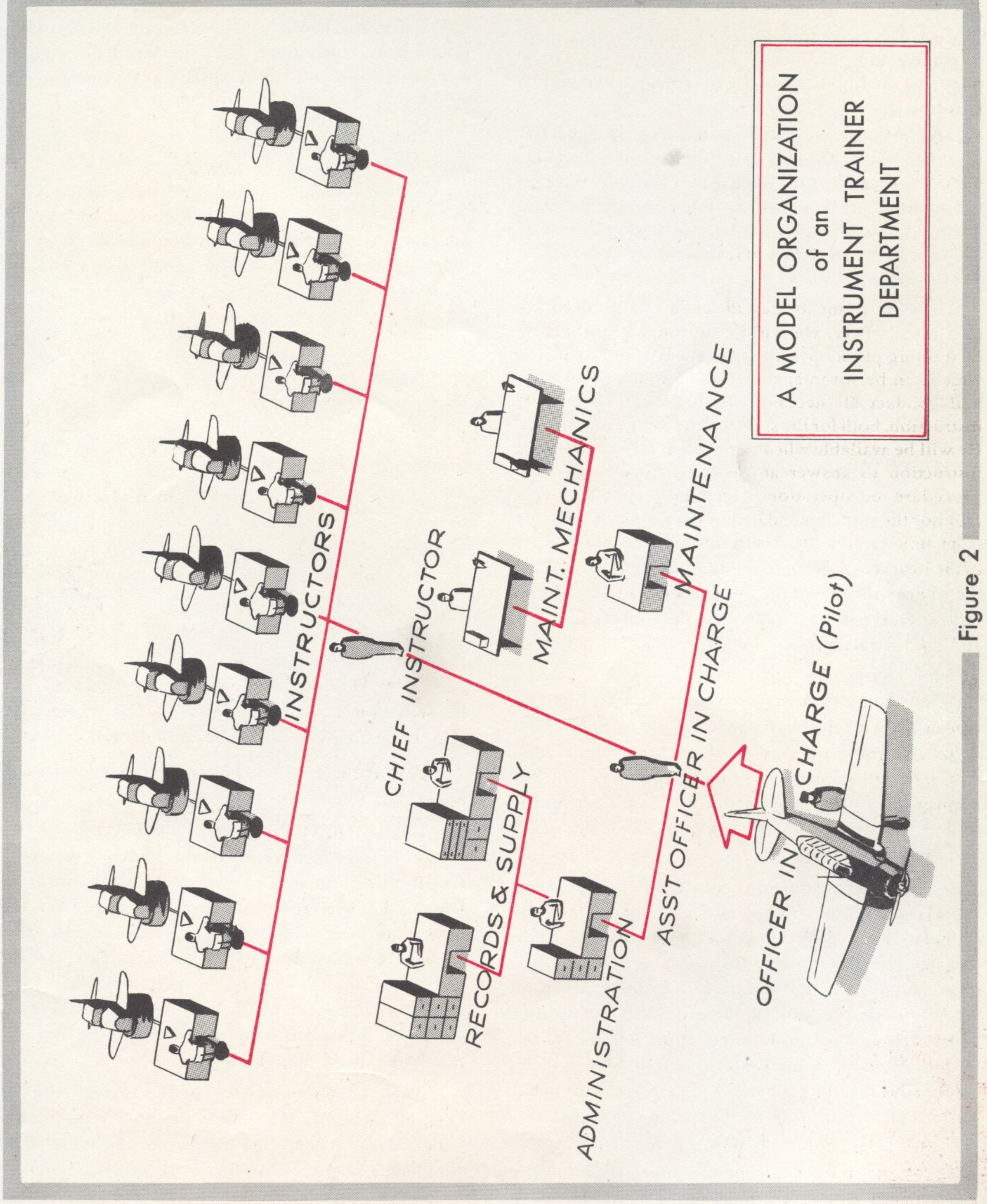

A MODEL ORGANIZATION
of an
INSTRUMENT TRAINER
DEPARTMENT
OFFICER IN CHARGE (Pilot)
ASS'T OFFICER IN CHARGE
ADMINISTRATION
RECORDS & SUPPLY
CHIEF INSTRUCTOR
INSTRUCTORS
MAINT. MECHANICS
MAINTENANCE

Figure 2

2. ORGANIZATION OF THE DEPARTMENT.

The table of organization for a model Instrument Trainer Department is included herein for the information and guidance of all concerned. The functions and qualifications of the personnel listed will be as follows:

a. The Officer in Charge should be a flying officer, who must be interested and qualified in instrument flight instruction. The standard of training received by the students assigned to the department is his direct responsibility. He will initiate training schedules and coordinate all phases of instruction with the Flying and Ground Schools.

b. The Assistant to the Officer in Charge need not be a rated officer. He will be thoroughly qualified in all training phases pertaining to the type of instruction which can be advantageously given in the trainer. He will conduct all necessary lectures and class room instruction, both for the students and for the instructors. He will be available whenever students are undergoing instruction to answer any pertinent questions as to procedure or operation which may arise. He will monitor the signals simulated by the various instructors from time to time, to assure himself that the quality of the instructors' technique is improving. He will assist the Officer in Charge in the preparation of training schedules, assignment of duties to the Chief Instructors and the Instructors, and will supervise the grading of the students.

c. The Administrative and Supply Assistant will be concerned with the maintenance of the records of the department, with the administration of personnel matters, and with property accountability. He will initiate requisitions for supplies needed for the proper operation of the trainers. A clerk will be assigned as his assistant.

d. The Chief Instructors will each be assigned the supervision of the operation of not more than 10 trainers. They will be constantly available while students are undergoing instruction, and will closely check the operation of the trainers by the instructors. They will devote part of their time to monitoring instructors and will make every effort to improve the techniques used in student instruction. They will be responsible that the problems and exercises to be flown by the student are properly set up and conducted.

e. The Instructors will perform the daily inspections of the trainer under the supervision of the maintenance personnel. They will operate the desk controls during radio exercises to closely simulate the signal of an actual radio range. They will use proper radio telephone procedures in their calls and replies to the student in the trainer. The student will be required to read and report all the instruments pertinent to the problem at intervals.

f. The Maintenance Assistant will be thoroughly qualified in all phases of Instrument Trainer maintenance. He will be directly responsible for their proper mechanical operation and condition to the Officer in Charge. He will personally inspect the maintenance work performed by the maintenance mechanics, and thus assure himself that the mechanical operation of all the trainers in the department is identical.

g. The maintenance mechanics will perform all maintenance of the trainers and will make the required inspections, excepting the daily inspection, which is the instructors' responsibility.

3. RECORDS AND REPORTS.

Overhead paper work and administrative detail will be reduced to the minimum. It is not desirable to burden the instructor with complicated forms and reports. Only the necessary records should be kept.

a. OPERATIONS RECORD.—A separate record is kept for each trainer. This form is used to keep an accurate record of the total time the trainer is in operation. At the end of the working day the total time is entered on W.D., AAF Form No. 47. This record is self-explanatory and should be faithfully followed.

b. AAF Form No. 1 will be accomplished as directed under AAF Regulation 15-1.

c. INDIVIDUAL PROGRESS RECORD. (*See figure 4.*)—This form is a record of the student's progress. Its primary purpose is to furnish the chief instructor with a complete record of the student's progress and time. One form will be kept for each student. The student obtaining instruction will take this card to the trainer. At the end of the period the necessary entries will be made by the instructor. These records should be forwarded with his records to the new station when the student is transferred.

d. Each lesson conducted in the trainer will be entered, supplying the time in the trainer in minutes under "Daily Time;" the number of the exercise or problem; and AA, A, or BA, in accordance with the following under "Grade:"

WEEKLY OPERATIONS RECORD

TRAINER NO.

DATE			DATE			DATE			DATE			DATE			DATE			DATE		
INITIAL	TIME	TOTAL TIME	INITIAL	TIME	TOTAL TIME	INITIAL	TIME	TOTAL TIME	INITIAL	TIME	TOTAL TIME	INITIAL	TIME	TOTAL TIME	INITIAL	TIME	TOTAL TIME	INITIAL	TIME	TOTAL TIME
																			DAILY TIME		
DAILY TIME			DAILY TIME			DAILY TIME			DAILY TIME			DAILY TIME			DAILY TIME			WEEKLY TOTAL		
TRAINER STATUS			TRAINER STATUS			TRAINER STATUS			TRAINER STATUS			TRAINER STATUS			TRAINER STATUS			TRAINER STATUS		

Figure 3. Weekly Operations Record

INDIVIDUAL PROGRESS RECORD

NAME

DATE	EXER.	GRADE	DAILY TIME	TOTAL TIME	DATE	EXER.	GRADE	DAILY TIME	TOTAL TIME

NAME

Figure 4. Individual Progress Record

AA—Above Average. In comparison with other students of his class this student's work is above average.

A—Average. This student is average in his ability to understand and perform the exercises.

BA—Below Average. This student is below the average of the other students in his class.

e. Exercises are listed only for grading code. The time spent on each exercise will depend on the student's progress.

BASIC EXERCISES, designated by the letter B, include the following:

B1—Familiarization.

B2—Constant altitude with varied power.

B3—Normal climb—increased power and reduced airspeed.

B4—Normal descent at constant rate—decreased power and reduced airspeed.

B5—Straight and level flight while maintaining heading.

B6—Straight climbs and descents.

B7—Turns.

B8—Turns—not within specified limits.

B9—Turns—90 and 180 degrees.

B10—Timed turns.

B11—Turn patterns.

B12—Climbing turns and straight descents.

B13—Descents to predetermined headings and altitudes.

B14—Related instruments.

ADVANCED EXERCISES, designated by the letter R, include the following:

R1—Beam bracketing—known beam heading.

R2—Beam bracketing—unknown beam heading.

R3—Procedure turns.

R4—Close-in procedure.

R5—True fade-out method.

R6—Holding procedure and pull-up.

R7—Instrument approach procedure.

R8—Radio compass.

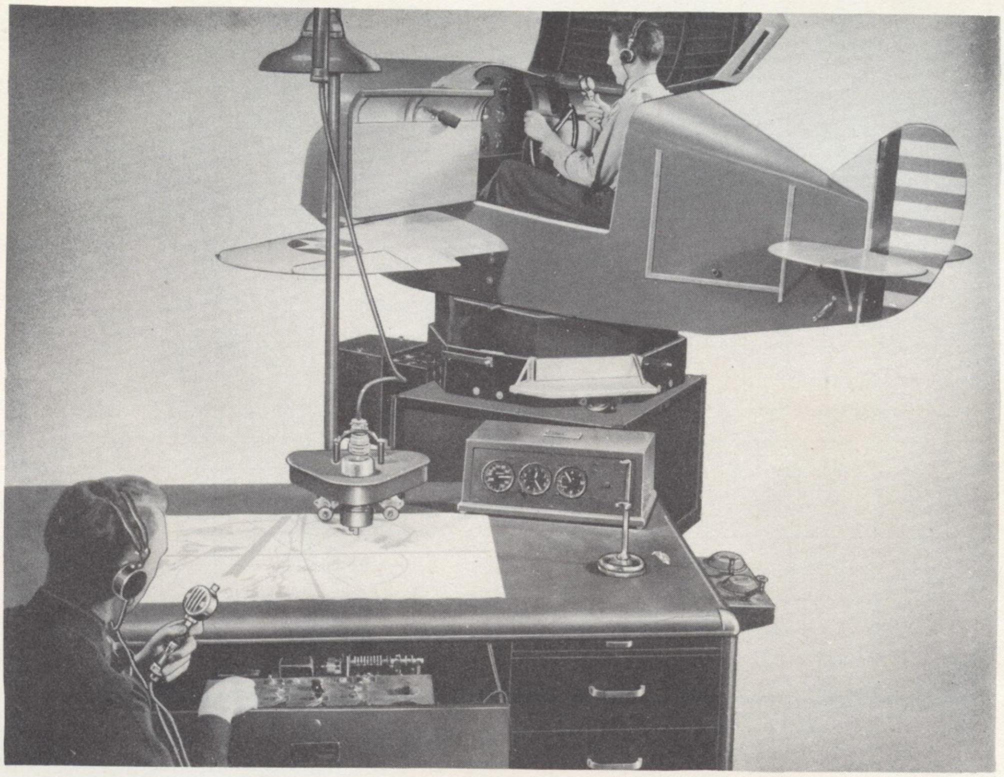
R9—Instrument landings.

R10—Radio air navigation flights.

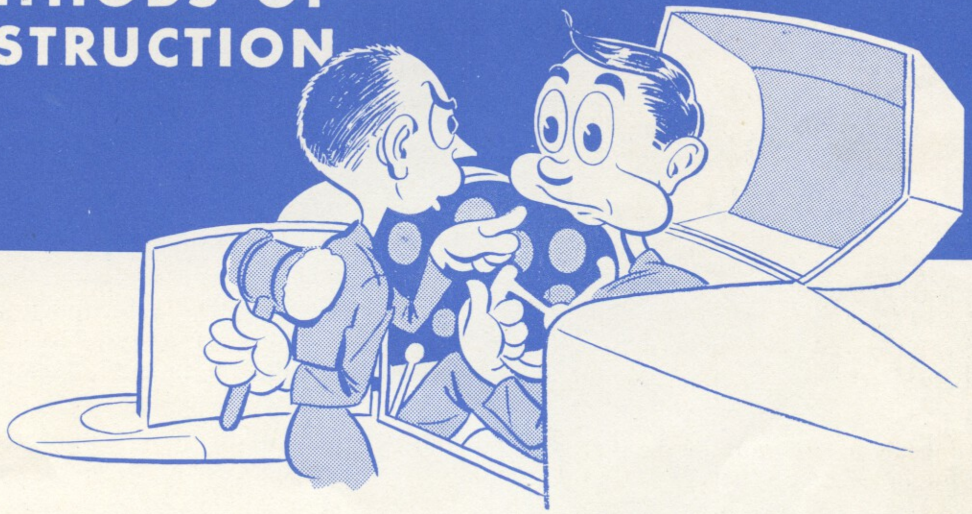
R11—Other procedures such as standard beam approach.

NOTE

Each of the basic exercises need not necessarily take one full period. If the student has difficulty with one particular exercise, too much time should not be spent thereon. In the later exercises further practice will be had.



SECTION III
METHODS OF INSTRUCTION



1. GENERAL.

A general review of the methods of instruction, past and present, is included herein for the benefit of personnel who have been engaged in the past in Instrument Trainer activity. The difference in the viewpoint between "systems" is so pronounced that unless they are compared and analyzed, the tendency of carrying on under the older method would be ever present.

2. FULL PANEL INSTRUMENT FLYING.

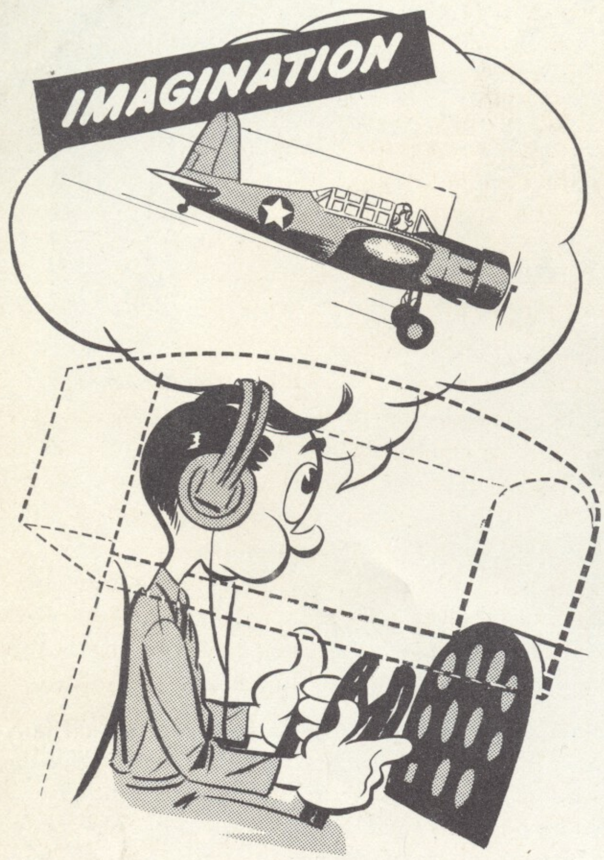
Modern instrument flying technique is based on the use of all the flight instruments. These include, of course, the "gyro" instruments (directional gyro and artificial horizon) as well as the "rate group" of instruments used in the 1-2-3 system.

a. In the early days of instrument flying the needle-ball-airspeed technique was the only one available, and was quite satisfactory for use with aircraft of that day. Satisfactory gyro instruments had not yet been developed. When the first gyro instruments were placed in service, frequent failures occurred. Many pilots came to regard these instruments with distrust even after they were developed to a satisfactory standard.

b. Modern aircraft—large heavy types and high speed types—cannot be flown on instruments by stopping the turn with the rudder only, centering the ball with the ailerons only and checking the airspeed with the elevators only. Experienced instrument flying pilots today use all the flight instruments on the panel, including the directional gyro and the artificial horizon. If these two instruments become inoperative due to violent maneuvering or enemy action, the aircraft must be flown by the full panel system by reference to the instruments remaining in operation.

c. Under the older system the student was taught that the turn indicator needle was controlled with the rudder only, that the ball was controlled with the ailerons only and that the airpseed was controlled with the elevators only. That is, each control was associated with one instrument and one instrument only. That this concept is faulty is known to every pilot. Turns require coordination between rudder and ailerons. Climbs and descents require coordination between throttle and elevators. An aircraft being flown on instruments still has the same characteristics that it has during contact flying. It is being flown through the same maneuvers, using the same set of controls. In any given maneuver its attitude is the same, whether flown on instruments or contact. If the pilot understands the theory of flight, all of the knowledge of flying he accumulated during the hours of contact flying may be made use of during instrument flight.

d. The modern concept of flying on instruments is based on the pilot's ability to visualize the position of the aircraft in relation to the ground by reference to instrument indications. This simplifies his problem because he has nothing to unlearn. He is flying the same aircraft and moving the same controls to produce



given attitudes, whether "contact" or "on instruments." It is relatively simple to do this by using the artificial horizon, directional gyro and sensitive altimeter. The first two of these instruments require little interpretation and they do not oscillate or lag. But, at times, due to precession, they give faulty indications. The pilot must, therefore, become familiar with their peculiarities before he can make intelligent use of them.

e. While practicing exercises using these instruments, the pilot should observe and note the indications on all the other flight instruments during any given maneuver in order that he may learn to associate a given indication with a given attitude. For example, with the horizon and directional gyro inoperative, straight level flight is indicated by the needle and ball of the turn and bank indicator being centered, power and airspeed at normal cruising, and altitude remaining constant. With these conditions prevailing, the aircraft can only be in normal level, straight flight, attitude. If the aircraft is, for example, turning to the left and at the same time climbing, the indications would be, (1) power at normal cruising, (2) airspeed below cruising, (3) turn indicator off to the left and ball centered, (4) vertical speed showing a climb, and (5) the altimeter registering a gain in altitude. With all of those instrument indications existing, the aircraft could only be in a climbing turn to the left, an attitude which the pilot can readily visualize.

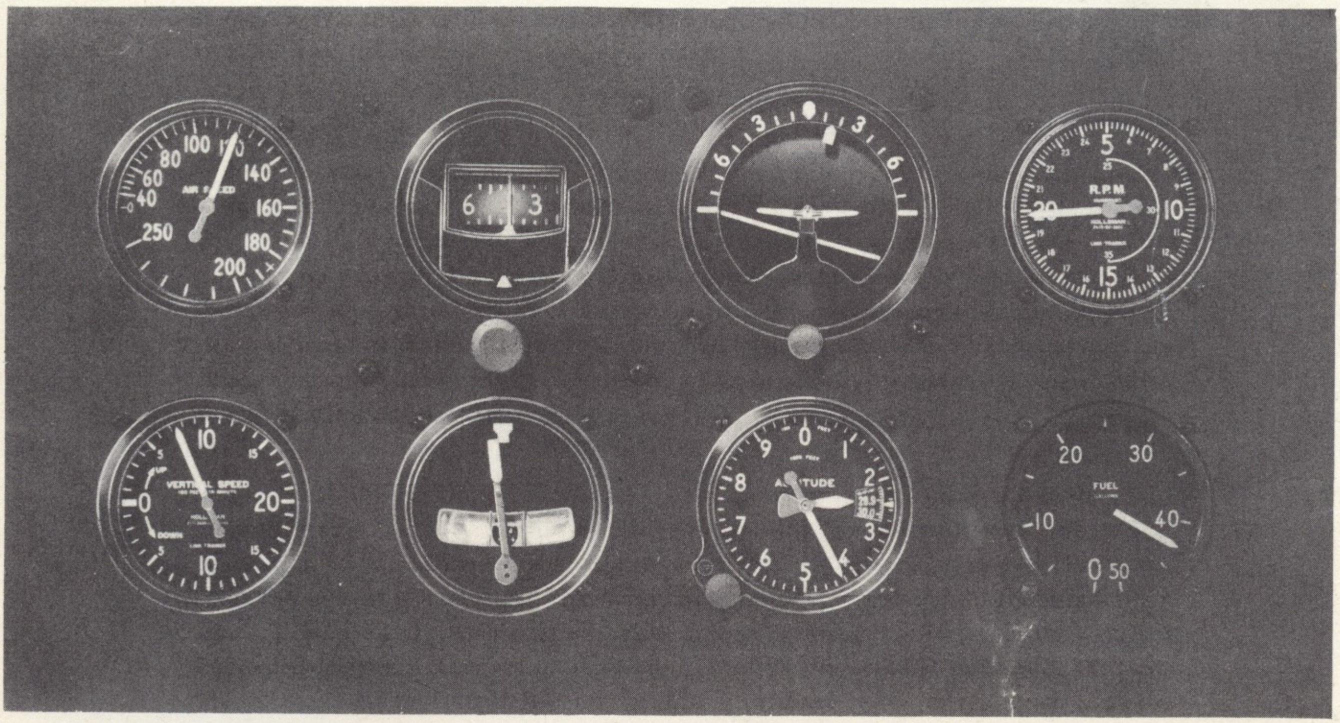
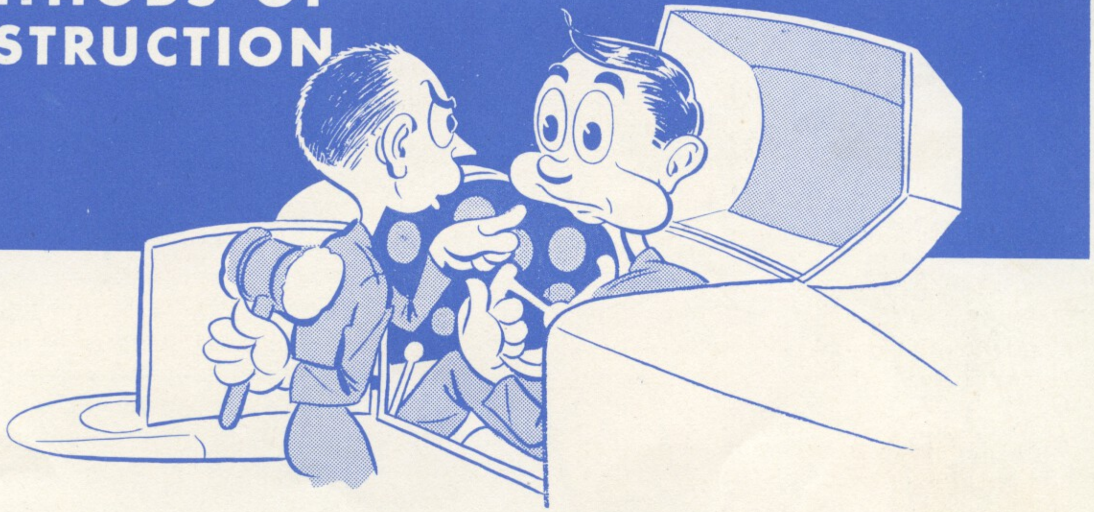


Figure 5—Standard Instrument Panel

SECTION III
METHODS OF INSTRUCTION



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d. The modern concept of flying on instruments is based on the pilot's ability to visualize the position of the aircraft in relation to the ground by reference to instrument indications. This simplifies his problem because he has nothing to unlearn. He is flying the same aircraft and moving the same controls to produce *f.* After the pilot becomes expert at instrument flying, he does not use any particular "system." The instruments on the panel give him all the information which he previously obtained by visual reference to the ground or horizon and he merely makes use of all the instruments and the information they give him to fly the aircraft as before.

g. The problem of attaining a high degree of skill may look complicated to the beginner and to simplify and speed his progress, it is necessary to break instrument flight training down into easy progressive steps. Simple basic instrument exercises are necessary; basic exercises must be practiced in the instrument trainer and in aircraft just as the student pilot must first master primary types of aircraft before advancing to the faster and heavier types used during later stages of his instruction.

h. The purpose of the following text is to illustrate and describe in sufficient detail the various exercises necessary to a comprehensive Instrument Training Course so that it may serve both as an instructor's guide and a reference and study text for the students themselves.

i. For a number of reasons originating with the impossibility of introducing centrifugal and other forces in a ground trainer the simulation of aircraft in flight is limited. These limitations are covered in the description and analysis of the maneuvers. The limitations must be brought to the attention of the pilot who receives time in the instrument trainer lest he acquire habits which will handicap him during his air training.

j. The student first learns control the easy way—that is, by reference to the artificial horizon, directional gyro, and sensitive altimeter. He will be instructed to note the effect of the maneuvers on the "rate instruments." During this stage the instructor should remind the student of any errors in control by referring not to the instruments (as formerly) but to the wings and nose. For example, during straight level flight the student allows one wing to drop, instead of saying "center the ball," the instructor should say, "raise the right (left) wing." In this way the student learns to associate *attitude* with instrument indications.

3. SUMMARY AND CONCLUSIONS.

a. In the final analysis, the pilot's ability on instruments must be developed to the point where the instruments provide him with a substitute for the natural horizon by which he maintains the aircraft's attitude under contact conditions. The interpretation of the instrument readings into a visualization of the aircraft's attitude, and the habit of cross checking his various instruments must be developed in the student until it becomes subconscious.

b. The student should be advised that rough action on the ailerons, rudder, or elevators of the trainer will require equally rough corrections, while a smooth technique may be very easily developed and little difficulty will thereafter be experienced. It is not the aim to develop skill in *flying the trainer* beyond the point where the student is able to "fly" the trainer without conscious concentration.

c. Instrument familiarization can be largely and efficiently conducted in the instrument trainer. Also since the student pilot must learn to control the trainer if he is to fly radio problems later on, the time devoted to learning this technique can be usefully employed in instrument familiarization.

d. It is not to be expected that a competent instrument pilot can be produced by practicing the basic exercises over and over again in the instrument trainer. There is no substitute for flight, and the pilot must take advantage of every opportunity to practice instrument flying in the air. These exercises are intended not only to develop the technique required for the control of the instrument trainer, but to demonstrate the instruments, and to develop "instrument consciousness" and habits of cross-checking at the same time. No more time should be spent on any one basic exercise than is necessary to enable the student to maintain satisfactory control. It must be remembered, however, that satisfactory control of the trainer must be at least a temporary goal, because the student will have to "fly" the trainer during radio work. If the student has difficulty in the control of the trainer, he will not be able to devote his attention to his radio work. It will then be very difficult for him to complete the advanced problems satisfactorily.

e. In addition the instrument trainer can be advantageously employed to indoctrinate the future pilot in standard radio telephone procedure through strict adherence by student and instructor to proper radio telephone technique.

f. Proper step-by-step instruction, that is, the introduction of additional instruments, procedures, etc., from time to time as the course progresses, will develop the art of "Division of Attention" which is so essential in instrument flying, until the student reaches the point where he can maintain control, interpret radio signals, read a map or chart or estimate his time of arrival, without becoming confused.

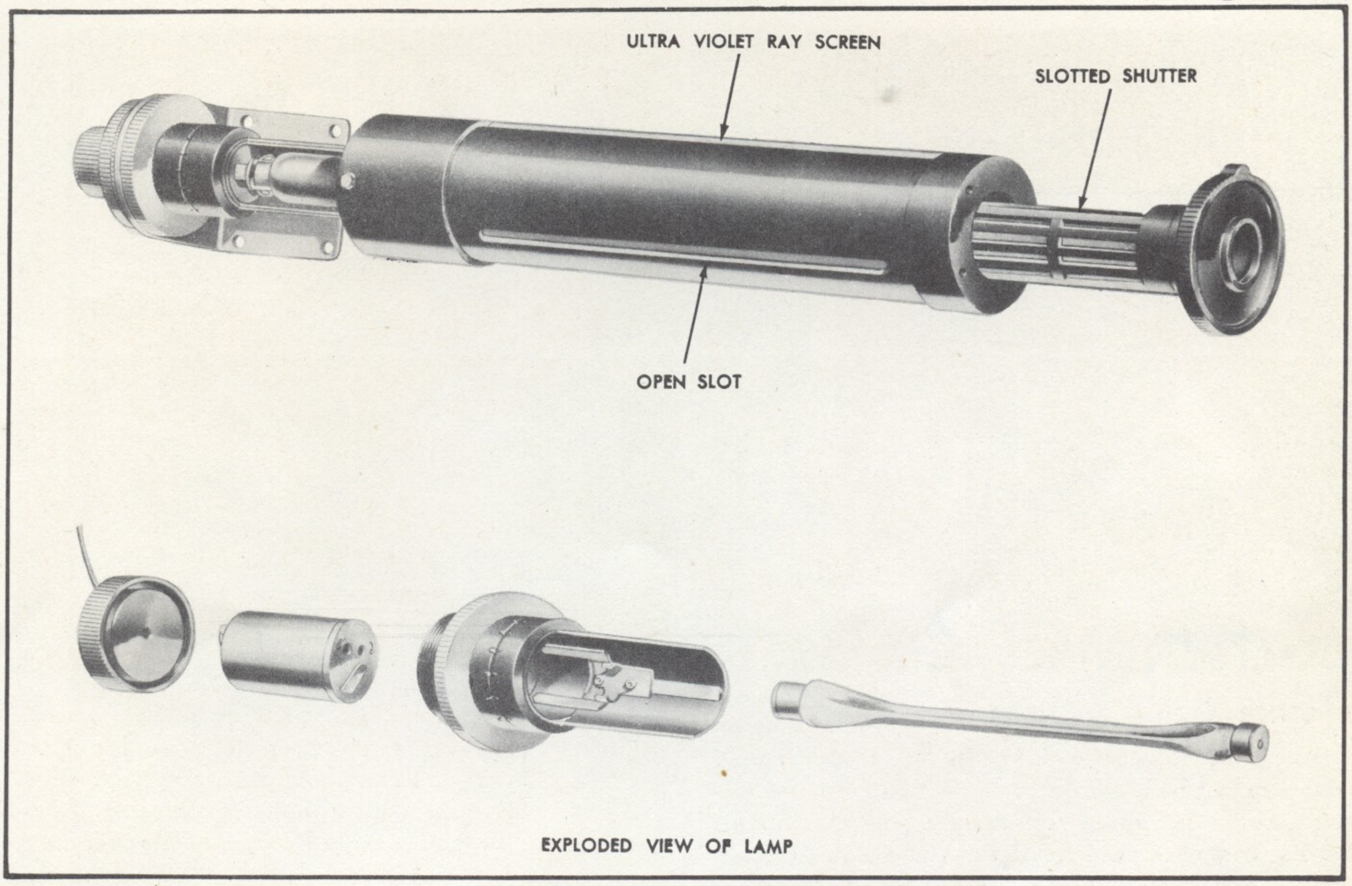


Figure 6—Fluorescent Light

d. STATION SELECTOR SWITCH.—This switch is not used fc: any purpose in basic instruction, and any explanation will be left until the advanced stage is reached by the student.

e. CALL SWITCH.—This switch is used in radio range work to overpower the range signals when the student desires to call the "Trainer Control." It is not necessary in basic instruction.

f. RADIO VOLUME CONTROL.—This control affects the volume of the radio range signals, and will be left at maximum during basic instruction.

g. MICROPHONE.—The ON and OFF switch of the microphone in the type C-3 and earlier model trainers should be left "ON" during basic instruction. The student should be advised that in later model trainers using the standard aircraft microphone, the push to talk switch must be held down while he is speaking into the instrument. The student will speak into the microphone slowly and distinctly whenever he makes a radio call to "Trainer Control."

h. HEADSET.—The earphones will be worn by the student at all times.

i. The foregoing applies to the student cockpit drill in the type C-3 trainer. The chief instructor will indoctrinate the instructors in the proper procedure along these lines for cockpit drill in any other type trainer which may be in use in the department. The flaps, landing gear and propeller pitch controls of the ANT-2550-1 (ANT-18) trainer are not used in basic "flying," neither are the controls for the various landing systems, included on the radio control panel.

3. FLIGHT CONTROLS.

a. Inasmuch as the basic student, when reporting for "flights" to the instrument trainer department, will already be familiar with aircraft controls, it is only necessary to point out that the rudder and control column or stick are used to control the trainer in a manner simulating the use of the same controls in an aircraft.

b. THROTTLE QUADRANT.—Full throttle and throttle off position. The student will work the throttle open and closed several times.

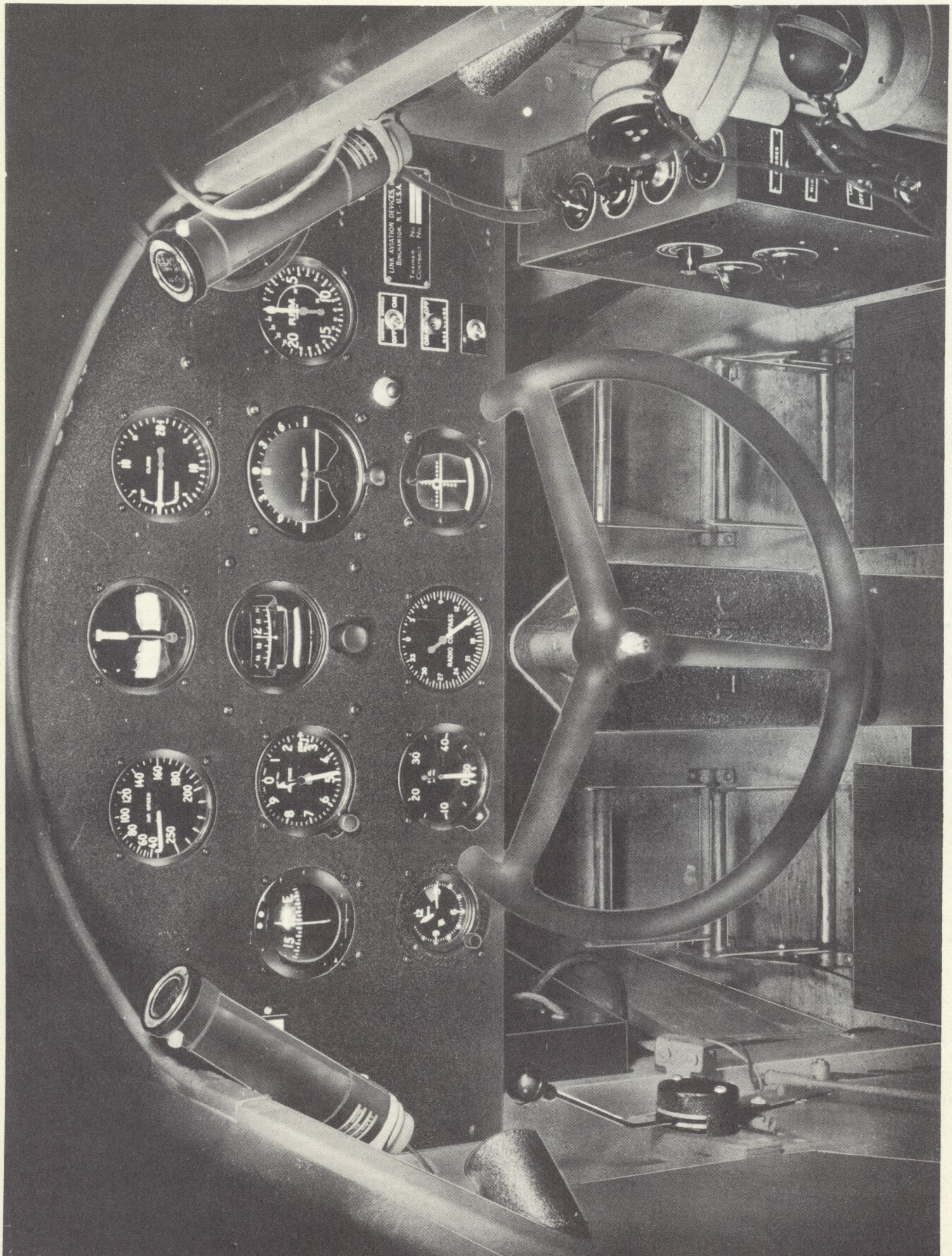


Figure 7—Trainer Panel and Controls (AN-2550-1)

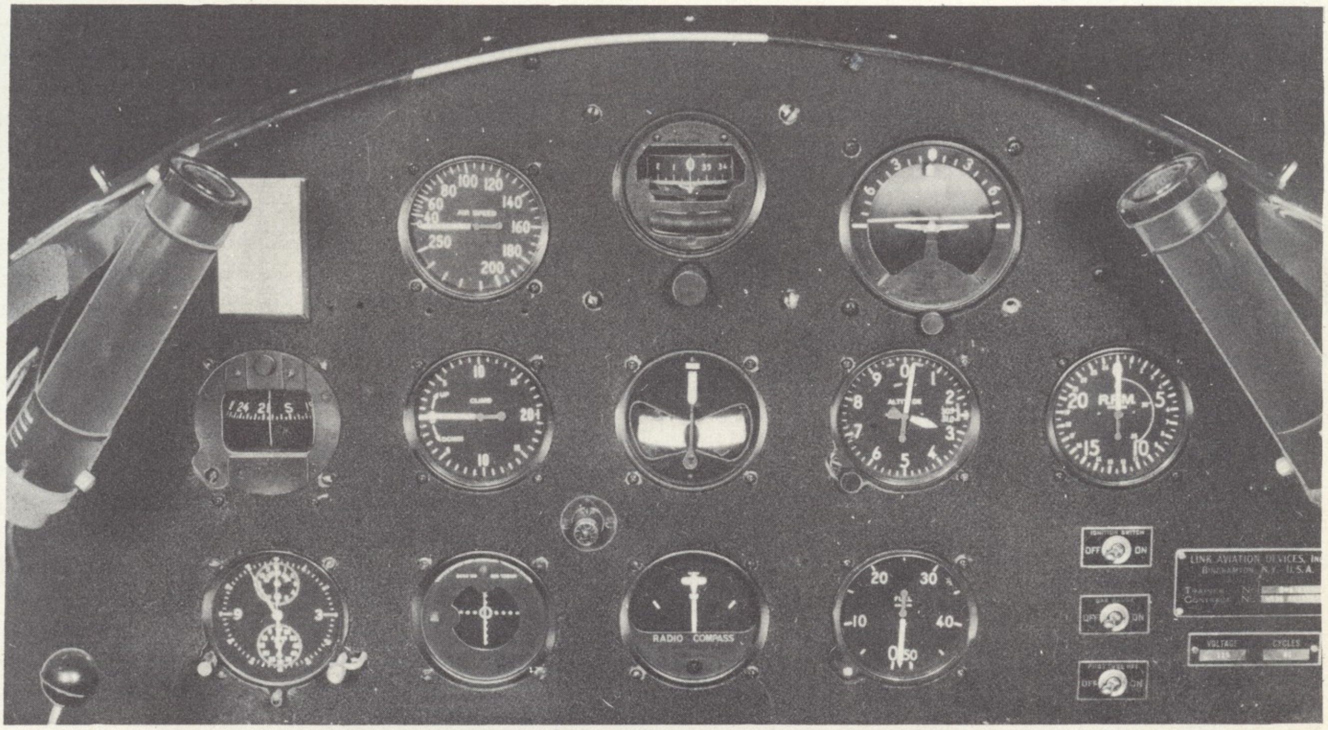
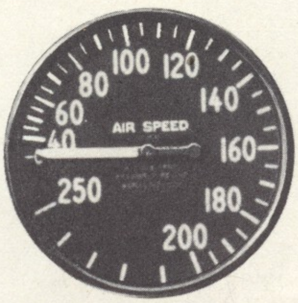


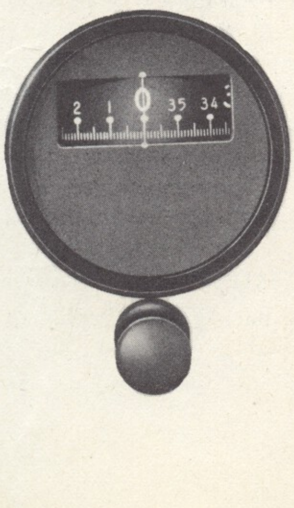
Figure 8—C-3 Trainer Instrument Panel (Modified)

4. INSTRUMENTS.

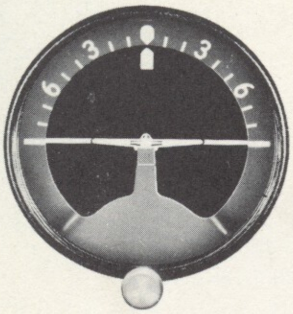
It is important that the student be informed at the outset that the instruments will provide him with a reliable picture of the attitude of the aircraft or trainer at all times, provided he is able to interpret their readings correctly. Understanding how the instruments show the attitude of the trainer (aircraft) at all times, and then flying the trainer (aircraft) upon the information thus gained, will make instrument flying relatively easy. The fact that the reading of *ali* the instruments must be correlated, must be firmly impressed upon the student's mind.



a. THE AIRSPEED INDICATOR.—This instrument indicates the actual speed at which the aircraft moves through the air, at sea level, under standard atmospheric conditions. The so-called lag of the instrument, while designed into the trainer instruments to simulate this apparent lag, is not actually present in the aircraft instrument. An aircraft is a heavy object, and to gain or lose speed requires an appreciable period of time. When, for instance, more power is applied, some time elapses before the aircraft is accelerated to the faster speed. This slow acceleration is properly shown on the airspeed indicator, and is simulated in some degree in the instrument trainer.

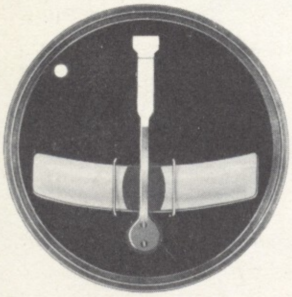


b. THE DIRECTIONAL GYRO.—This instrument, being vacuum operated, will require from 4 to 5 minutes before the rotor builds up sufficient speed for proper operation. After sufficient time has elapsed, the directional gyro will be set to coincide with the reading of the magnetic compass. To set the directional gyro, the caging knob of the instrument is pushed in as far as it will go, and the card is turned to the desired heading. Then the caging knob is pulled out all of the way. The directional gyro will precess slightly and must be reset to agree with the magnetic compass from time to time.

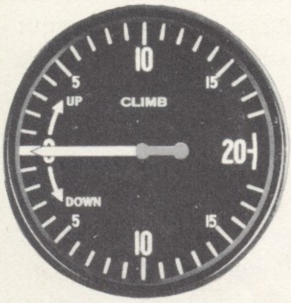


c. THE ARTIFICIAL HORIZON.—This instrument is designed to simulate the reactions of the gyro operated instrument used in aircraft. Basically, the indications are similar, but due to design difficulties, the trainer instrument is not as steady as an aircraft instrument. The degree of bank for a standard rate turn at 160 m.p.h. is only 5 to 10 degrees in the trainer; this limited bank of the trainer is shown on the horizon. In an aircraft, however, a standard rate turn at this airspeed requires about 21 degrees of bank, and this difference should be brought to the student's attention. The miniature aircraft of the instrument may be adjusted by the adjusting knob until it is exactly on the horizon bar while the trainer is in level flight attitude. The white reference line indicates the approximate position of the miniature aircraft for level flight at cruising airspeed. The horizon bar, as the name implies, represents the natural horizon. Reference marks on the semicircular bank scale can be used to read the degree of bank.

d. THE ALTIMETER.—This instrument indicates the simulated altitude at which the trainer is "flying." The face of the instrument is similar to the sensitive altimeter used in aircraft, including the feature of altimeter setting. The large hand indicates altitude in hundreds of feet, while the small hand indicates thousands of feet. It is a peculiarity of the trainer that the altimeter should be set at 500 feet below sea level when the trainer is at rest to provide sensitivity when the trainer is flown above sea level. The student should consider that the trainer is airborne when the altimeter indicates above sea level.

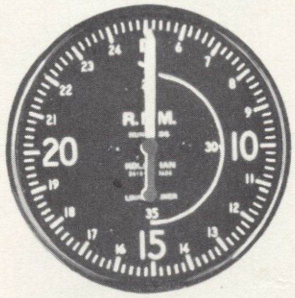


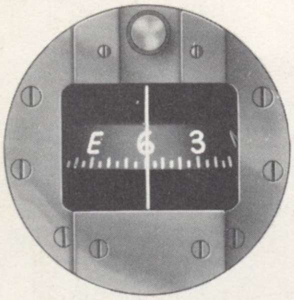
e. THE TURN AND BANK INDICATOR.—When the needle of this instrument is centered and the ball is at rest between the lubber lines, the trainer is flying straight and the wings are level. When the ball is centered and the needle is deflected to the right, the trainer is banked to the right and is turning in that direction. When the ball is centered and the needle is deflected to the left, the trainer is banked to the left and is turning in that direction. The ball being off center indicates either a slip or skid.



f. THE VERTICAL SPEED INDICATOR.—This instrument measures the approximate rate of change of altitude.

g. THE TACHOMETER.—This is not strictly a flight instrument but will be useful to determine throttle settings.



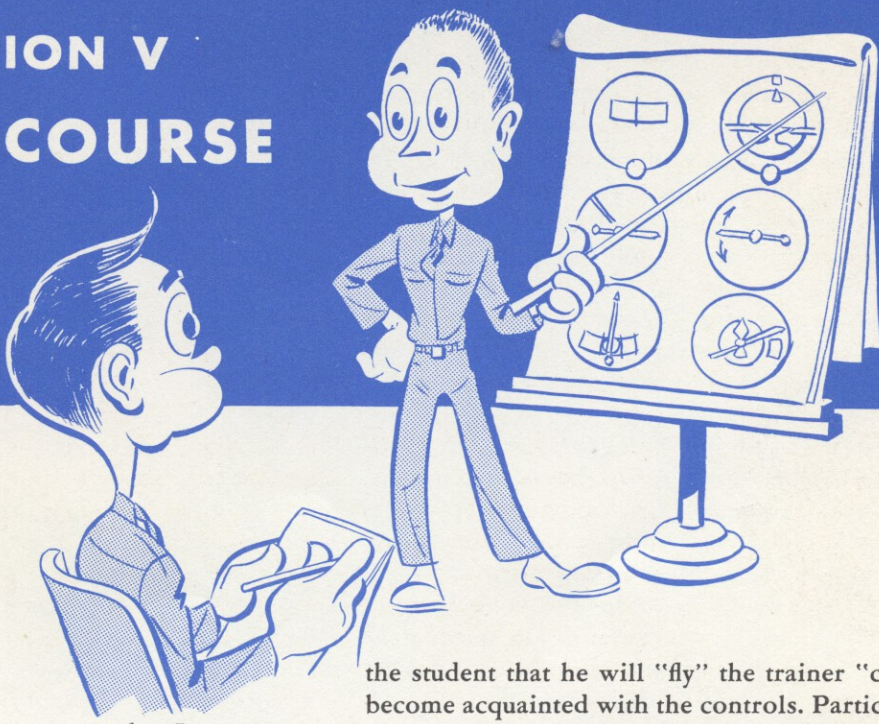


h. THE MAGNETIC COMPASS.—This instrument shows the compass headings of the trainer in degrees. To obtain the magnetic heading of the trainer, deviation must be applied to the compass heading. This deviation is obtained from the compass correction card mounted alongside the instrument. To obtain a true heading of the trainer, from the magnetic heading, variation must be applied. If the magnetic variation of the locality over which the aircraft is flying (or of the instrument flying trainer chart being used) is EAST, the easterly variation must be added to the *magnetic* course to obtain the *true* course. Westerly variation is subtracted from the magnetic course to obtain the true course.

i. THE RADIO COMPASS AND THE LOCALIZER INDICATOR.—These instruments will be explained to the student during advanced instruction, as will the Z or fan marker indicator.

j. THE FUEL GAUGE.—The fuel gauge will not be used during basic problems.

SECTION V
BASIC COURSE

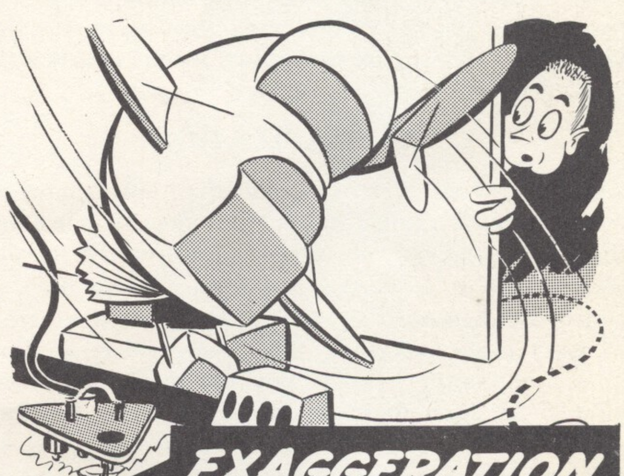


1. GENERAL.

a. When the student reports to the Instrument Trainer Department for instruction, he will be indoctrinated by a qualified instructor. This indoctrination lecture will include a short synopsis of the training the student will receive. The importance of instrument flying, and the value of the instrument trainer in providing simulated indications of instrument flight while on the ground in the class room, must be explained to the student. The student should understand that air instruction must be supplemented by class room work and ground trainer instruction, if he is to become a qualified instrument pilot. The value received by the student will directly depend upon his application and attention. Excellent material upon which to base this indoctrination lecture will be found in Instrument Flying—Basic, and Instrument Flying—Advanced, T.O.s Nos. 30-100A-1 and 30-100B-1.

b. After the indoctrination lecture the student will be shown the manner of entering the trainer. After the student has been seated, the operator will take his position on the trainer step and will point out the controls and instruments as outlined under Section IV. This cockpit drill should be as detailed and thorough as necessary to insure that the student will fully understand the functions of the trainer controls and instruments.

c. The instructor will have the student start the "engine" (turn on the ignition switch), while he keeps the trainer from turning. He will then inform the student that he will "fly" the trainer "contact" to become acquainted with the controls. Particular attention will be called to the slight pressures needed to maneuver the trainer. The student will be cautioned from the start against overcontrolling and rough handling of the trainer. The manner of handling the controls will be similar to the techniques the student has already acquired in contact flight. The rear and side locking straps will now be unlocked. The throttle will be set at approximate cruising position, and the student will then make climbs and dives by backward and forward pressure on the control column. Next the student will make gentle banks and turns to the right and left. This familiarization will continue until the instructor is satisfied that the student understands the control pressures necessary to "fly" the trainer.



d. If a pilot not qualified on instruments flies under instrument conditions, he may sooner or later end up in a spiral or even a spin. It is not practical to teach recovery from unusual positions in the instrument trainer, and this phase of instrument flight instruction will be left to the flight instructor. If the student neglects his instruments, the trainer will fall off into a spin, warning the student of an error on his part. Instruction cannot proceed until the spin is stopped, and the student must be instructed in how to stop the spin, when it occurs. The student will be shown the trainer spin and how to recover. To spin the trainer, the student will slowly apply back pressure on the control column, reducing the airspeed below the stalling point of the trainer. The trainer will stall and then begin to spin in a nose-high attitude. When the spin is started the student will apply full rudder in the direction of the spin, and pull the control column full back. To recover he will then apply full opposite rudder, move the control column forward and then neutralize it. The turn is now stopped and the airspeed brought back to cruising. Several trainer spins and recoveries will be made.

2. BASIC EXERCISES.

It must be assumed that the student is not familiar with instrument indications, nor is he able to interpret the attitude of the trainer by correlating these instrument indications. In contact flight the student controls the attitude of the aircraft by visual reference to the natural horizon, when this reference is not available he must control the attitude of the aircraft (trainer) by reference to the indications of the instruments. To accomplish this transition from contact to instrument flight he must first be familiarized with the instruments, and their indications. Second, he must be able to interpret and control attitude from instrument indications. Third, the knowledge thus gained must be perfected by practice. With these objectives in view the following exercises are prescribed for the instructor's guidance.

I. FAMILIARIZATION.

a. Instruct the student to enter the trainer and turn on the ignition switch. Assist the student to adjust the throttle to approximate cruising position. With the trainer still in the straps, show the student how to adjust the miniature aircraft of the artificial horizon to level flight position. The white reference line indicates the approximate position of the miniature aircraft for level flight at cruising throttle. Impress upon the student that the movement of the miniature aircraft about the horizon bar gives an instantaneous

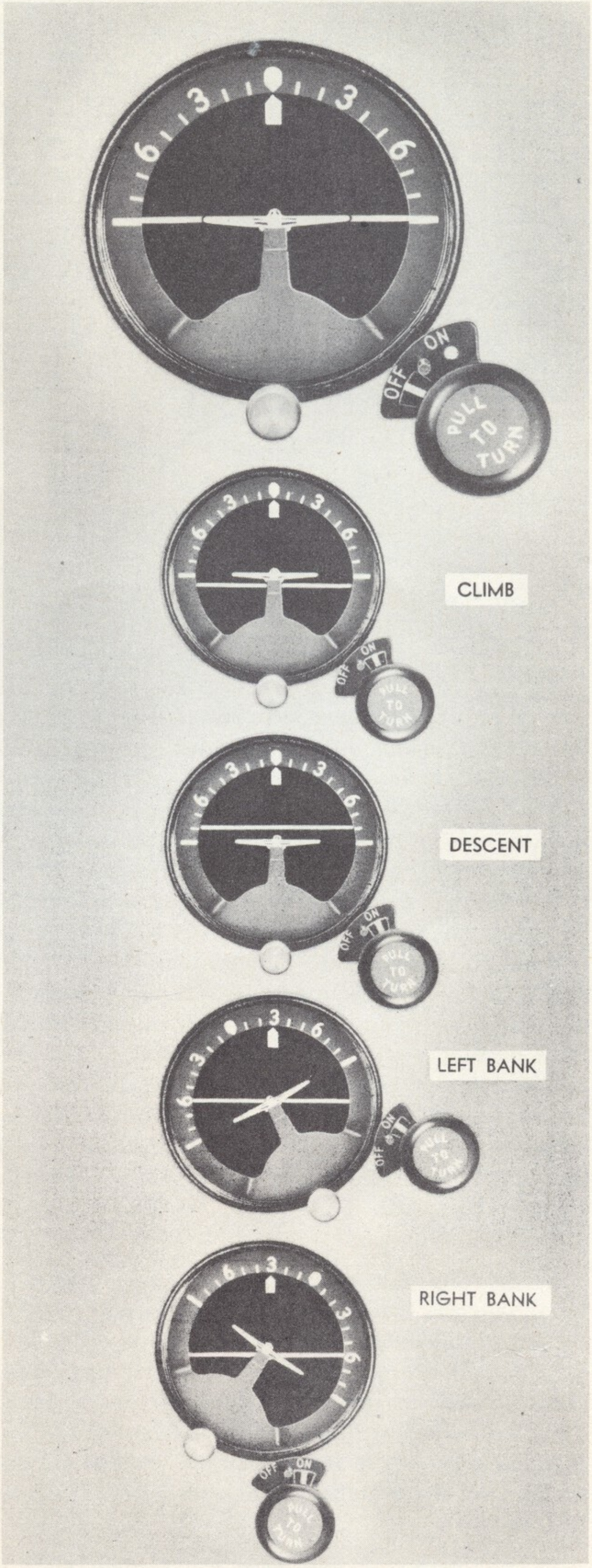


Figure 9—Indications of the Artificial Horizon

indication of the attitude of the aircraft. Show him that the artificial horizon permits holding the trainer at any attitude short of a stall irrespective of airspeed or vertical speed. Point out that great care is required to hold an exactly constant attitude, as small changes in the position of the miniature aircraft correspond to considerable changes in the attitude of the trainer. Tell the student that he must control the miniature aircraft in relation to the horizon bar. He must fly the miniature aircraft and imagine that the miniature aircraft is doing all the moving and not the horizon bar. When the student understands the mechanics of the artificial horizon, unlock the trainer by removing the straps and take your position at the trainer desk and continue the instruction over the interphone. With the hood still open, have the student hold the rudders in neutral position, and instruct him to fly the miniature aircraft slightly above the horizon bar by back pressure on the control column. Insist that the student keep the miniature aircraft just slightly above the horizon bar with the wings of the aircraft parallel to the bar. Now have the student note the altimeter and airspeed indicator. The altimeter will show a steady increase in altitude, the airspeed indicator will show reduced airspeed. As long as the position of the miniature aircraft in relation to the horizon bar remains constant, indicating a constant attitude, the airspeed will be constant. Now have the student fly the miniature aircraft back to the horizon bar. The airspeed will slowly return to cruising value and the altimeter will show constant altitude, providing the miniature aircraft is indicating level flight. If the altimeter still indicates a change in altitude, the trainer is not in level flight attitude and a correction must be made accordingly. If the altimeter shows a loss of altitude, have the student fly the miniature aircraft up in relation to the horizon bar. If the altimeter shows a gain in altitude, have the student fly the miniature aircraft down in relation to the horizon bar. When the altimeter shows constant altitude, the trainer is in level flight, and this level flight attitude will be shown by the position of the miniature aircraft in relation to the horizon bar.

b. Now have the student bank the trainer slightly with the ailerons, to demonstrate the indications of the artificial horizon when the trainer is banked. The student must understand that the little aircraft is banking and not the horizon bar. When the left wing of the little aircraft is down, the left wing of the trainer is down, and vice versa. Aileron action must be taken to correct this attitude. Have the student make several banks to left and right, and climbs and dives. When the student has familiarized himself with the indications of the artificial horizon and altimeter, have him close the hood and repeat these maneuvers on instruments.

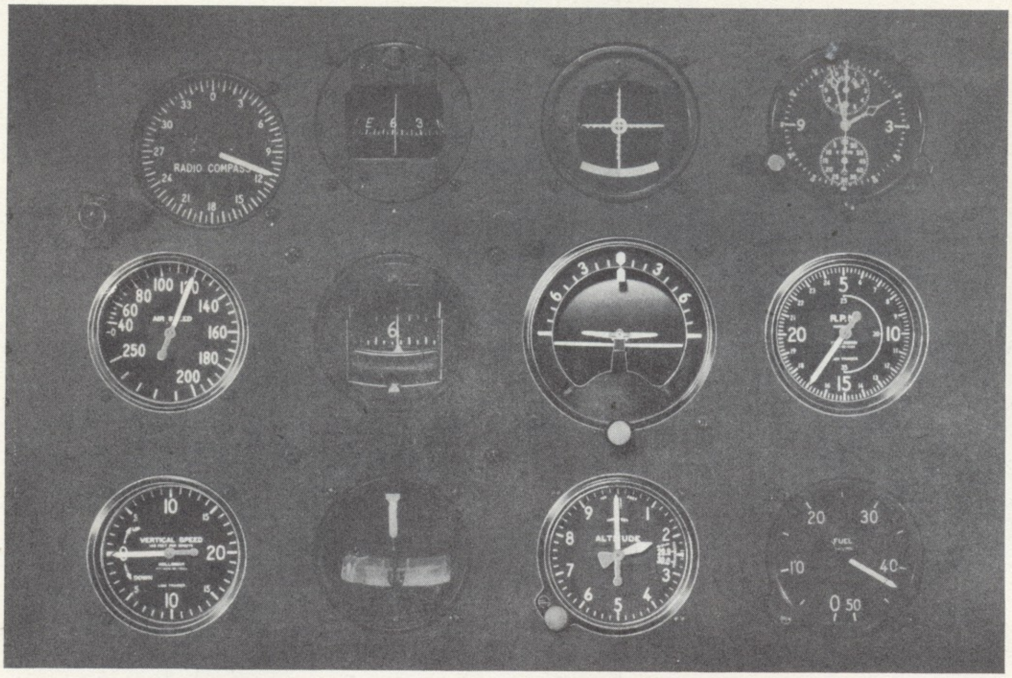
c. After the student has demonstrated that he is familiar with the indications of the artificial horizon and the altimeter, his attention will be called to the airspeed indicator.

d. The trainer being in level flight attitude at cruising airspeed, instruct the student to raise the miniature aircraft slightly above the horizon bar by applying back pressure on the control column. Holding the miniature aircraft in a constant nose-high attitude have the student note the trend of the airspeed indicator. The airspeed will drop and become constant at a lower value, if the attitude of the trainer is constant. After a constant climbing attitude has been attained, instruct the student to return to level flight by applying forward pressure on the control column. After level flight has again been reached, instruct the student to apply forward pressure on the control column to fly the miniature aircraft slightly below the horizon, and again have the student note the indications of the airspeed indicator and the altimeter. The airspeed will increase and become constant at a higher value when a constant nose-low attitude is held. The altimeter will indicate a steady loss of altitude. Have the student level off when this constant condition is obtained. Repeat these maneuvers and instruct the student to level off at predetermined altitudes.

e. With the trainer at level cruising flight, instruct the student to maintain the miniature aircraft, of the artificial horizon, at constant attitude while advancing and retarding the throttle slightly. Have the student note indications of the altimeter and airspeed indicator. After the student demonstrates satisfactory knowledge of these maneuvers, he is ready to proceed to the next exercise.

NOTE TO INSTRUCTOR

This exercise is included to familiarize the student with the artificial horizon, airspeed indicator and altimeter. The throttle setting remains at cruising position, and the student will be required to keep the wings of the trainer level by proper use of the ailerons. The student will not be required to maintain a constant heading, but should be cautioned to keep the rudder pedals in the neutral position.



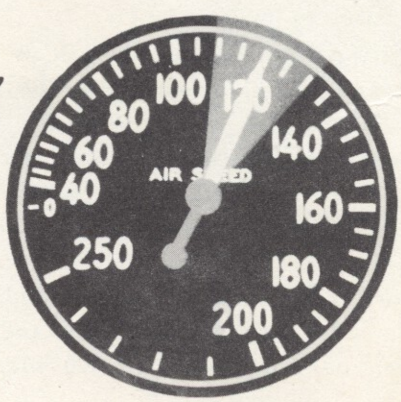
II. CONSTANT ALTITUDE WITH VARIED POWER.

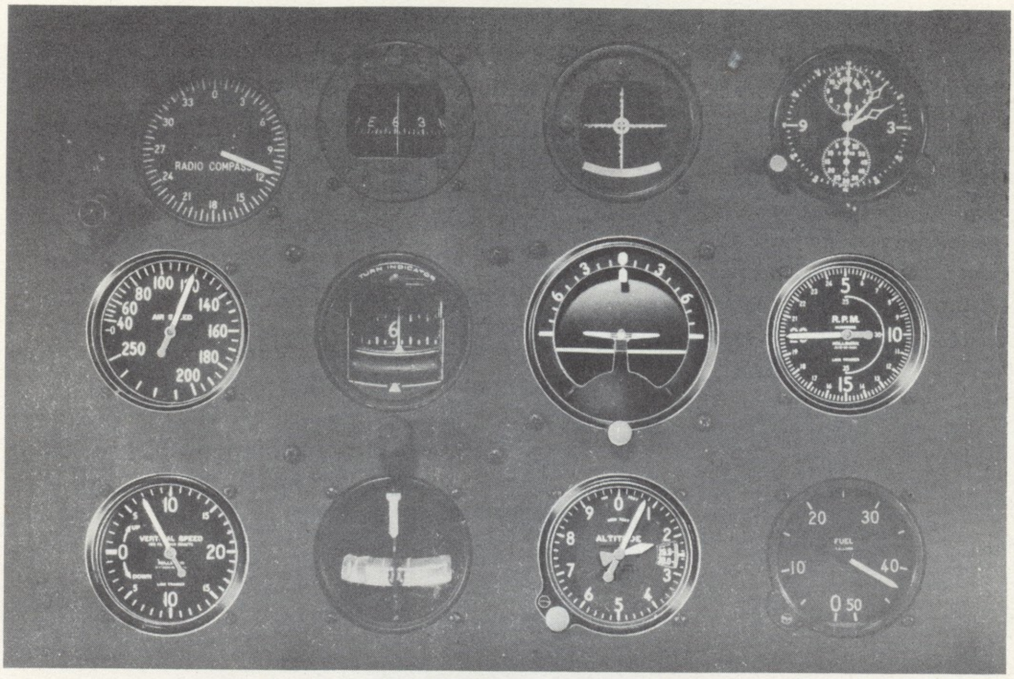
a. The instructor will set the throttle at cruising and then instruct the student to fly the trainer to an even altitude and level off at cruising airspeed. Then have the student check the instruments for this condition of flight. The miniature aircraft of the artificial horizon will be on the horizon bar and the wings parallel to the horizon bar. The altimeter will be constant at an even altitude and the airspeed at cruising airspeed. The vertical speed indicator will indicate no change in altitude. Instruct the student to reduce the airspeed slowly by applying back pressure on the stick at the same time slowly reducing engine r.p.m. as necessary to maintain constant altitude. Airspeed will be reduced to a constant value of 120 m.p.h., while maintaining flight altitude. The artificial horizon will indicate a slight nose-high position, and the altimeter and the airspeed will be constant, the vertical speed will be at zero and the tachometer will indicate reduced r.p.m. To hold altitude at reduced power, attitude must be changed to nose-high position.

Have the student return to cruising airspeed when he has completed this maneuver, holding altitude constant. Power must be increased and level flight attitude regained. Have the student repeat this exercise several times, maintaining level flight and changing airspeed to values specified; i.e., instruct student to change airspeed from 160 to 120, from 120 to 140, from 140 to 170, etc. The student must keep the wings of the trainer level by reference to the artificial horizon. This exercise will be repeated until the student shows smooth coordination of throttle and elevators.

Tolerances

± 100′





III. NORMAL CLIMB—INCREASED POWER AND REDUCED AIRSPEED.

a. The trainer being at cruising airspeed in level flight, have the student apply slight back pressure on the stick and increase power at the same time. By checking the artificial horizon against the airspeed, these two factors will ve varied until a steady airspeed of 120 m.p.h. and a rate of climb between 500-800 f.p.m., as indicated on the vertical speed, is achieved. If the rate of climb is excessive, throttle will be slightly retarded while holding airspeed constant with the control column. If the vertical speed is too low, more power must be added. When a steady climb is attained, have the student note the indications of the instruments in the following order: airspeed, artificial horizon, vertical speed, tachometer. The altimeter will show a steady gain of altitude.

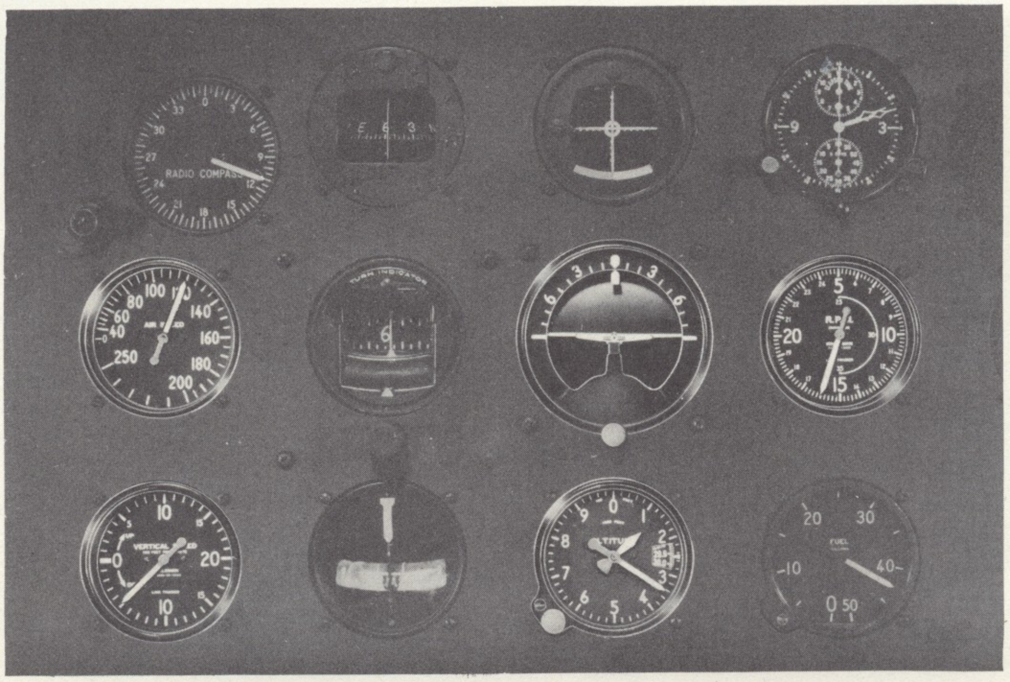
b. Now have the student level off at some even altitude level, regaining cruising airspeed by use of elevators, and then retarding throttle. Constant cross-checking of airspeed, artificial horizon and altimeter is necessary for this maneuver.

c. The instructor will have the student demonstrate to himself that if the trainer or aircraft is pulled up from level flight to an excessively steep angle of climb, the airspeed does not drop immediately, but remains very near its previous reading for some time. In aircraft this is due to inertia of the aircraft and not to lag in the instrument. This apparent lag is simulated to some degree in the trainer. When flying on instruments the steep attitude is not obvious and unless this apparent lag is understood the student may raise the nose still further until the airspeed does drop rapidly. When the airspeed does start to decrease rapidly he will have to put the nose down again almost to the level flight position to regain airspeed. If the student watches the airspeed indicator *only* he may stall before he realizes that the attitude is too steep.

d. This "chasing" of airspeed is a very prevalent fault in instrument flying. The instructor must eliminate it by insisting that the pupil climb by attitude on the artificial horizon, just as in flying by reference to the real horizon. The airspeed will then remain steady and can be increased or decreased by making small changes in attitude on the artificial horizon.

e. Caution the student that the rudder pedals must be kept in a neutral position and the wings of the miniature aircraft, of the artificial horizon, must be kept parallel to the horizon bar or a turn will result. The student should not be required to keep a constant heading but should be reminded when he is turning that a wing is down or that the rudder pedals are not in a neutral position.

Tolerances: Airspeed ±10 m.p.h.; attitude in level flight ±100 feet; vertical speed ±200 f.p.m.



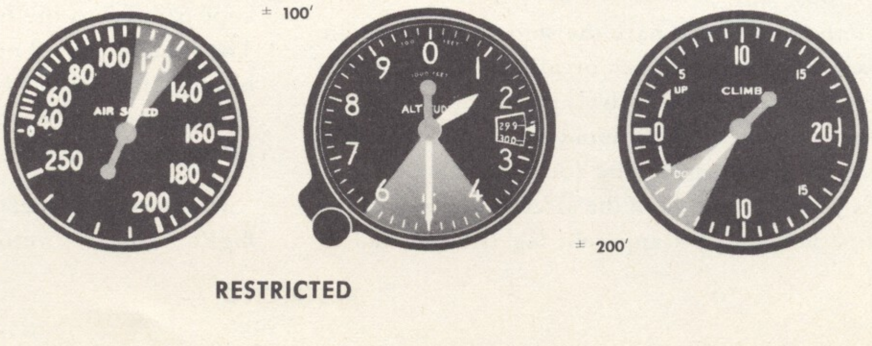
IV. NORMAL DESCENT AT CONSTANT RATE— DECREASED POWER AND REDUCED AIRSPEED.

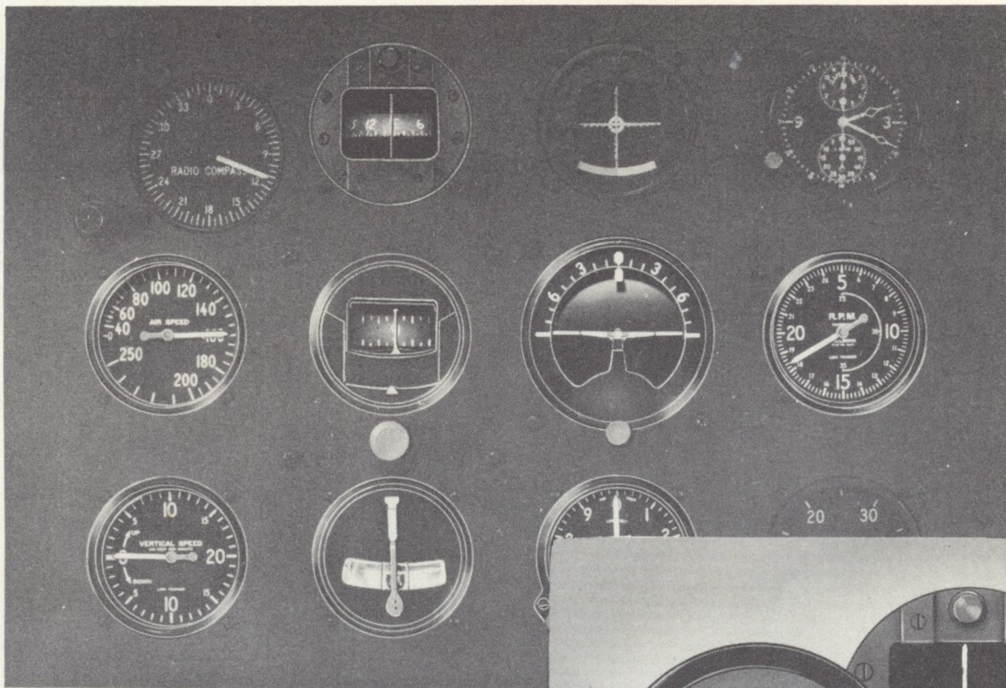
a. The trainer being at cruising airspeed in level flight, have the student note the position of the artificial horizon, altimeter, airspeed and vertical speed indicators. Then have him reduce power setting and at the same time apply slight back pressure on the stick. The student will hold constant altitude until the airspeed reaches 120 m.p.h., then the airspeed is held constant with the control column. Keeping the airspeed at this constant value, the vertical speed is brought to its desired value of 500 f.p.m. by increasing or decreasing the throttle setting. If the rate of descent is more than 500 f.p.m., more power must be added; if the rate of descent is less than 500 f.p.m. less power must be used. The artificial horizon will show approximately the same attitude as for level flight at normal cruising. The airspeed will be constant at 120 m.p.h., while the vertical speed will indicate a steady rate of descent of 500 f.p.m. The altimeter will indicate a steady loss of altitude, and the tachometer will show reduced r.p.m.

b. Have the student note the indications of his instruments in the following order: airspeed, artificial horizon, vertical speed, tachometer, and the altimeter, which should indicate a steady descent.

c. Then instruct the student to level off at some even altitude level, and regain cruising airspeed by coordinated use of elevators and throttle. A series of *Normal Climbs* and *Normal Descents* will be practiced by the student. After each climb and descent the student will be instructed to return to level cruising flight. Remind the student to note the indications of the Airspeed, Artificial Horizon, Vertical Speed Indicator, and Tachometer and the altimeter frequently. Instruct the student that the vertical speed indicator is not used to maintain level flight, but to measure the approximate rate of change in altitude. The indications of the vertical speed indicator should only be used *after* a constant airspeed has been established and the indication of the vertical speed is approximately constant.

Tolerances





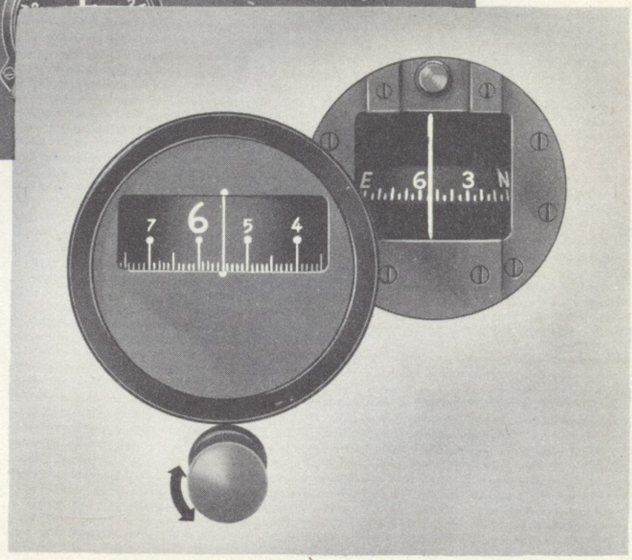


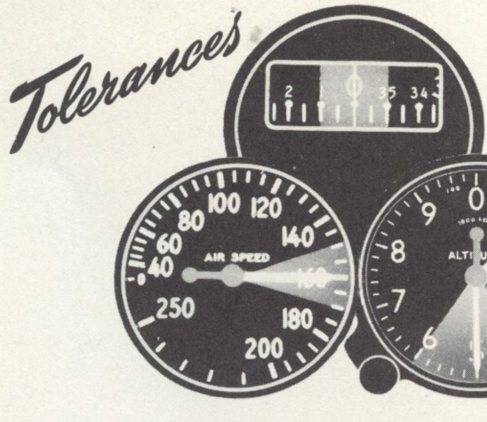
Figure 10—Setting the Directional Gyro

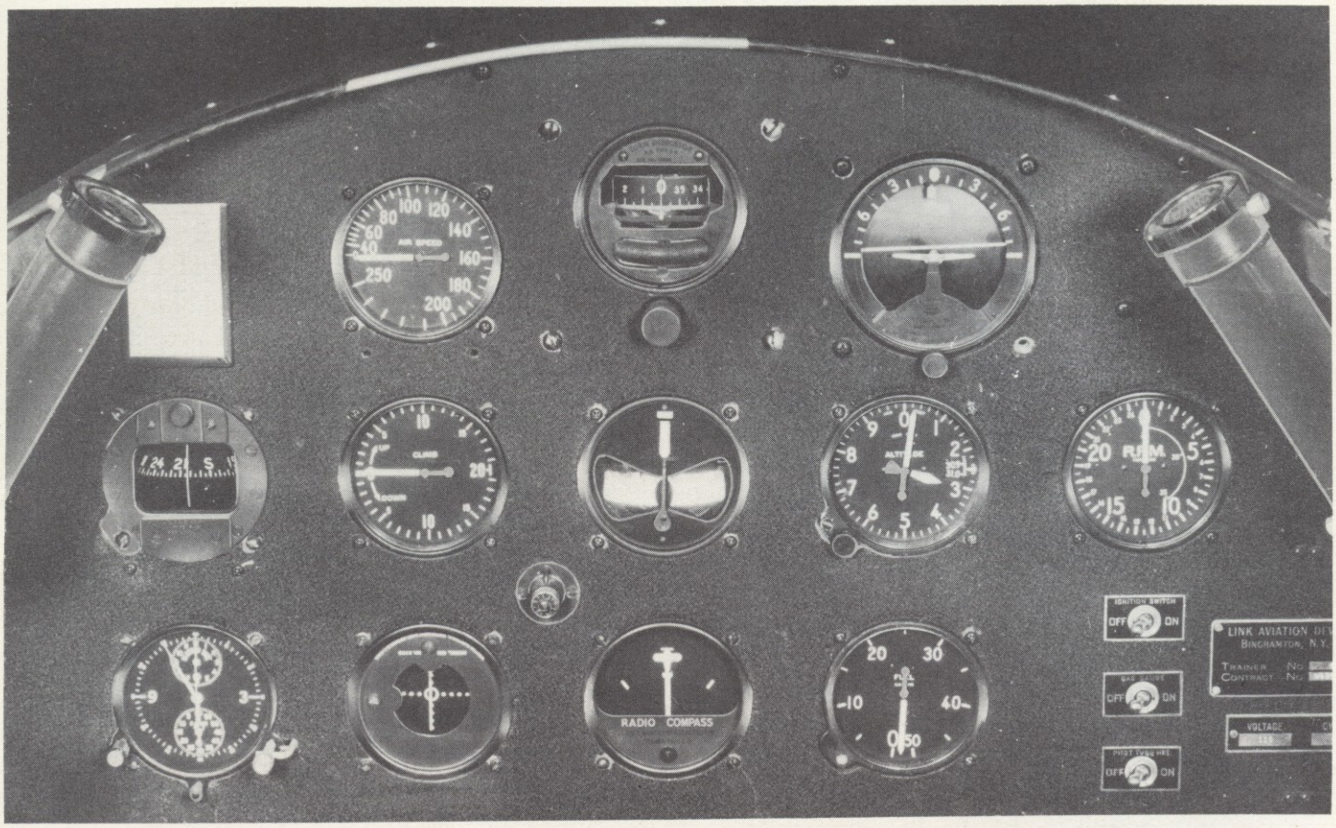
V. STRAIGHT AND LEVEL FLIGHT WHILE MAINTAINING HEADINGS

a. Instruct the student in the proper method of setting the directional gyro with the magnetic compass. Magnetic compasses are subject to error introduced by the magnetic field of the aircraft in which installed. This error is reduced by compensators which are part of the installation. The remaining error is determined and marked on the compass correction card installed near the instrument. When flying a heading, the correction indicated on the compass correction card must be taken into account. This installation error is known as deviation. Demonstrate to the student that there are additional errors inherent in the magnetic compass. The northerly turning error can be shown in the trainer. Have the student bank and turn, using aileron and rudder, in either direction from a northerly or southerly trainer heading. Have him note the reaction of the compass. The compass card will either be ahead or behind the turn, depending upon the original heading and the direction of the turn. When the turn is stopped the compass will not come to rest for an appreciable length of time. Instruct the student that before a heading is set on the directional gyro, he must be certain that he is flying straight and level at constant airspeed. The directional gyro will not lag or oscillate, regardless of rough air, turns or yaws. The instrument will precess slightly as a flight goes on, and the directional gyro should be compared with the magnetic compass whenever the compass is steady. It should be reset as necessary.

b. The instruments indicating straight flight are: the turn indicator—the absence of turn being shown by the turn needle remaining vertical; the artificial horizon—by the wings of the miniature aircraft remaining parallel with the horizon bar, and by the bank indices being centered, showing that no bank is present; the directional gyro—indicating, by unchanged heading, that no turn is being made; the magnetic compass by an indication similar to that of the directional gyro.

c. Have the student climb to an even altitude and assume cruising airspeed. The miniature aircraft of the A/H will be set to level cruising attitude. When this condition has been attained, have the student bank the trainer slightly to the left and right, resuming level flight and cruising airspeed after each maneuver. A bank will be indicated by the miniature aircraft being banked in the same direction with relation to the horizon bar, by the needle of the turn and bank being deflected in the direction of the bank, and by a changing directional gyro heading—indicating a turn. These small banks should be repeated until the student becomes familiar with the reactions of these instruments. If the trainer wings are not level, or if the nose is up or down, the instructor will direct the student to level off by saying: "level your wings" or "raise the nose" as the case may be. The student will now be required to maintain straight flight and constant altitude while varying the airspeed as in exercise II.

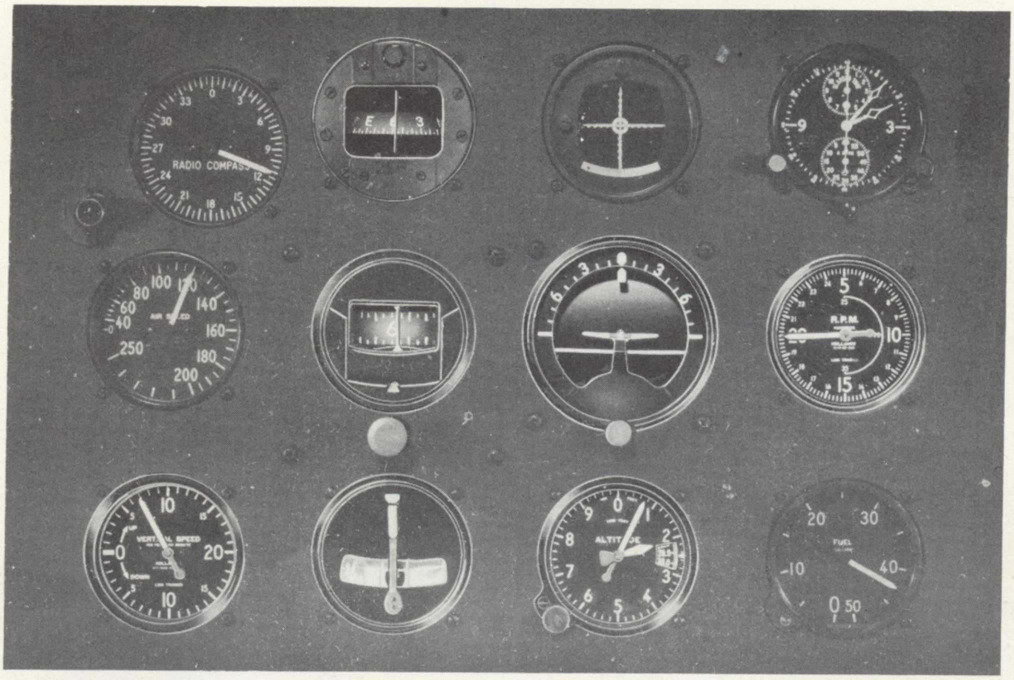




This procedure will be followed by the student at the start of this and all succeeding Basic and Advanced exercises.

1. Ignition Switch "ON".
2. Adjust Artificial Horizon.
3. Uncage Directional Gyro.
4. Fly trainer up to 0 feet.
5. Recheck Artificial Horizon.
6. Cage Directional Gyro, turn knob and at the same time uncage it. If the card continues to turn after the knob is pulled out, the gyro rotor is turning too slow and the instrument will be unreliable.
7. Set the Directional Gyro to magnetic heading.
8. While "taxiing"—flying trainer up to 0 feet indicated altitude—turn right and left to check turn needle.
9. Set altimeter to station altimeter setting and note reading of altimeter which will be the altitude of the field.
10. Check Vertical Speed Indicator for zero.
11. Check free swinging of compass.
12. Report to instructor over interphone.

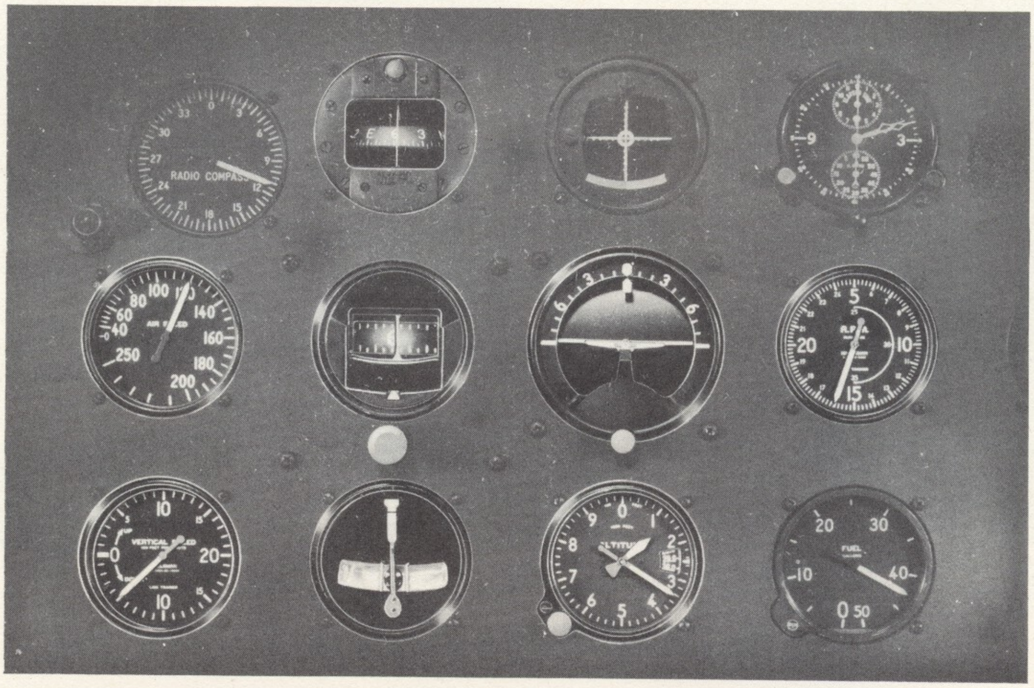
Figure 11—Cockpit Procedure



VI. STRAIGHT CLIMBS AND DESCENTS.

a. Instruct the student to enter the trainer, turn on the ignition, and close the hood. Now instruct him to climb to some even altitude and level off at cruising airspeed.

b. The trainer being at cruising airspeed and level flight at some even altitude, instruct the student to reset the directional gyro with the magnetic compass and turn to the nearest cardinal heading. When the student recovers from the turn, instruct him to climb 1,000 feet at reduced airspeed, while maintaining the heading on the directional gyro. Climbs will be at the rate of 500-800 f.p.m. After 1,000 feet have been gained the student will level off at the new altitude and bring the airspeed back to cruising. A series of these climbs



will be done having the student level off after each step. When sufficient altitude has been gained, instruct the student to descend 1,000 feet at reduced airspeed, while maintaining the trainer heading on the directional gyro. These descents will be done at the rate of 500 f.p.m. as indicated by the vertical speed indicator. As a check on the vertical speed indicator the rate of descent may be determined by the altimeter and clock. In one minute 500 feet in altitude will be lost at a rate of descent of 500 f.p.m. In 30 seconds 250 feet in altitude will be lost. After each descent the student will level off and regain level flight at cruising throttle. A series of these descents will be done having the student level off after each step. The student will be cautioned to maintain the trainer heading throughout the exercise. This will require frequent checking of directional gyro and compass.

c. Sufficient climbs and descents should be practiced until the instructor is satisfied the student is able to perform these maneuvers smoothly and satisfactorily.

VII. TURNS.

a. GENERAL.—All turns specified herein will be approximately standard rate turns.A turn at the rate of 180° per minute (3° per second), or a one needle width deflection either right or left on a properly calibrated turn and bank indicator is considered a standard rate turn. To make a smooth standard rate turn, coordination of controls is necessary in entering and during the turn, and in the recovery to straight and level flight. The turn should be started by the coordinated use of ailerons and rudder in the direction of the turn, and then the elevators are used to hold the altitude constant. (It should be pointed out to the student that in an aircraft the airspeed will drop slightly in a turn.) Once a turn has been started it is not too difficult to maintain a constant rate. This is done by constantly cross-checking the attitude of the miniature airplane of the artificial horizon, the altimeter, the airspeed indicator and the turn and bank indicator. In the recovery it is equally important for the controls to be coordinated. In a properly coordinated turn, the ball of the turn and bank indicator will remain in the center between the lubber lines.

b. SLIPS AND SKIDS.—If a turn is improperly coordinated, either a slip or a skid will result. A slip in an aircraft is caused by banking the aircraft, which would normally cause the aircraft to turn. The aircraft is prevented from turning as fast as it normally would by the application of top rudder. This is indicated by the ball being deflected toward the low wing.

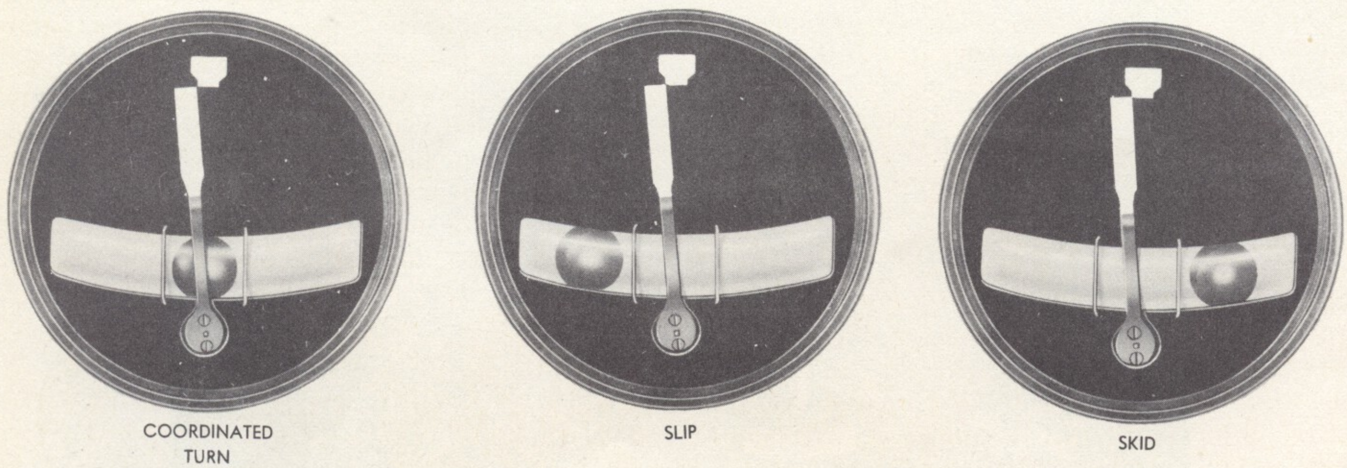


Figure 12—Slip and Skid on Turn and Bank

c. A skid in an aircraft is caused by the aircraft being turned with the use of too much rudder. Similarly, when an aircraft is skidding in a turn, as indicated by the ball being deflected away from the direction of the turn, the aircraft is turning faster than it normally would for the degree of bank. This is caused by using too much rudder in the direction of the turn and is indicated by the ball being deflected away from the direction of the turn.

Conclusion: Both the skid and the slip are caused by improper use of the rudder. Coordinate controls.

d. To demonstrate these effects to the student, have him hold the wings of the trainer level with the ailerons while he applies left or right rudder; have him note that the ball will be deflected away from the direction of the turn as shown by the turn needle, and a skid is indicated: Then have him bank the trainer left or right while holding top rudder to prevent the trainer from turning. Have the student note that the ball will be deflected in the direction of the low wing, indicating a slip, while the needle shows no turn or a very small rate of turn. These demonstrations should be made with the trainer hood open.

VIII. TURNS–NOT WITHIN SPECIFIED LIMITS.

a. With the student under the hood, instruct him to climb to an even altitude, level off at cruising airspeed, and note his instrument indications. The student will then be instructed to make a standard rate turn to the left. After the turn is established, call the student's attention to the instruments indicating a level turn. The miniature aircraft will be banked in the direction of the turn. The directional gyro will be moving, indicating a turn. The turn needle will be deflected in the direction of the turn (deflected toward the low wing). The ball bank will be centered, indicating the absence of a slip or skid. The altimeter and airspeed will be constant, indicating a level turn.

b. After the student has had an opportunity to look at all his instruments in the turn have him regain level flight attitude. Then direct the student to turn in the opposite direction and re-establish level flight in the same manner. A series of these turning exercises will be repeated until the student shows that he can roll in and out of a turn smoothly and maintain a constant rate of turn. At the end of such a series of turns, require the student to note his instruments when he has regained level flight.

Tolerances: Altitude ± 100 feet. Entry into and recovery from turns must be made positive and smooth. Degree of bank as indicated by the trainer wings should remain approximately constant in the turns.

IX. TURNS–90 AND 180 DEGREE.

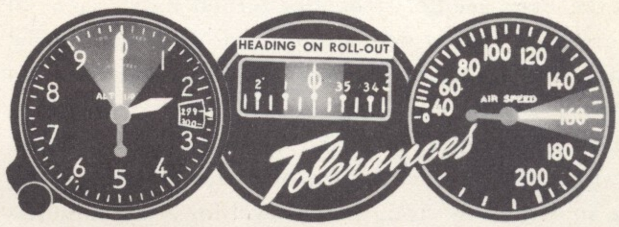
a. The trainer being at cruising airspeed and level flight, instruct the student to set the directional gyro with the compass. The student is now instructed to turn to a cardinal heading, and to make a series of standard rate 90 and 180 degree turns to the left and to the right. If the student under or overshoots the cardinal headings, he will be required to regain that heading before starting the next turn. The student will check the needle and ball for proper coordination and rate of turn, and the altimeter, airspeed, and the artificial horizon for maintaining constant altitude. In the turn, the directional gyro need only be checked to watch for the roll-out heading. When the roll-out heading appears, the student must concentrate on a smooth technique of regaining level flight attitude. He will check his heading on the directional gyro with the compass, the trainer attitude with the A/H, the altimeter and airspeed. Roll-out of turns should be started before the desired heading is reached. Experience will indicate the amount to lead the D/G.

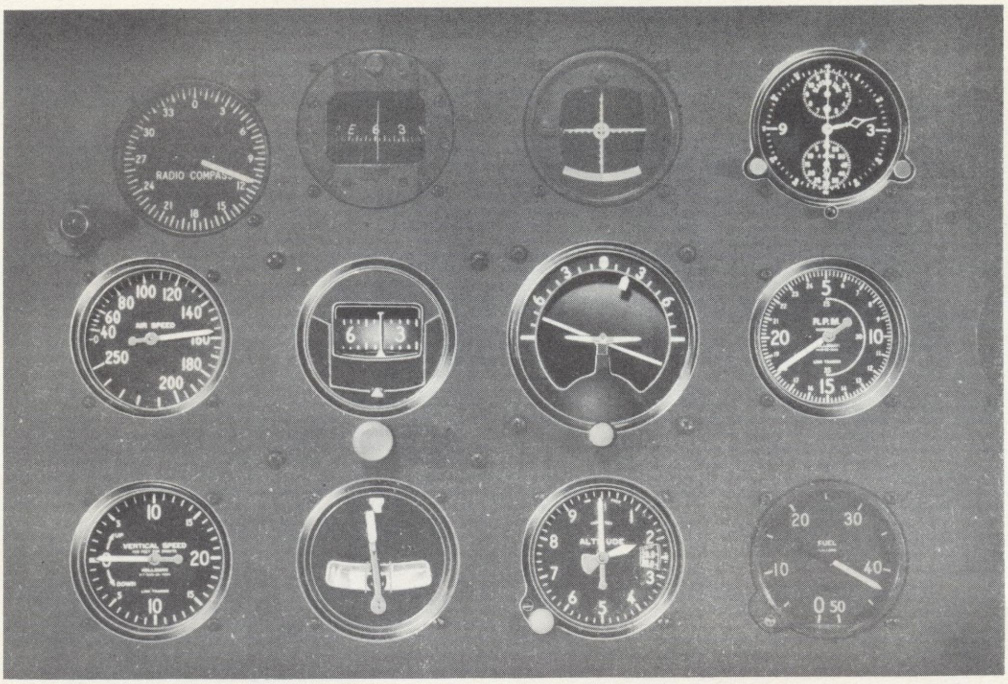
b. Sufficient turns should be made until the instructor is certain that the student has a knowledge of the directional gyro and the compass card.

c. A few points will be helpful to the student. To increase the heading of the D/G or the compass, turn right; to decrease the heading, turn left. If the desired heading lies to the left of the lubber line of the instrument, turn the trainer to the right, and vice versa.

d. To determine reciprocal heading quickly, use the following simple method: If the heading is less than 180, subtract 20 and add 200; if the heading is 180 or more, add 20 and subtract 200.

e. Resetting of gyro headings must be made immediately, if compass headings are to be held accurately.





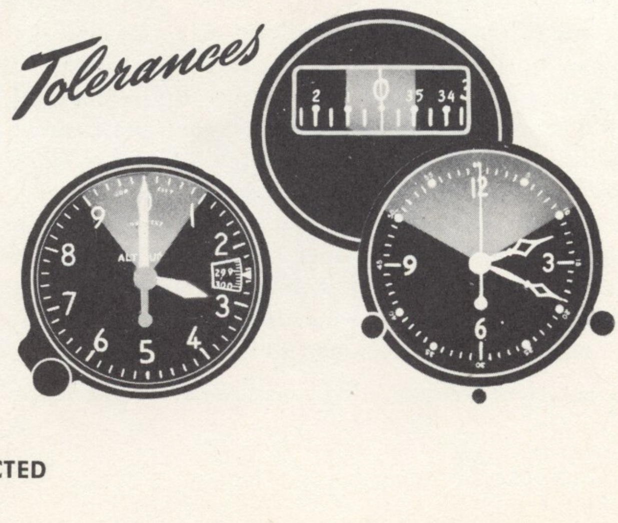
X. TIMED TURNS.

a. The trainer being at cruising airspeed and level flight, instruct the student to make a 180-degree, one minute turn, by timing the turn with the clock of the trainer. To make this turn, the student will be instructed to roll smoothly into the turn as the sweep-second hand of the clock passes a cardinal point. The roll-out, at the same smooth rate, will be started as the second hand passes the same point again.

b. The directional gyro will be used for this exercise. The student, by planning throughout the turn and checking the directional gyro, the turn needle and the clock, should be able to make the turn and the time come out together. A standard rate turn, a turn at the rate of 3 degrees per second, will require one minute for 180 degrees of turn. In a 180-degree turn the student should check after one-half minute has elapsed just how many degrees he has turned on his directional gyro. If he has not turned 90 degrees he should increase the rate of turn slightly as indicated by the turn needle. If he has turned more than 90 degrees he should decrease the rate of turn slightly. Small corrections only should be necessary. The instructor will have the student make several 180, 270, 90, and 360-degree standard rate turns to the left and to the right. After each turn or series of turns, allow the student to fly straight and level for a few minutes.

NOTE

Recovery from turns to straight and level flight should be made smoothly and positively, but should not be done so rapidly as to be jerky. It is necessary to start rolling out of a turn several degrees in advance of the desired gyro heading. In actual flight the number of degrees by which the D/G must be led will vary with the speed of the aircraft which will, in turn, affect the rate of turn, and the amount of bank used. The rate of recovery to straight and level flight is not too important. It is essential that the rate be the same each time. The pilot will then know how much to anticipate or lead the directional gyro.



XI. TURN PATTERNS.

a. Pattern flying will develop the student's ability to fly instruments while thinking and planning his maneuvers in advance. To test this ability the student will be shown the pattern at the trainer desk and will be required to fly it in the trainer from memory, without the aid of a kneepad or chart. Pattern flying will also develop Precision Instrument Flying.

Pattern "A." THE 90-DEGREE PATTERN.—The pattern will be started on a cardinal heading of north. Each leg is two minutes straight and level flight. Turns are 90-degree standard rate. Altitude is to be held constant and throttle at cruising throughout the pattern.

Pattern "B." THE 270-450-DEGREE PATTERN.—This pattern starts and ends on a heading of north. Each leg is two minutes straight and level flight. All turns are single needle-width deflection or standard rate. Altitude will be constant throughout the pattern. Airspeed is as indicated in figure 14. Change airspeed after completing turns.

NOTE

Recorder track may or may not end at starting point. Proficiency should be graded by tolerances and not by track.

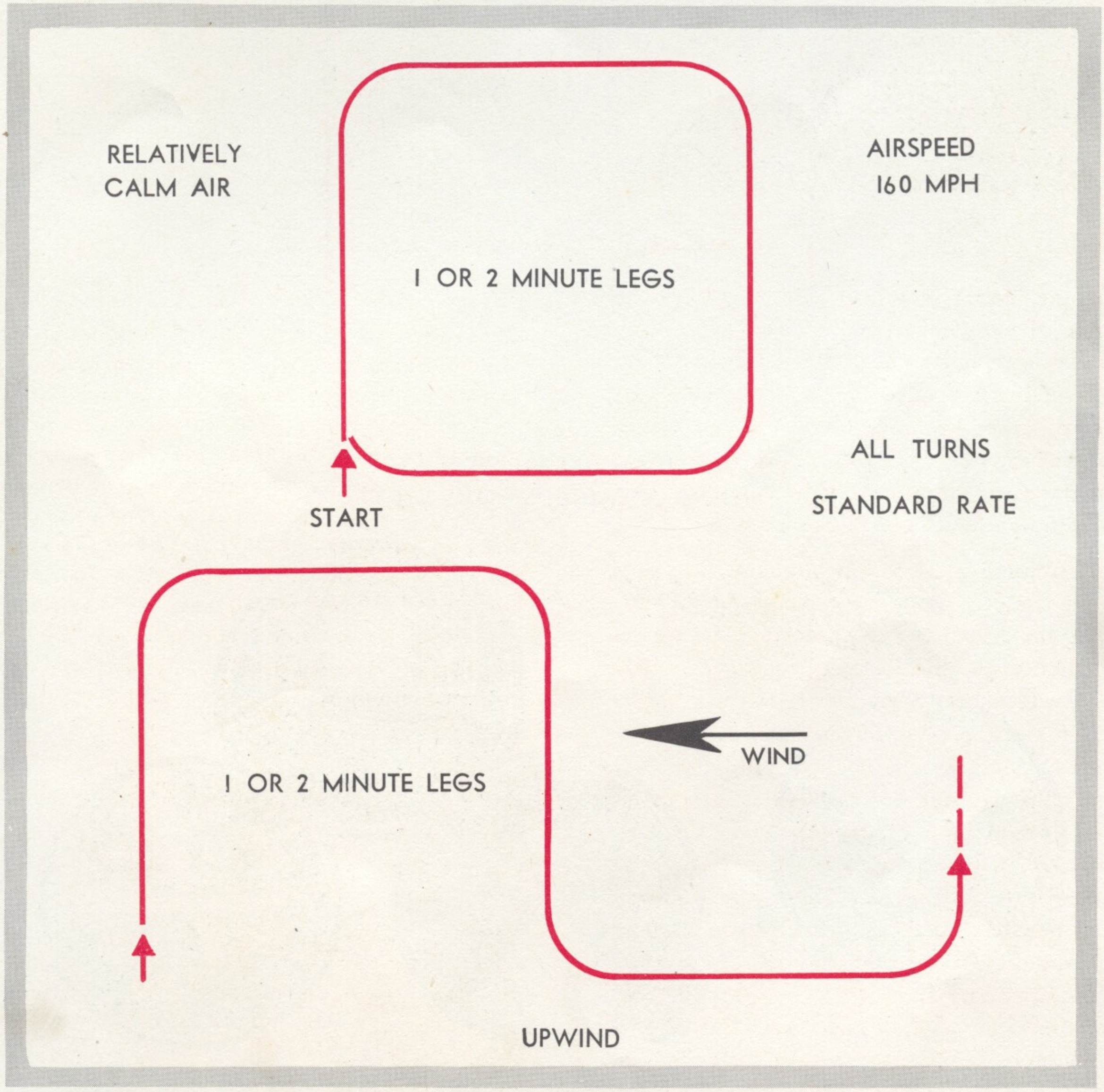


Figure 13—Pattern "A"

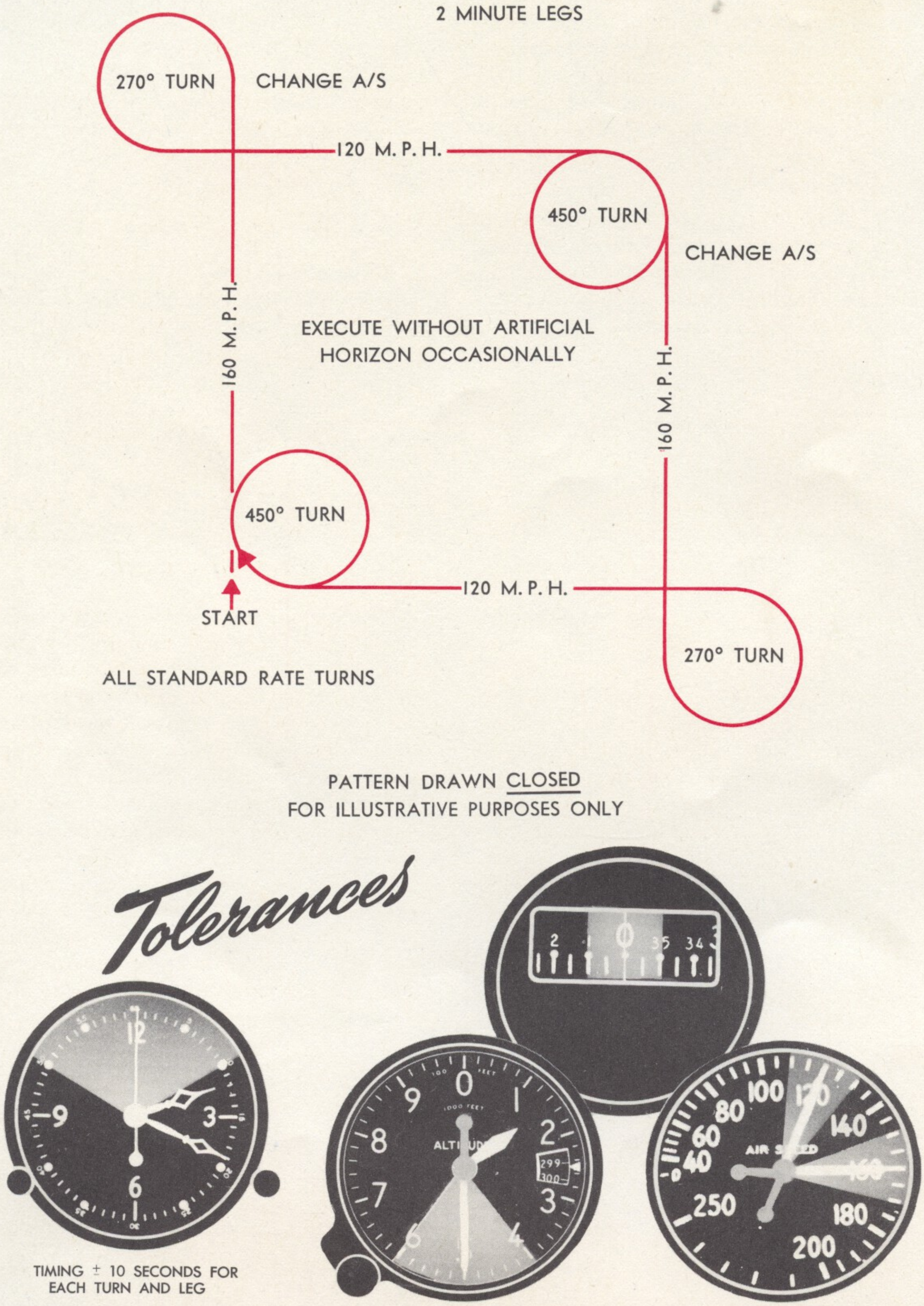
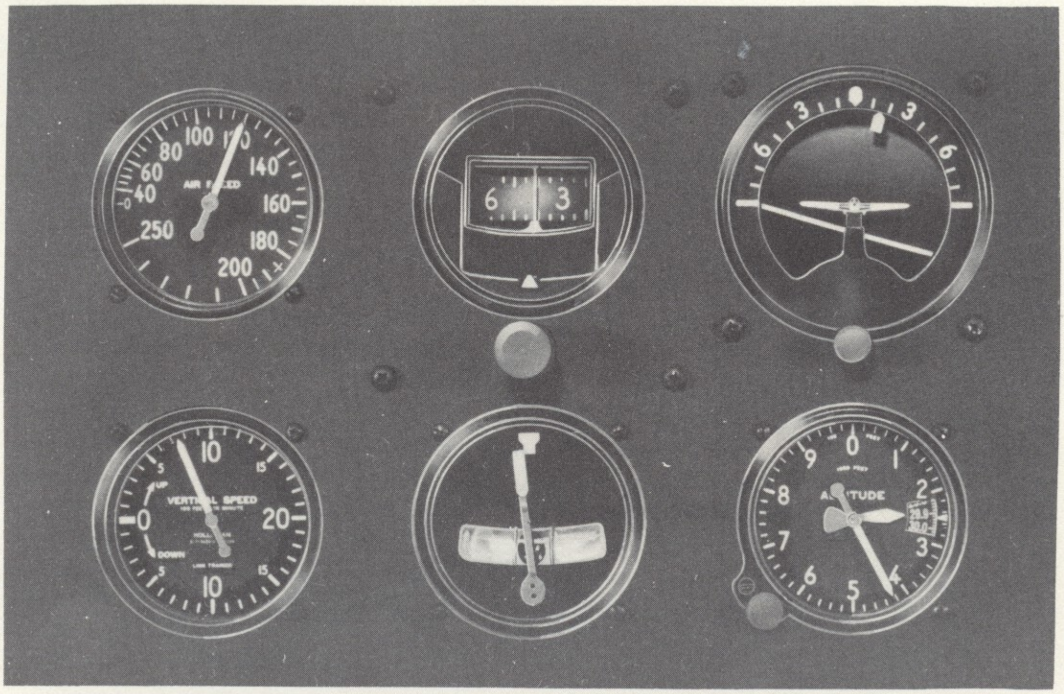
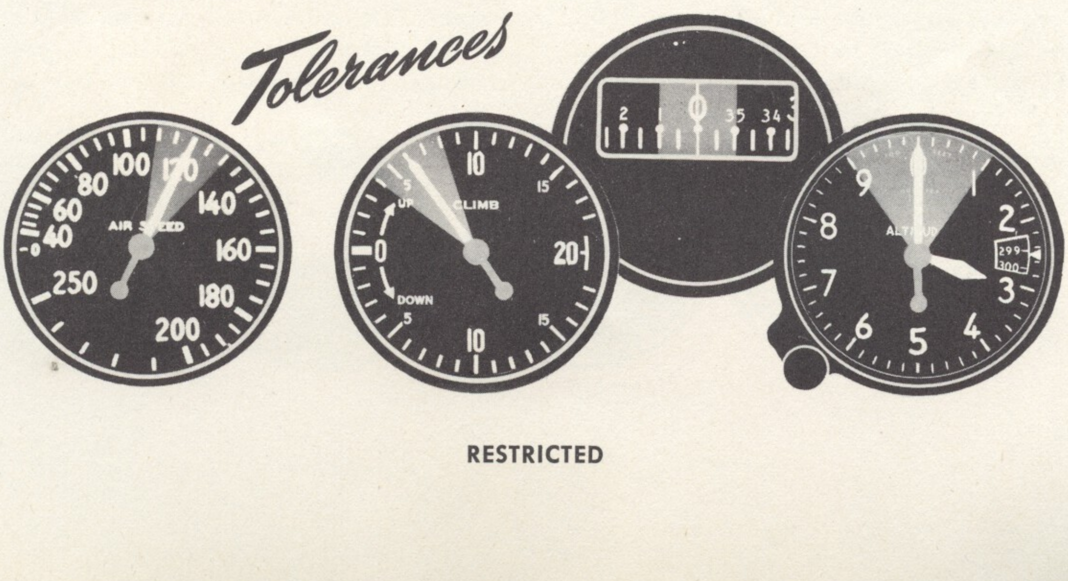


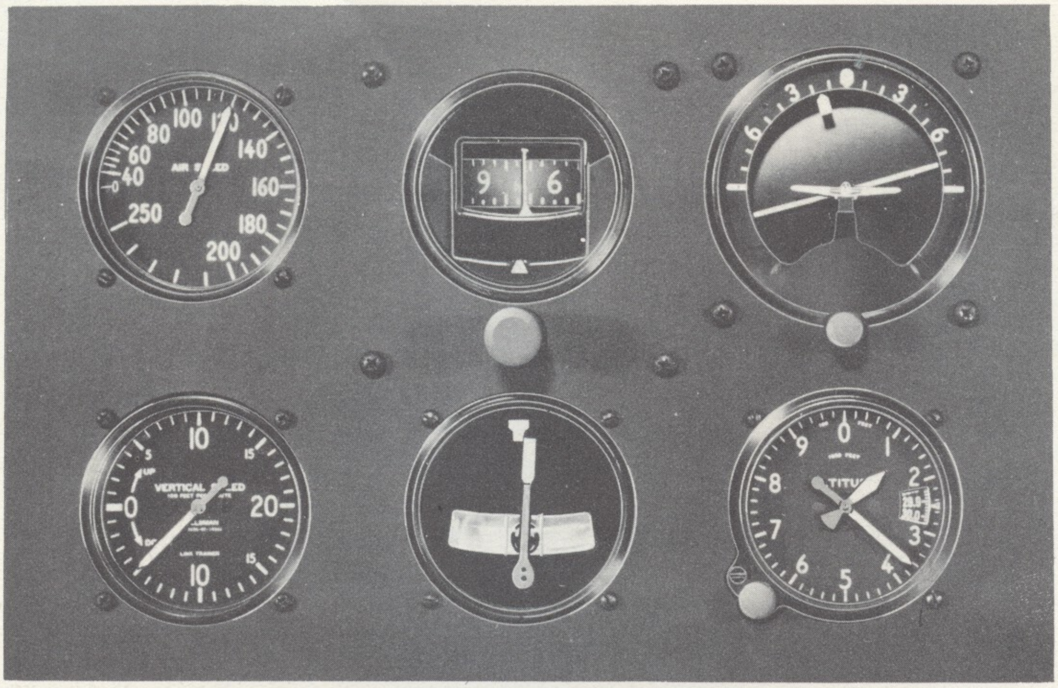
Figure 14—Pattern "B"



XII. CLIMBING TURNS, AND STRAIGHT DESCENTS.

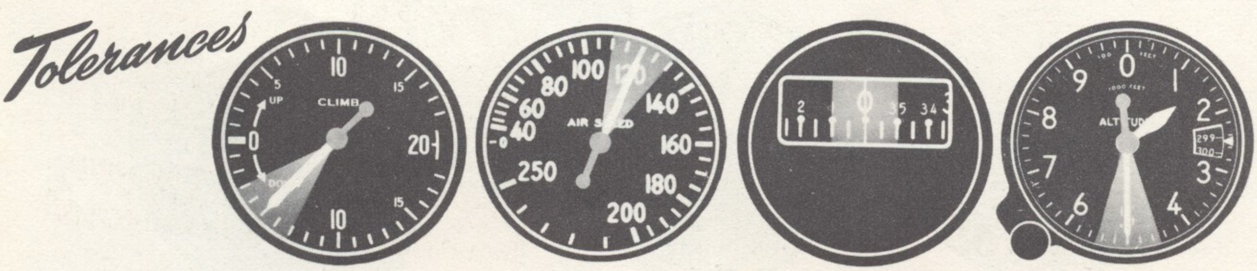
a. The trainer being at an even altitude at cruising airspeed, instruct the student to climb the trainer at a constant airspeed of 120 m.p.h. and a rate of climb of between 500 to 800 f.p.m. When a steady rate of climb is achieved, the student will be instructed to make a standard rate turn of 180 degrees to the right, while maintaining a constant airspeed. On completion of the turn, the student will continue the climb and start a 180-degree turn to the left. When this turn has been completed, the student will climb straight ahead maintaining constant airspeed and heading until a predetermined even altitude has been reached. At this even altitude have the student level off and regain cruising airspeed. The instructor will then have the student again establish a constant rate of climb. When the climb has been established instruct the student to make climbing turns to the right and to the left, leveling the wings and climbing straight ahead after each turn. The magnitude of these turns will be varied by the student on command from the instructor. 90, 180, 270 and 360-degree climbing turns will be given the student. Turns will be started from a cardinal heading, and will be made to cardinal headings. After roll-out from each turn the student will correct to the proper cardinal heading before commencing the next turn. After a series of climbing turns have the student level off and regain cruising airspeed before commencing another series of turns. When excessive altitude has been gained, the student will do straight descents on a cardinal heading on command from the instructor until sufficient altitude has been lost to permit another series of climbing turns.

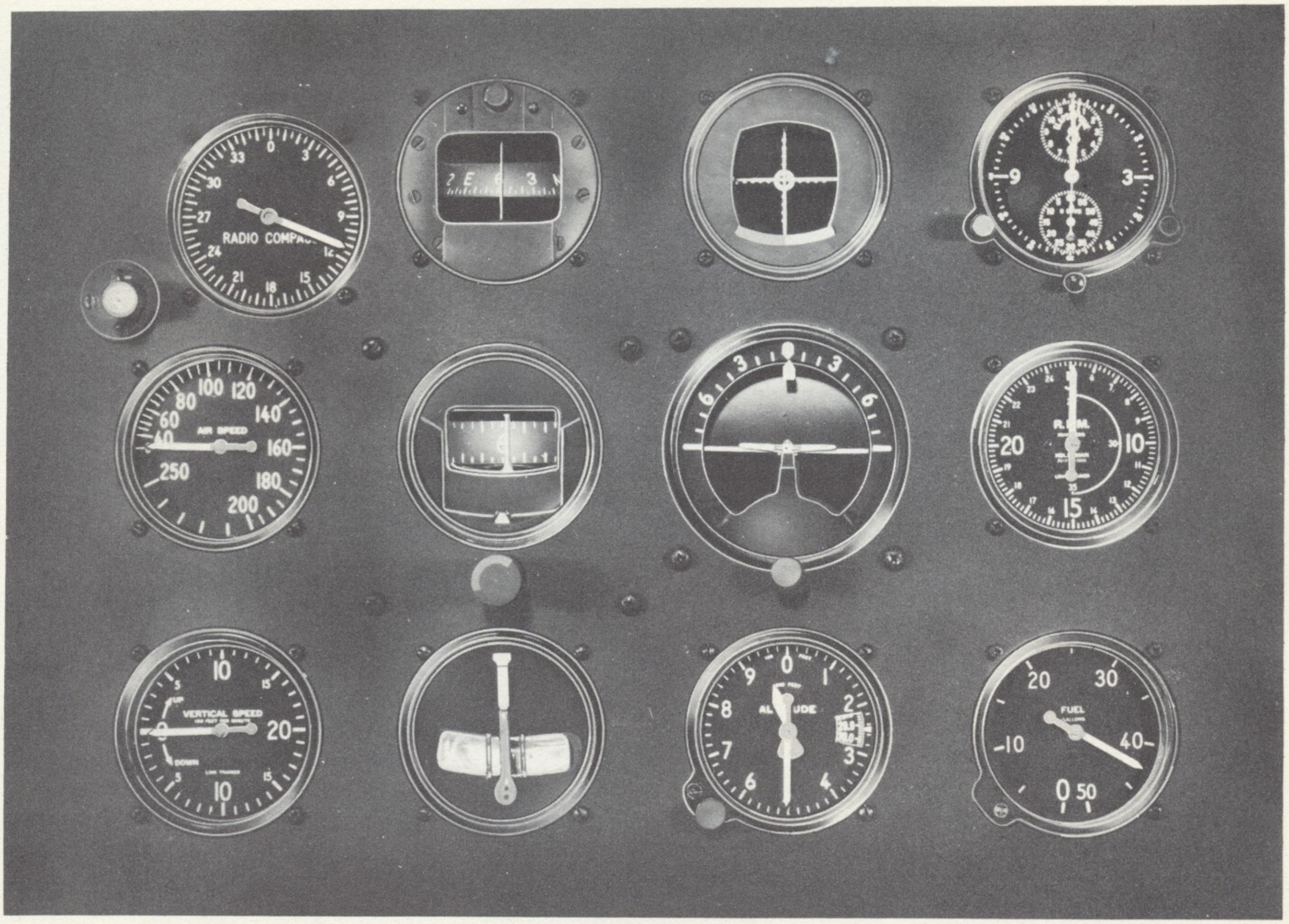




XIII. DESCENTS TO PREDETERMINED HEADINGS AND ALTITUDES.

The trainer being at cruising airspeed in level flight, have the student note the position of the artificial horizon, altimeter, airspeed, turn and bank indicator, and directional gyro. Then have the student reduce the power setting and at the same time apply slight back pressure on the stick. The student will hold constant altitude until the airspeed is reduced to 120 m.p.h.; the airspeed is then held constant with the control column. Keeping the airspeed at this constant value, the vertical speed is brought to its desired rate of 500 f.p.m. by decreasing or increasing the throttle setting. When the desired rate of descent is established, a standard rate of turn of 180 degrees is started on some even altitude and heading, increasing power slightly to maintain the rate of descent as the airspeed is held constant. In one minute, 500 feet of altitude should be lost, and the trainer should have turned 180°. At the one-half minute mark, the turn should be half complete, and 250 feet in altitude should have been lost. The student, by careful planning throughout the 180° turn, should be able to make the altitude and heading come out together without making large corrections during the turn. In this connection, it should be noted that in an aircraft more power will be necessary in descending turns, than would be needed for a straight descent at the same rate. When the turn has been completed, the student will hold the heading and rate of descent until he reaches an even 500 or 1000 foot altitude level. The instructor will instruct the student over the interphone well in advance of reaching this new altitude level. At the new altitude level instruct the student to start a standard rate turn of 180 degrees to a predetermined heading and altitude. After several 180 degree turns, 360 and 90 degree turns will be practiced. To insure sufficient workable altitude the instructor will have the student level-off and regain cruising airspeed after a series of descents. The student will be instructed to climb at reduced airspeed, while turning to predetermined headings, until sufficient altitude has been gained.





XIV. RELATED INSTRUMENTS.

If the time allotted to the training of the student permits, the relationship of the various instruments to one another should be demonstrated by blacking out the gyro instruments and then requiring the student to go through some or all of the preceding exercises. With the artificial horizon and directional gyro inoperative, direction and attitude may be maintained by reference to the magnetic compass, airspeed, altimeter, turn and bank and tachometer. The attitude in a rolling plane can be recognized by correlating the readings of the turn and bank indicator; in the pitching plane by airspeed and change of altitude; and direction in the yawing plane by the turn indicator and the magnetic compass.

The importance of the foregoing exercises lies in the development in the student of the "Full Instrument Panel" consciousness. Substitution of instruments may be done during the radio exercises listed under Section VIII.

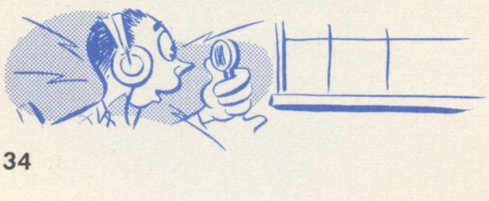
SECTION VI
RADIO PROCEDURES

1. RADIO TELEPHONE PROCEDURBS.

Space is not available for a detailed treatment of radio telephone procedures used by pilots of aircraft in flight. It is, however, important that standardized calls and replies be used during trainer exercises to familiarize the student with the essentials of proper voice contacts.

a. In radio telephone communication the accuracy with which messages are received depends upon the transmitting pilot's and/or operator's clearness of speaking. Correct understanding of all speech over the radio must be effected through clear enunciation. Loud talking into the microphone is unnecessary, and will make clear reception very difficult. A normal tone of voice should be used. When speaking into the microphone, it should be held about one inch from the lips. When numerals are to be transmitted, as in altimeter settings, a slight pause before and after will materially assist the pilot in reading the figure. Radio telephone transmissions will be made in a concise and business-like manner. Irrelevant words and phrases will not be transmitted. Never speak in an excited tone of voice. A request for a repetition will be made as "Say again."

b. To establish communication the following form of call will be used: "Hello, Army............(insert here the serial number of the trainer). This is Trainer Control, over." The student, having received the call, will reply: "Hello Trainer Control this is Army 1234, over." The instructor will now issue instructions: "Army 1234, climb to 2000 feet and level off, over." The student replies, if he has understood the message: "Wilco." If the student has not understood the message, he will reply: "Say again."



c. The following radio telephone procedures will be used.

THE CALL

THE FULL CALL	EXAMPLE
Hello	Hello
Call sign of receiving station: Trainer Control	Trainer Control
This is	This is
Call sign of sending station: Army 1234	Army One Two Three Four.
THE ABBREVIATED CALL	
Used after communication has been established: This is	This is
Call sign of sending station: Army One Two Three Four	Army One Two Three Four.

THE TEXT

The text (subject matter) may consist of plain language, code words, or figures. When spelling out becomes necessary the phonetic alphabet must be used.

THE ENDING

Every transmission will end with one of the following procedure words:

WORD	MEANING
Over	My transmission is ended and I expect a reply from you. (Signifying that the transmitting station is switching "over" to receive.)
Out	This conversation is ended and no reply is expected.

PROCEDURE PHRASES

The following phrases have been adopted and will be used in the text of the message when applicable:

WORD	MEANING
Roger	I have received all of your last transmission.
Wilco	Your last message understood and will be complied with.
Say again	Repeat. (The word "repeat" will not be spoken in Radio Telephone transmission.)
I say again	I will repeat . . . .

THE PHONETIC ALPHABET

LETTER	SPOKEN AS	LETTER	SPOKEN AS
A	Able	N	Nan
B	Baker	O	Oboe
C	Charlie	P	Peter
D	Dog	Q	Queen
E	Easy	R	Roger
F	Fox	S	Sugar
G	George	T	Tare
H	How	U	Uncle
I	Item	V	Victor
J	Jig	W	William
K	King	X	Xray
L	Love	Y	Yoke
M	Mike	Z	Zebra

NOTE

Reference is made to War Department Basic Field Manual, FM 24-9, "Combined United States-British Radio Telephone Procedure."

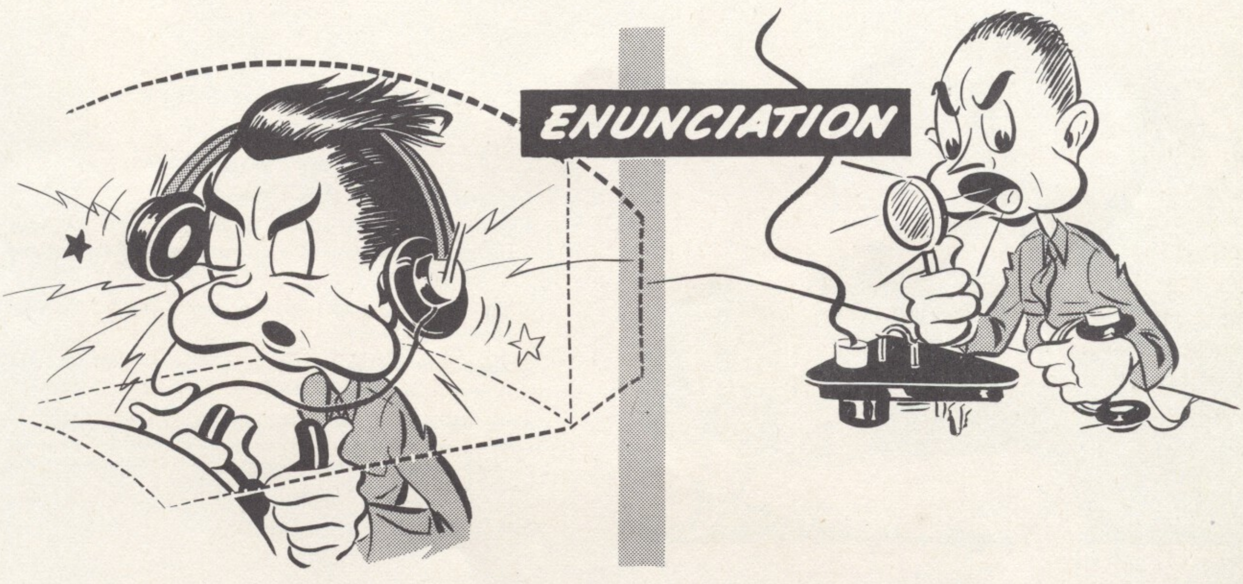
d. Figures are transmitted by speaking the individual digits, except that ceilings, flight levels, upper air levels, etc., are spoken as one hundred, one thousand, etc., i.e., two thousand four hundred for 2400 feet.

e. Time is stated in four figures, using the 24 hour clock. 1:05 PM would be transmitted as: one three zero five. Midnight is zero, zero, zero, zero; not 2400. Only the last two digits, that is the minutes, need to be stated in traffic control procedures.

2. AIRCRAFT RADIO CALL LETTERS.

a. For the purpose of radio telephone reference and identification, each Air Corps aircraft will be designated by not less than four numerals, to be obtained from its Air Corps serial number in the following manner: The first numeral will be the last numeral of the year in which the aircraft is manufactured, the remaining three numerals to be the serial number of the aircraft using "zero" when necessary between the year designated and the serial number, to make four numerals; for example, the third aircraft of 1938 serial number 8003, would be designated by the call numerals eight-zero-zero-three; the twenty-fourth aircraft of the 1942 serial number 20-24 would be designated by the call numerals two-zero-two-four.

b. When an aircraft serial number contains more



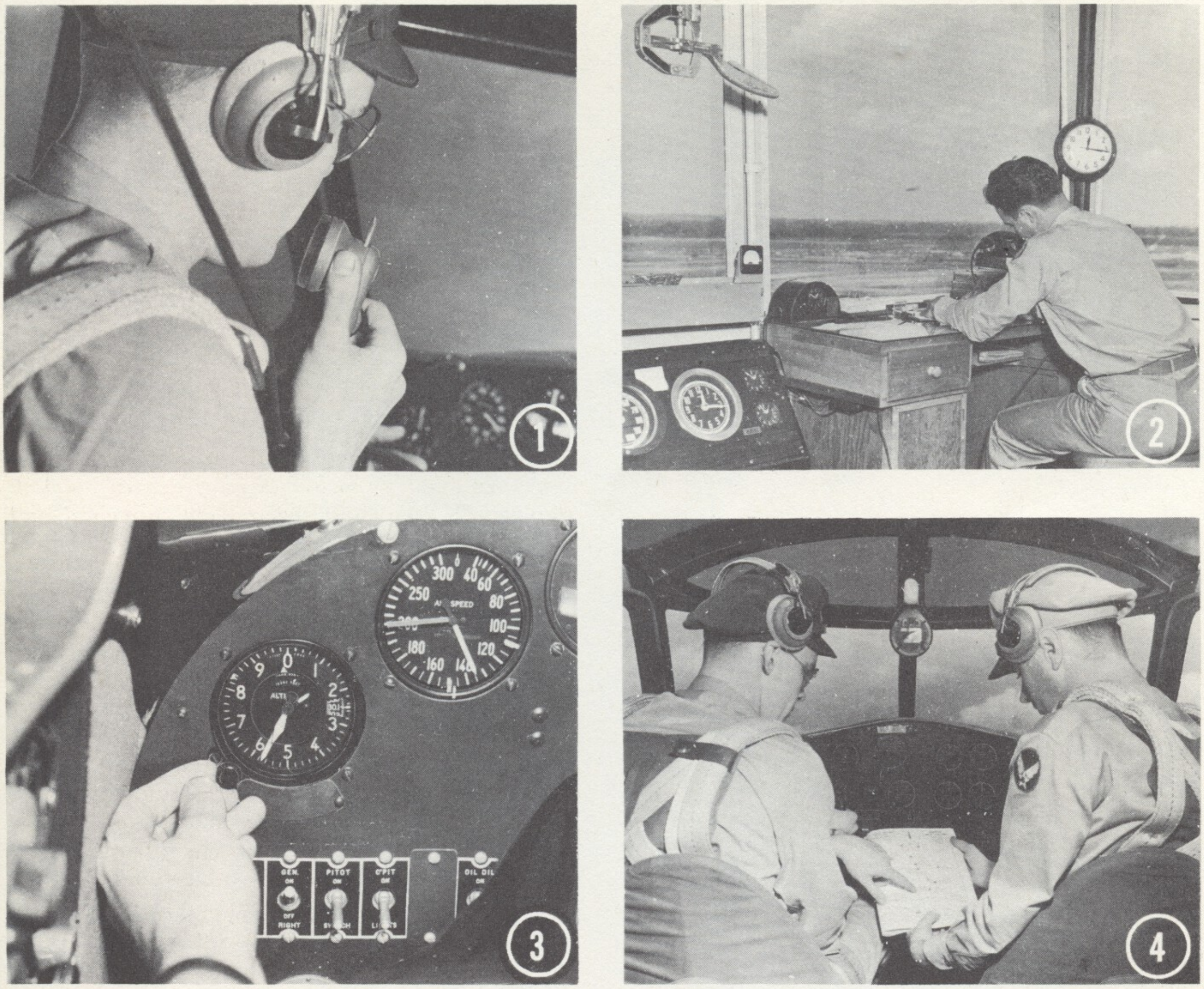


FIG.15

USE OF "ALTIMETER SETTING" FOR LANDING

1. Call in to the tower and request altimeter setting.
2. Tower replies and gives altimeter setting.
3. Set the barometric scale to correspond to the altimeter setting. The altimeter will indicate the altitude over sea level.
4. Plan your approach procedure on the basis of the new altimeter indications.
5. Upon landing the aircraft your altimeter will read the surveyed elevation of the field.

NOTE: *Due to various factors in the mechanism the altimeter may not be depended upon for an exact reading and consequently it is not recommended to depend upon the instrument for an indication accuracy closer than 75 feet.*

than three numbers following the numeral designating the year, the call sign of the aircraft will be determined in the same manner, by using the last digit of the year of manufacture plus the remaining numerals of the serial number.

3. GROUND STATION RADIO CALL LETTERS.

a. Control towers are designated by the name of the airport or the city at which they are located, i.e., Randolph Tower or Greenville Tower.

b. Radio range stations are called by adding "radio" to the name of the station as indicated on current charts. That is, "Atlanta Radio", would be used when calling the Atlanta radio range operator for Airway Traffic Control information.

c. Army Airways Communication Stations (AACS) are called by adding "Army Airways" to the name of the station, i.e., Gowen Army Airways, when calling the AACS Station at Gowen Field.

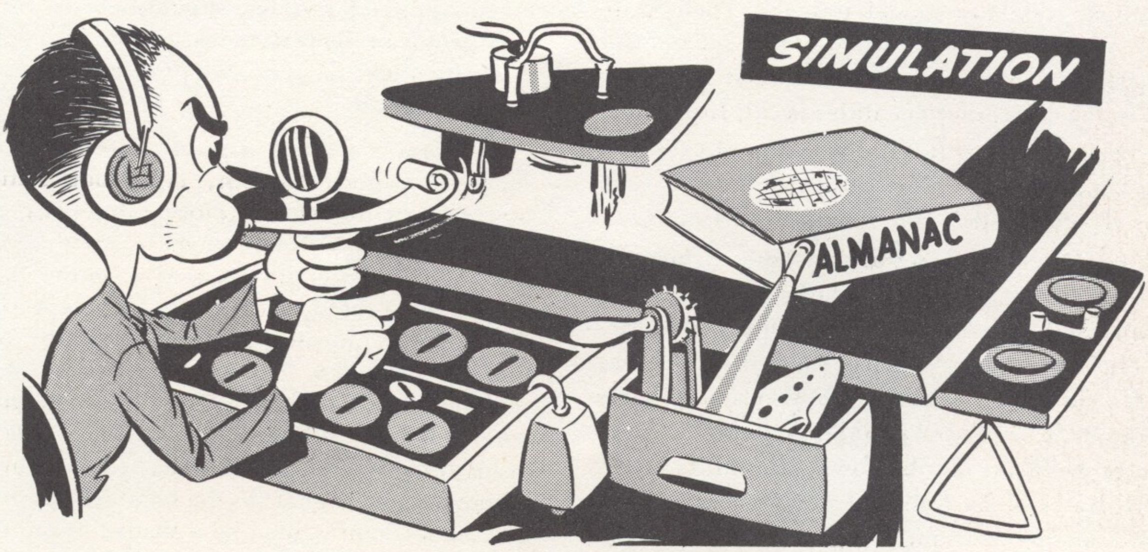
4. ALTIMETER SETTING.

a. The station altimeter in the control tower is set with the indicating hands reading the surveyed elevation of the airport above or below sea level, corrected for the height of the instrument above the runways. The tower operator then reads the barometric scale of the instrument. The figures thus determined are denoted the "Altimeter Setting". This altimeter setting is then broadcast to the pilot requesting it. The pilot turns the setting knob of the aircraft's altimeter until the barometric scale reads the setting received by radio. The aircraft's altimeter now reads indicated altitude of the aircraft above sea level, and upon landing will indicate the elevation of the airport. Because the barometric scale only covers a range of from 28.00 inches of mercury to including 31.00 inches of mercury, only the last three digits of the altimeter setting need be broadcast to the pilot.

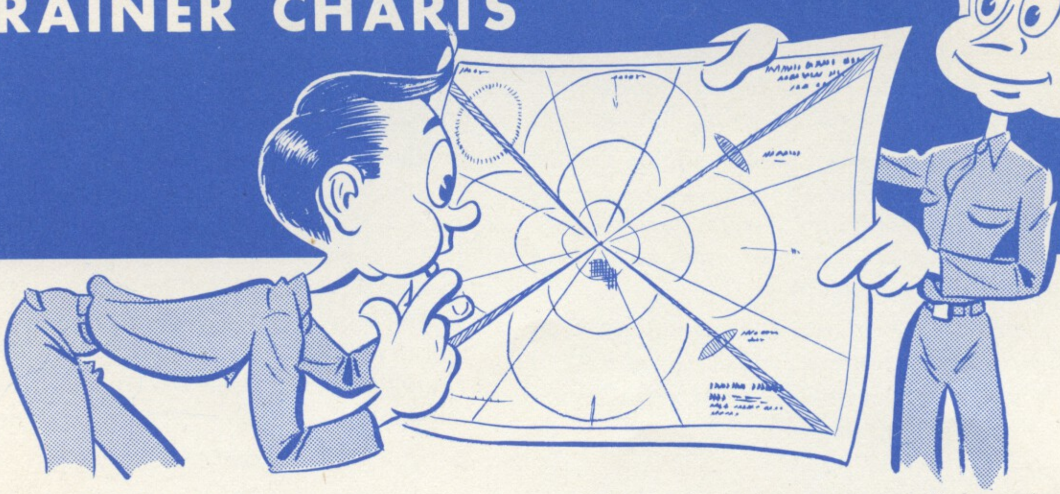
b. When the student is flying problems such as instrument approaches, instrument landings or any other type of exercise where the maintenance of sea level altitude should be stressed, the instructor will "broadcast" the altimeter setting to the student upon his request. If such a request is not made by the student when the problem indicates that he should have reset or checked his altimeter, his attention should be invited to this serious error. When the trainer instructor broadcasts the altimeter setting, he will only broadcast the last three digits, and he will choose a setting such as 30.05 or 29.70 or any other figure consistent with actual settings. The instructor must also set the desk altimeter to the same setting so the altimeters will correspond.

5. WEATHER REPORTS.

It will be necessary to introduce weather reports in advanced instrument trainer exercises. Consequently, weather should be "broadcast" to the student who is about to practice a simulated instrument approach procedure or instrument landing. Weather reports will also be required during cross-country flights, at the student's request. The student "flying" the instrument trainer will primarily be interested in ceiling, visibility and altimeter setting at the airport where his simulated approach is to be made. The instructor will be prepared to furnish a typical weather report including this data when the student requests it. The report must indicate ceiling and visibility minimums suited to the problem being flown.



SECTION VII
INSTRUMENT TRAINER CHARTS



1. DESCRIPTION OF THE RECORDER CHARTS.

a. To assist the instructors in the accurate simulation of varied radio problems and in the operation of the desk radio controls of the trainers, a series of standard desk charts has been published by the Air Service Command. On the radio range type of "Army Air Forces Instrument Trainer Charts" actual radio range installations are shown to scale. Airports are included in their proper relation to the radio transmitter, to make their use in approach procedure problems possible. On other charts commercial broadcasting stations on the entertainment band that are to be used with the radio compass in the trainer are also indicated. These charts are accurate for use with the type C-3 and later model trainers. Their scale does not match the recorder speed of the C-2 and C-4 trainer. Because these charts are changed whenever changes in the actual radio facilities occur, Instrument Trainer Departments will avoid stocking of excessive quantities which may become obsolete. A stock sufficient for 45 days' operation should be maintained.

b. Additional charts which are available include the modified A-1 system of instrument landing, the localizer instrument landing system and the British beam approach (Lorenz) system. Charts for radio compass, both left-right and automatic, are also available, as are charts for cross-country flights on which a combination of problems may be flown. Section XI, T. O. No. 00-1, Index of Technical Orders carries a list of currently available Instrument Trainer Charts. Requisitions for this material will be submitted as outlined in that technical order.

c. Figure 16 is a typical example of an Instrument Trainer Chart. Note that space is provided for the student's name, the date, time (duration of the problem), and the instructor's initials. The data for three different flights may be entered and the chart should be used several times, provided the courses previously recorded are not such as to confuse the instructor. The same chart is printed on the reverse side to conserve paper, making its use in six problems possible. The used charts should be filed for reference until the students whose records appear thereon have completed their courses. Charts which have been used for an approach problem should be used for orientation problems thereafter because under ideal conditions the tracks on approach problems should be very nearly identical.

d. Charts covering square stations, scissor or squeezed pattern stations, crow-foot stations and others showing two or more ranges are available. Signal strength in different types varies; therefore, the lines of equal strength are drawn on the charts. The innermost of the signal strength lines represent 50 on the volume control, decreasing until the outermost line represents 20. The lines for 60, 70, 80, 90 are not shown and should be imagined, and the volume control used accordingly. The 15 line of the A and N beam shift control dial is indicated to either side of each on-course signal. As the recorder approaches the on-courses, represented by a shaded beam, the A and

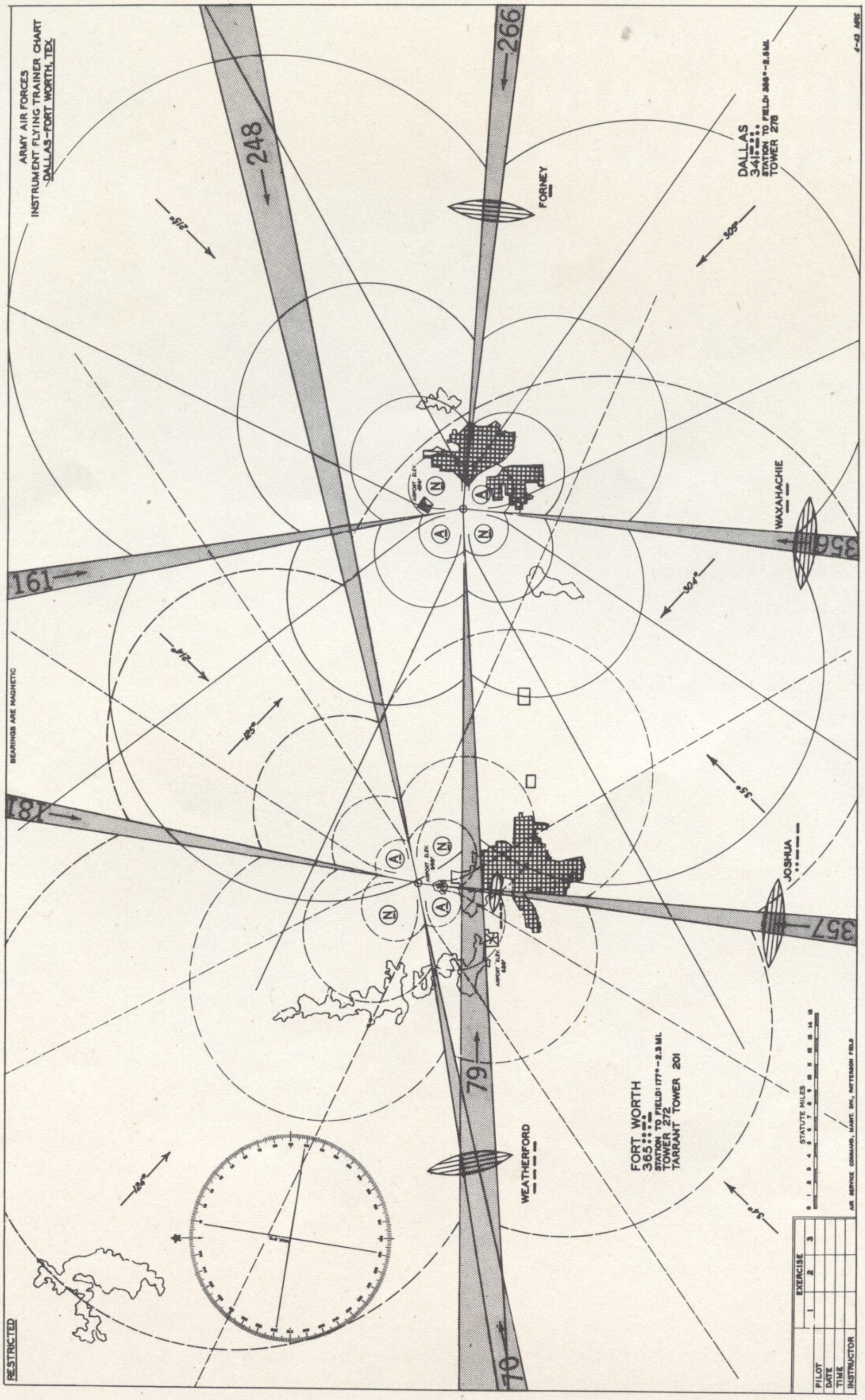


Figure 16—Trainer Chart

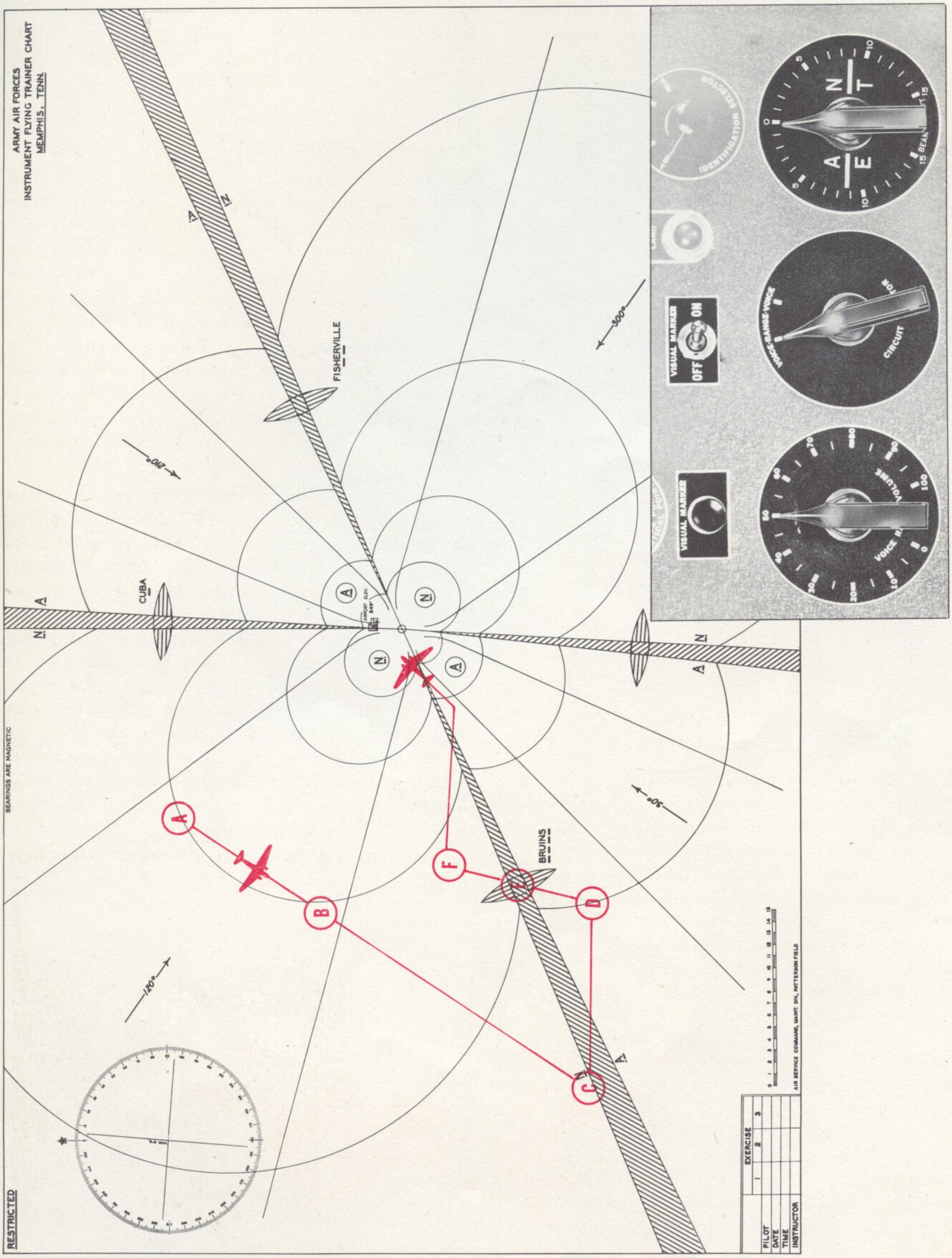


Figure 17—Use of Trainer Chart

N control should be gradually turned until a pure on-course is given as the recorder intersects the beam. The rapidity with which this control is shifted will, of course, depend on the distance from the station and the angle at which the beam is being intersected. For example: Referring to the chart, the student is flying southwest from the theoretical position "A". The volume should be set at 30 and the A and N beam shift control as far off-course in the N quadrant as possible, which is 15. The student flies southwest for a few minutes, bringing him to position "B". The volume should be changed to 31 as the recorder progresses during this change of position. The student continues to fly southwest, reaching position "C". During this time the volume will be changed slowly to about 15, and the beam shift control will be very gradually changed from 15 (at B) to 0 (at C). Turning east the beam shift is kept at 0 until the center of the beam has been crossed. It is then gradually turned toward the A side until 6 is used as the recorder reaches point "D". The volume will have gradually been increased to 20. Turning farther toward northeast the volume is increased to 28 by the time point "F" is reached, while the A and N control will have been moved from 6 on the A side through 0 to about 4 on the N side. The proper fan marker will have been given as the recorder passes position "E". As the flight progresses it will be noted that both volume and beam shift controls will have to be moved more rapidly.

NOTE

IMPORTANT.—This description refers to the numerals on the beam shift and volume control name plates to illustrate the proper manipulation of the desk controls. The experienced instructor does not refer to the numerals at all but sets and moves the controls by sound, using the inking wheel's position relative to the beam and station to determine the character and volume of the signal.

e. Because most radio range stations in the United States are now equipped with 75-megacycle station location markers, it is not necessary to show a symbol for these installations on the charts. These markers should be given when the problem being flown requires it. In Army aircraft the marker beacon receivers are a part of the Radio Compass installations, and no indications will be received if the radio compass is not in operation. The standard A.A.F. equipment provides visual indications only, that is, no aural signal is heard when an aircraft passes over a fan marker.

f. Because of the unrealistic presentation of the "beams" on the beam bracketing chart its use should be avoided. While this chart can be used in the initial bracketing exercises, standard charts should be used thereafter.

2. PLACING THE RECORDER.

a. Placing the recorder on the chart properly is of the utmost importance, since the trainer can draw lines on the chart in the proper direction only if the recorder heading agrees with the trainer heading. The instrument trainer charts furnished for the use of the service are charts of actual radio range installations at selected localities in the United States. These charts are scaled for use with the variable speed recorders of the type C-3 and C-5 instrument trainers, having a recorder travel of 0.84375 inch per minute at an indicated airspeed of 160 miles per hour. Radio ranges, landing fields, obstructions, etc., are shown in their true relation to one another on these charts.

b. To place the recorder first draw a line East-West through the variation line included on the compass rose printed on the chart. This line is being included on later editions of these recorder charts. Place the recorder on the chart with the inking wheel on the desired starting point and so that the edge of the recorder top plate which is farthest from the inking wheel is parallel to the E-W line. The inking wheel is then turned by means of the large recorder gears until it is traveling in the same direction on the chart as the trainer is headed. This may be verified by noting the pointer on the radio compass control name plate on top of the recorder. The radio compass control must be set, however, so that the zero is under the fixed pointer.

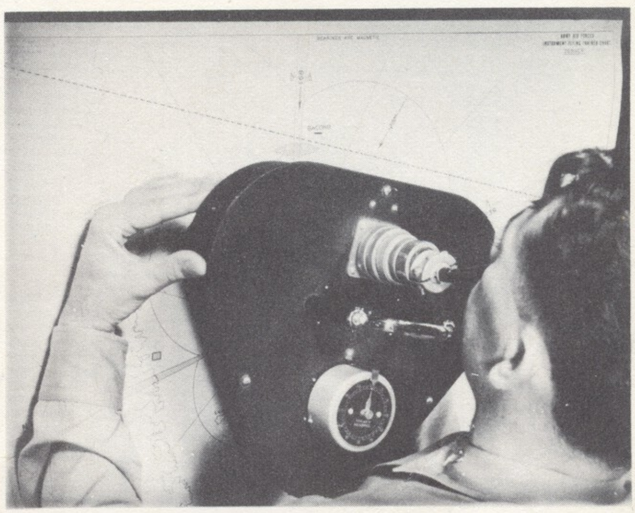


Figure 18—Placing the Recorder

3. APPLICATION OF WIND DRIFT TO TRAINER.

a. It is essential that drift be applied during many orientation problems. The habit of teaching all orientation problems without wind encourages the students to depend altogether too much on compass headings to fly a beam.

b. At stations where the C-2 and C-4 instrument trainers are available, as well as the C-3 and C-5 later type trainers, it is advisable to use these newer type trainers for problems which include wind drift. If the C-2 and C-4 trainers must be used for such problems, the drift is simulated by rotating the recorder gears up or downwind. In this case the most practical amount of drift simulated is 30 degrees, one "electrical notch" on the large recorder gears.

c. To apply wind in problems flown on the type C-3 or later type instrument trainers, it is only necessary to set the desired wind direction by rotating the "wind direction" crank to the proper dial reading. For example, if the problem calls for a wind from the west, the dial will be turned until the figure "27", representing 270, is opposite the pointer. The desired wind velocity can then be applied by turning the crank marked "wind velocity" to the proper setting.

d. Since the recorder speed and direction of travel on the type C-3 or later type trainers vary with both the indicated airspeed and the applied wind, the path of the recorder inking wheel represents the actual ground speed and track of an aircraft flying under identical conditions in the air (assuming the indicated airspeed to be the same as the true airspeed). This makes it possible to simulate radio range flying with a high degree of realism.

e. When using the wind drift mechanism the qualified instructors should be able to introduce any desired drift angle by the proper selection of wind velocity and wind direction. Drift angles should be suited to the particular problem being flown and should demonstrate the effect of the wind. It must be considered that the effect of the wind diminishes as the speed of the aircraft increases. Hence, the drift angle produced by a 60 m.p.h. wind on the instrument trainer traveling at 120 m.p.h. is equivalent to the angle produced by a 120 m.p.h. wind on an aircraft traveling 240 m.p.h. The effect of wind should be introduced in every problem at velocities and directions which will be of maximum training value. For instance, moderate head winds becoming tail winds after a procedure turn has been made, have a considerable effect on maneuvers involving timing, such as approach procedures. This is true particularly if the procedures are worked at slow cruising speed. It is also desirable to make an upper air broadcast reporting winds at different velocities at different altitudes, in some problems. In this case the proper wind must be introduced depending on the student's flight level. A detailed explanation of the wind diagram which will be useful to the instructor will be found in War Department Technical Manual, TM 1-205, Air Navigation.

4. COCKPIT CHARTS.

The student will be furnished with a copy of T. O. No. 08-15-1 and/or T. O. No. 08-15-3 depending upon the type of the problem flown. Provision for two copies of these technical orders for each instrument trainer is made in their distribution. The student should select the chart desired without an assistance by the instructor, who will only inform him of the station which will be used during the period Non-standard charts of local manufacture will not be used.

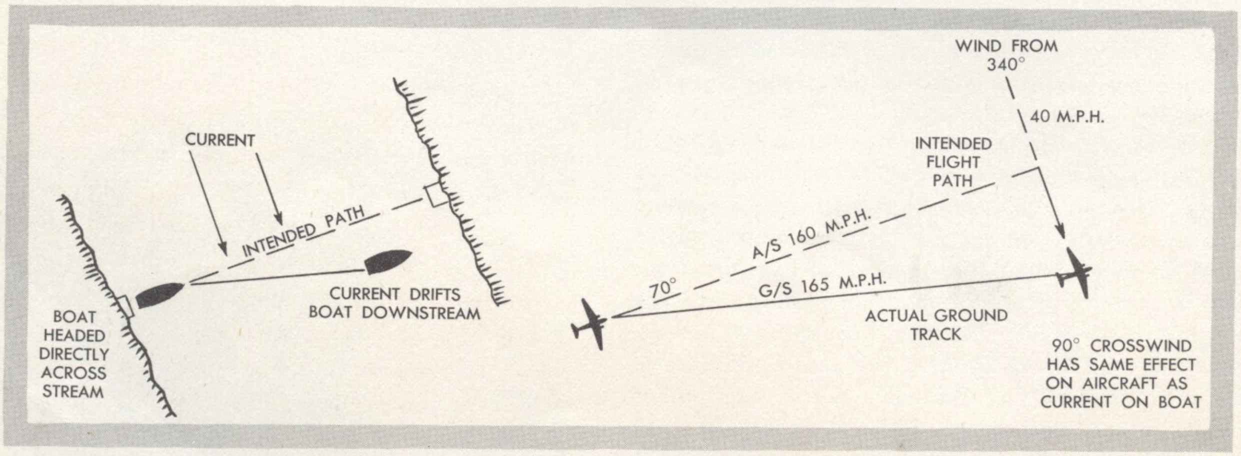


Figure 19—Wind Drift

SECTION VIII
RANGE FLYING TRAINING

1. THE RADIO RANGES.

During the last 15-20 years a system of radio stations, providing directional guidance to the pilot in flight, has been developed and installed throughout the United States and Canada. These stations are known as radio ranges and, utilizing their signals, pilots may fly almost everywhere on the North American Continent and in some other localities without reference to visual landmarks, yet always aware of the approximate position of the aircraft. Naturally, the pilot must know what these ranges are, how to use them for guidance, and their limitations, before he can have confidence in his own ability to utilize them. An individual may read all of the books on piloting which have been published, and yet be unable to solo a primary training airplane until he has received from 6 to 10 hours of dual flight instruction. The information which he has gained through his study will not, of course, have hindered him. Just so, the student pilot may receive excellent instruction on the characteristics of the radio range through study of books and blackboard diagrams, and yet be unable to recognize an A or N signal when he hears it. He certainly will not be able to fly a radio range until he has been "soloed." The student who has soloed a primary airplane does not by virtue of this accomplishment become a qualified and skilled pilot, excepting after many hours of diligent practice; neither does a student become qualified in radio range flying unless he is willing to apply himself to long hours of practice.

a. It is the instructor of the instrument trainer on whom the length and the arduousness of the "dual" period of the student pilot largely depends. Some few of the students will report to the department for instruction with an indifferent attitude, but most men will come in expecting interesting and satisfying work. The instructors must handle the course to awaken and to sustain this interest. This can best be done by thorough explanation of each problem presented to the student. *A problem understood is a problem solved.* For instance, in beam bracketing it is not to be said that "this exercise is kind of dull, but it must be done because the book prescribes it—so let's do it and get it over with." On the contrary, the student should be made to realize that beam bracketing is the first step in developing the student's ability to learn to recognize the beam, to follow it to the station; and to condition his perceptions until he can fly the beam by ear, without resorting to a series of mechanical turns. By beam bracketing, basic skill must be developed in the student pilot. Without it he will never be able to successfully solve an orientation problem, fly an approach procedure, or bring the aircraft to a safe landing under instrument conditions.

b. Just as the pilot must undergo further dual instruction when he advances from one type of training aircraft to another, so he must be coached when proceeding from basic instruments to radio instrument flying to instrument landing. Throughout the course of instruction, clearly explain to the student the whys and wherefores of each step. After he understands, confine your remarks to "Tower" or "Radio" contacts. If the explanations given are clear and easily understood, that is, if the student is guided to think the problem through before it is started, the time required to teach him the procedure used on the radio ranges will be relatively short. If he masters the theory and application in the instrument trainer, the flight instructor's time can be devoted to smoothing out his technique. The flying instructor will then not have to devote all of the air time

to explaining to the student such simple things as "You are now in an A quadrant," or "to intercept the beam you must do this or that." If the instrument trainer instructors are doing their job properly, they will very materially assist the flying instructor and the student. With excellent instrument trainer instruction, the time in the air can be devoted to improvement in the student's technique. Always remember this.

c. The instructor will thoroughly study the characteristics of the radio range. The data on their operation and irregularities are contained in T. O. No. 30-100B-1, Instrument Flying, Advanced. Because this material is adequately covered in that text, no repetition is necessary here. The following should, however, be emphasized: the instructor who, simulating a radio range with the trainer desk controls, reproduces very nearly a real radio range without exaggeration of fade or builds, will be the best instructor. He who neglects his duty by improper operation is ruining the student's opportunity for a good performance in the air.

d. Another word of caution is in order. It is well recognized that the instructor can "lead" the recorder and thus produce a perfect pattern. No useful purpose is achieved by this type of performance, and harm to the student will result. The grading of the student must be based on his reaction to the signals, not primarily on the appearance of the track. During the turns the instructor should not permit the student to "tighten" the turns beyond a standard rate in an effort to catch the beam as it is passed. Whenever turn tightening is noted, the instructor should warn the student. If the inexperienced pilot on instruments begins to tighten a turn, a spiral may result. The student should be made to watch and read all the instruments. To assure that he does so, the instructor should request instrument reports at least twice during every radio problem.

e. Since a large amount of the student's instrument flying experience will be developed on the radio range installations, the student pilot must be provided with a satisfactory method of solving an orientation problem for use if ever he should become lost. Only one technique should be taught to prevent him from becoming confused by the introduction of too many *if's* and *but's*. The training should therefore only include the method necessary to achieve this end. While most aircraft are fitted with radio compass and/or direction finding equipment and the pilot may easily determine the position of the aircraft in relation to a range station without resorting to an extended orientation method, he must nevertheless, master a satisfactory method of locating himself without the radio compass. Instruction in radio range flying should begin with basic technique such as beam bracketing, beam edge flying, procedure turns, etc., before advancing the student to a complete orientation problem. If the student is allowed to pass the basic phase without acquiring the necessary degree of proficiency, he will have extreme difficulty in later phases of radio range flying. The instructor should be careful to avoid instructing the student in such procedures as skidding turns to stay on the beam when near the station. Any reference to the handling of an actual aircraft should be avoided and it should be pointed out to the student that the instrument trainer is capable of performing turns which cannot be reproduced in an aircraft.

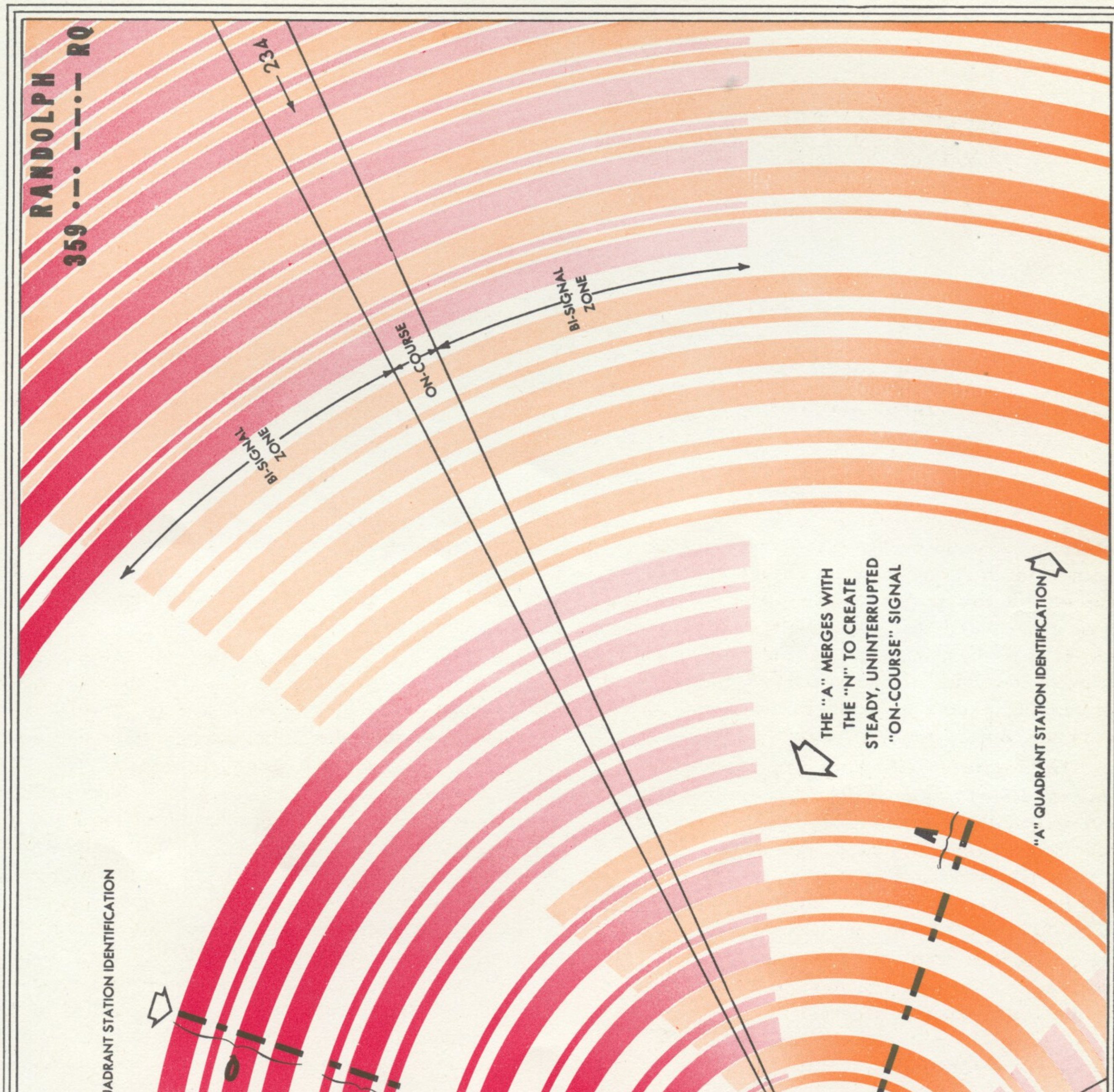


Figure 20—Signal Pattern, Radio Range

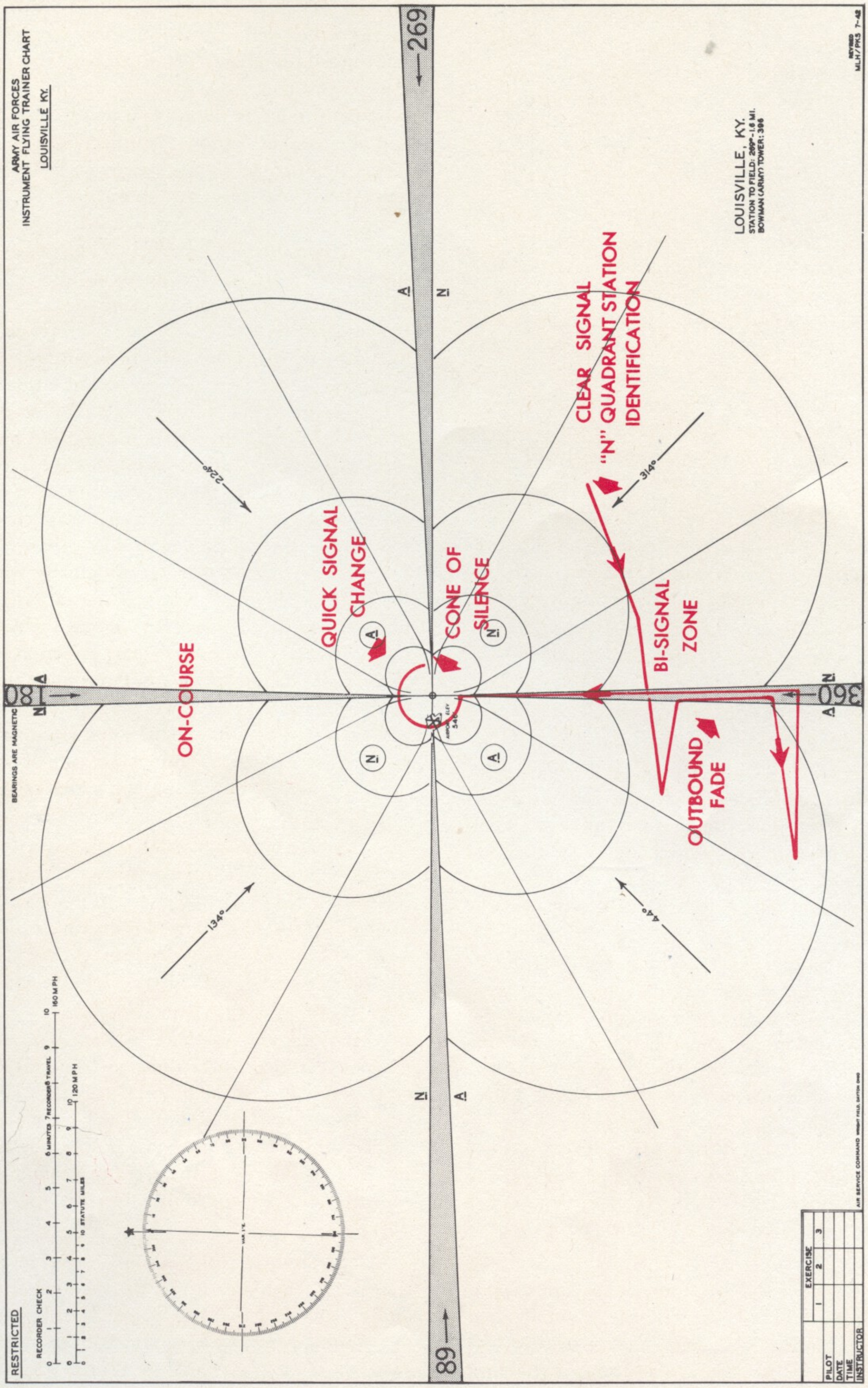


Figure 21—Signal Familiarization

2. FAMILIARIZATION WITH RADIO RANGE SIGNALS.

Inasmuch as the student up to this point has never heard the sound produced by the radio range, it will be necessary to have him listen in as the instructor produces the signals. He should, however, have had an indoctrination lecture on the mechanics of the radio ranges.

a. The instructor will place one of the A.A.F. Instrument Trainer Charts upon the trainer desk. He will then explain to the student that he will now simulate the signals produced by a radio range. Both instructor and student wearing headsets, the instructor will place his pencil, or perhaps a small model airplane, on the chart. He will operate the A and N mixture and the volume controls to simulate the signals transmitted by an actual radio range installation. The pencil will be moved over the chart while the operator sends the proper signals. The following points should be covered and stressed during the familiarization.

b. The instructor will assure himself that definitions of the terms relating to radio ranges are understood by the student. The most important are as follows:

(1) Leg, on-course, or beam is that directive portion of the radio range identified by a continuous monotone interrupted only by two sets of identification letters, each of which is heard with equal intensity.

(2) Bi-signal zone is the area in which both A and N are heard, while a background of the on-course monotone can still be discerned. It must be noted that in the bi-signal zone one set of the station identification letters will be louder than the other, and that the station identification sent over the N antennas is transmitted first, followed by the station identification sent over the A antennas.

(3) Clear quadrant signals. The student's attention will be called to the fact that only one identification signal is heard when the aircraft is flying in the center of an A or an N quadrant. He will be informed that the station identification is sent twice every 30 seconds, first in the N quadrant, and next in the A quadrant. There will be instances when it will be very difficult to distinguish the A from the N, due to severe static or to other causes. When this occurs, this sequence of sending the station identification can be used to identify the quadrants. (The identification signal is sent first in the N quadrant.)

c. Slowly moving the pencil or model airplane toward the zone where the other quadrant signal is audible, and recognized as a background tone, the instructor will have the student note this background tone explaining that the area is properly called the "Bi-signal Zone" and not the "Twilight Zone." He will also call his attention to the other station identification which will become faintly audible at this point. Moving the pencil slowly, toward and then away from the on-course signal, it will be demonstrated to the student that the background tone and the weaker station identification signal slowly increase in intensity as the on-course is approached, and will slowly decrease in intensity if the aircraft flies away from the on-course. When the student understands these important facts, the pencil will be moved toward the on-course signal. The steady increase in the intensity of the background will be pointed out to the student. Upon reaching the on-course, the instructor will call attention to the sound of the beam and to the equal intensity of the two sets of identification call letters. The fade in signal strength will now be demonstrated by slowly "flying" the pencil on the beam, but away from the station. The student should be told that a fade is difficult to detect if the volume control is not kept at a minimum level. Moving the pencil slightly off-course at this point, the student's attention will be called to the fact that the beam fades very gradually when far from the station. "Flying" the pencil down the beam toward the station, the increase in volume should be demonstrated to the student. Particular attention will be given to the reproduction of the fast build-up in signal strength as the station is approached. At this point, the student's attention will also be called to the fact that when using an aircraft radio, the automatic volume control must never be used when flying the radio ranges; build or fade cannot be detected if this device is used.

d. The surge of signal intensity, quick fade, build up and slow fade of the cone of silence will now be demonstrated. "Flying" around the station close in, the quick change of on-course signals to off-course signals will be explained to the student. The student will be very easily confused when flying close-in if he is unable to interpret the signals properly.

e. Turning the fuselage of the trainer so that the marker beacon receptor indicator can be seen, the indications received when passing over the cone of silence or over the marker beacons will be demonstrated. The student will be informed that these signals can only be received visually with the receiving equipment installed in Army aircraft and only when the radio compass is operating.

f. The student will now be instructed to enter the trainer. He will be shown the station selector switch, and will be told that this switch must be on "range" at all times during these problems. The use of the call switch will also be explained to him. The radio volume control must be used by the student to reduce the signal strength received to minimum in radio range problems. Then have the student fly the trainer and level it off at cruising airspeed at some even altitude.

g. The instructor will now start the recorder on the instrument trainer chart, having placed it in one of the off-course signals. He will then lead the student through the above familiarization by instructing him to fly courses which will approximate this demonstration. As the recorder reaches each change, the instructor will point out the pertinent facts over the interphone. It is not to be expected that the student will be able to fly the signals without being advised when to turn. Caution the student to keep his volume control at a minimum. From time to time the student should be required to state his location. At the end of this familiarization the track of the recorder will be shown to the student and the entire problem will be again explained.

3. BEAM BRACKETING—KNOWN BEAM HEADING.

a. The published bearings of a radio range will be known to the pilot but, because of drift, caused by wind at his flight altitude, the pilot must establish a corrected heading when he first intercepts an on-course signal. The method developed to achieve this is known as beam bracketing. Two cases may occur; first the pilot may know which leg he will intercept, and second he may be intercepting a beam, the alignment of which is unknown to him. Intercepting a known beam being a much simpler problem for the student, it will be explained first in this text.

b. It is assumed that the student has planned his flight to intercept the west leg of a radio range at some distance from the station. The published bearing of the

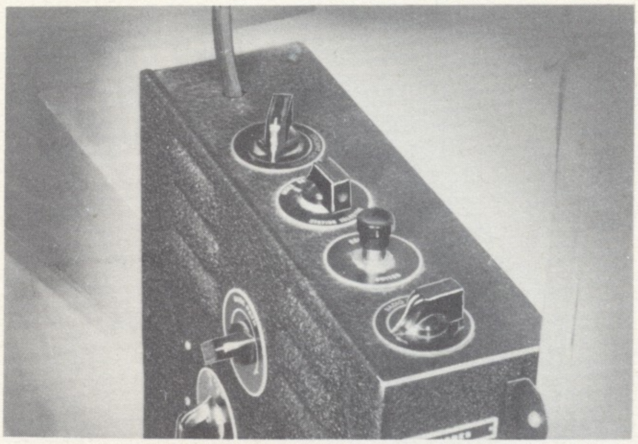


Figure 22—Station Selector Switch

beam being 110°, he will fly to intercept the beam at a right angle. If he is coming in from the south, this heading will be 20°. As the student reaches the monotone of the on-course, he will turn to cross the beam at an angle of 30° to the inbound bearing of the beam. In this case his heading will be 80°. Holding this course until the first opposite off-course signal is heard, the student will turn right to a heading not greater than 140° (a course 30° off the beam bearing). He has now checked the width of the beam and has eliminated the possibility of multiple course. The two headings 140° and 80° are the limits of the bracket about the beam alignment of 110°. The brackets are next reduced to 20° to either side of the right-hand edge, that is, the limiting headings will be 130° and 90°. Thereafter, reducing the bracket to 10°, the headings will be 120° and 100°. The next reduction is 5°, to 115° and 105°, respectively.

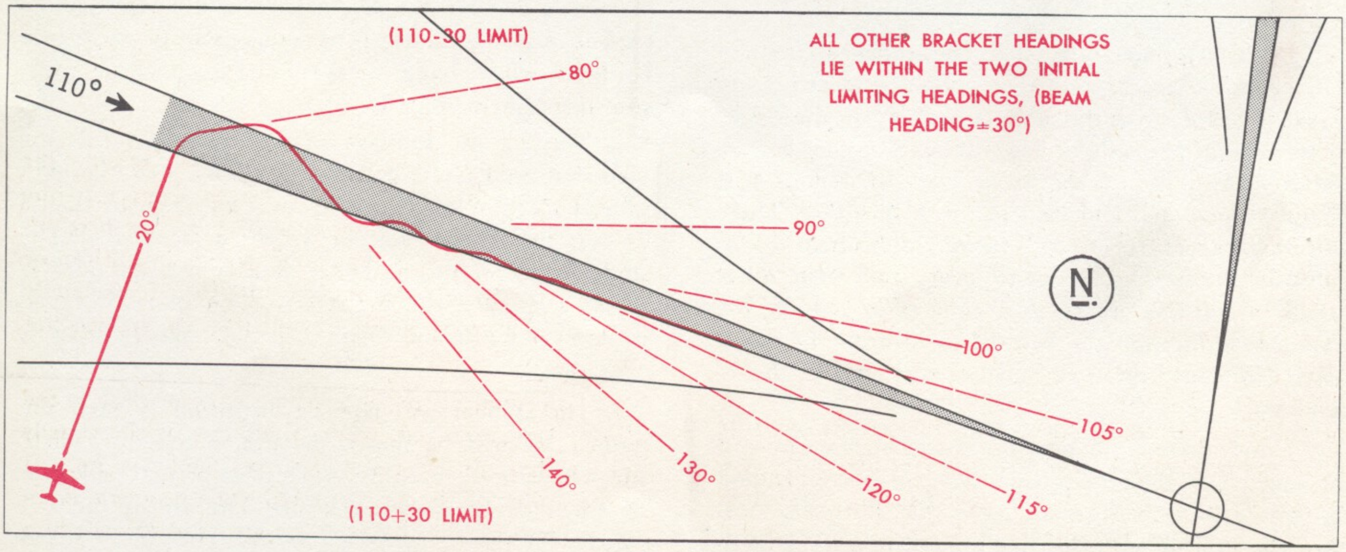


Figure 23—Bracketing a Known Beam

c. The method is purely mechanical up to this point. However, as the student pilot becomes familiar with the changing signals, he will stop his turns immediately when he detects a change of signals. The student's ability to bracket the beam by sound, rather than by a computation of headings, will be very quickly developed. The various headings specified for this type of bracketing will be considered as limits *beyond* which turns should not be continued if a change of signal is not received.

d. The effect of wind on this method will affect the "size" of the brackets as follows: If the wind is from the right, the limit will be the beam heading *plus* 30 degrees. If the wind is from the left, the limit will be the beam heading *minus* 30 degrees. The reasons for this can be explained as follows: A wind velocity one-half the indicated airspeed of the aircraft at right angles to the course will produce a drift angle of approximately 27°. Therefore, the heading to hold a given track will not be more than 30° from the magnetic course. If the correction of 30° is too great, the aircraft will be drifted back onto its course if the uncorrected heading is flown. Hence, the correct heading to maintain a given track lies somewhere between the magnetic bearing of the track and a 30° correction toward the direction from which the wind is blowing. The direction of a strong side wind can be deduced by the length of time required to regain the beam when making the initial turn.

e. When close in near the cone of silence the heading necessary to hold the beam, which was found during the bracketing, should be flown. No attempt should be made to "catch" the cone by large corrections as the station is approached. The rapidly increasing signal strength surge and rapidly changing signals prove that the aircraft is passing in close proximity to the station. After passing the station on this gyro heading, the fact that the cone has been passed will be verified by one of the following. If the student finds himself to one side of the opposite leg, he will turn not over fifteen degrees toward the leg. Then if this new heading takes him back to the on-course signal, he knows he has passed the cone, and he can continue on toward the procedure turn. If he finds himself on-course upon passing the cone, he should turn not over fifteen degrees to the right and hold this heading until he hears the first off-course signal. If this is the correct signal, he will know he has passed the cone and he will then immediately return to the on-course signal and then fly the heading necessary to hold the beam.

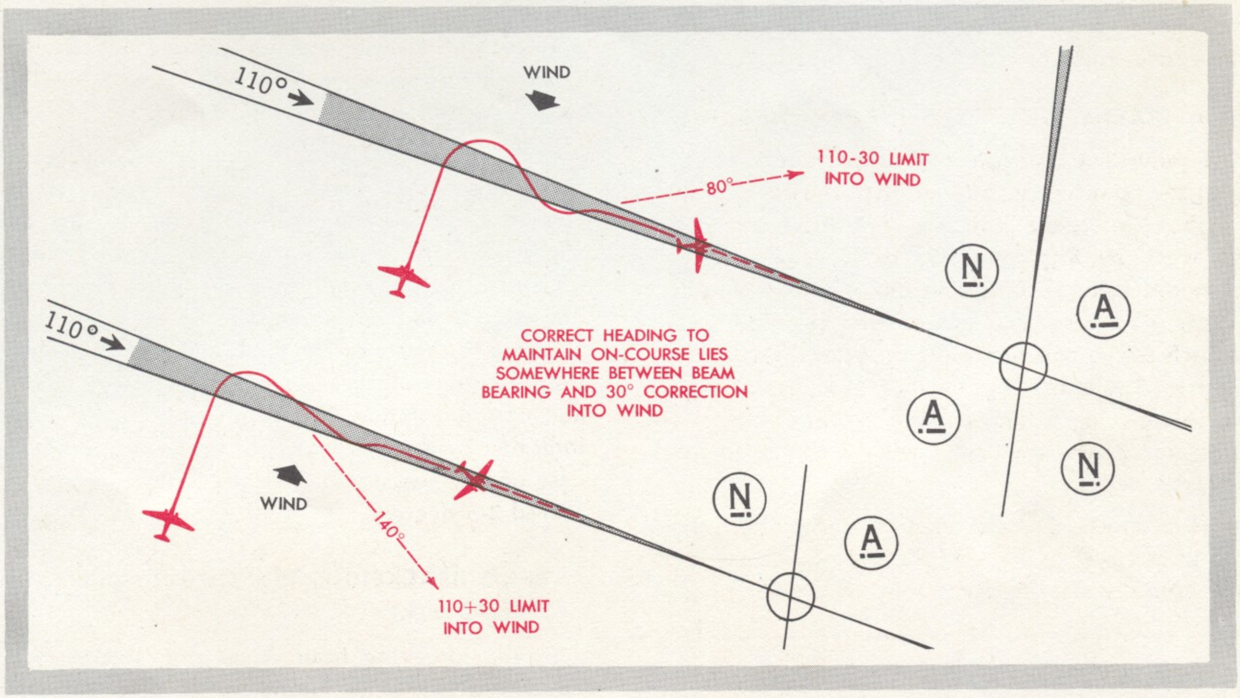


Figure 24—Wind Effect

f. If the student first intercepts the beam close to the station, as determined by the sharpness of the signals and the short time necessary to cross the beam, he will fly the center of the beam. Holding the magnetic bearing of the beam, he will wait for the wind to drift him off-course. At the first off-course signal, he will turn into

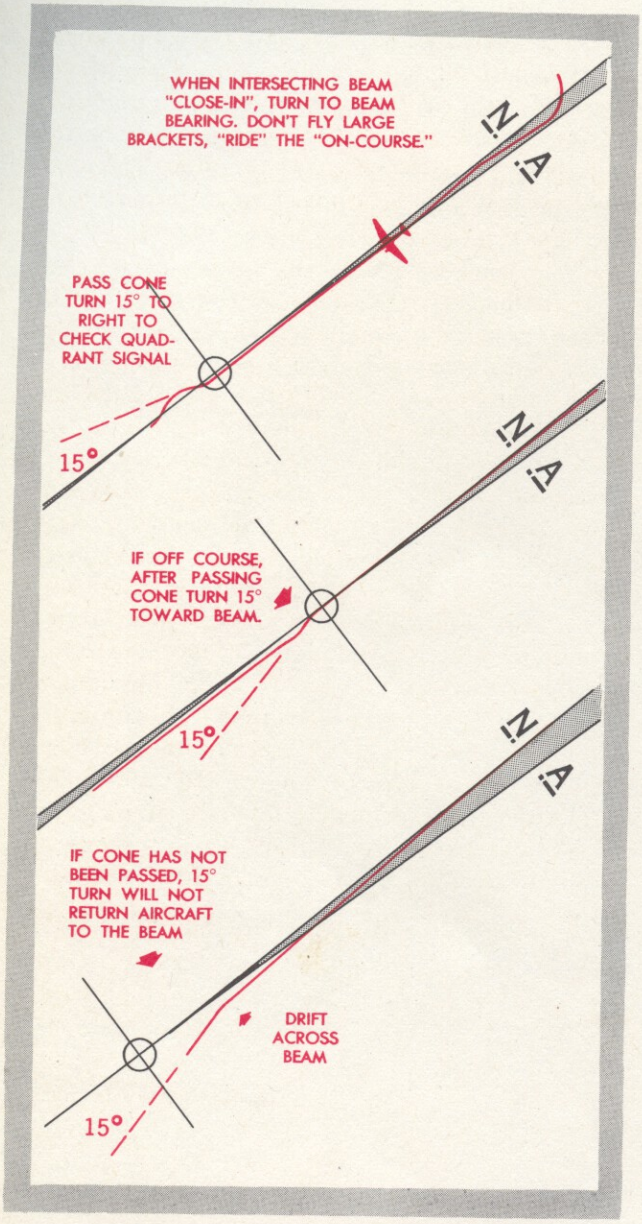


Figure 25—Approaching the Station

the wind to regain the center of the beam. When the cone is approached, the remarks under *e.* above will apply.

g. After bracketing the beam as previously described and the brackets are reduced to 2 degrees or 3 degrees, the next phase of the problem is to maintain the beam edge until close to the station. Small changes in heading will be necessary from time to time when following the edge, even though the bracketing has been done properly and the brackets are small.

h. Most students will display a tendency to remain in the off-course signal too long. If the left-hand side of the small bracket already established does not gradually lead back into the beam after a reasonable length of time, the mistake should not be made of making a series of further small corrections. Rather, apply a 10° or a 15° correction toward the beam, and then when the signal sounds as if it would be impossible to hear more than one or two more off-course letters, remove this large correction and return to the small brackets previously established. Then move both sides of the small bracket 3° to 5°. If the right-hand side of the small brackets does not result in taking aircraft off the beam within a reasonable length of time (depending on how long the previous outbound heading had to be held to reach the edge), a 15° correction to the right should be applied and then removed when the edge is reached. Good contact with the beam edge must be maintained until close to the station.

i. As the station area is approached, the beam narrows. When close enough to the station so that small corrections in heading will take the aircraft from a slight off-course signal on one side of the beam to an off-course on the other side, the pilot should remain "on course" and not attempt to fly the edge from that point on to the cone. The final mile or two is where the insufficiently trained pilot will make large corrections and miss the station. When this close to the station, as indicated by the narrowness of the beam and the sharpness of the signals, all changes in heading must not exceed 2-3 degrees.

4. BEAM BRACKETING—UNKNOWN BEAM HEADING.

In the foregoing beam bracketing exercise, it is assumed that the pilot knows his position with relation to the radio range station. This exercise was included first to familiarize the student with the signals of the radio range, and to teach him to react promptly upon noting a signal change.

a. Properly bracketing a beam enables the student to obtain, in the shortest possible time, the heading which will keep him on the right-hand edge and thus enable him to fly a straight course to the station. It enables him quickly to determine his drift by comparing the heading with the published beam bearing, the difference being the drift correction. Bracketing an unknown beam must be mastered before the student can be advanced to orientation problems.

b. Since the air is rarely calm in bad weather, it becomes obvious that the heading required to stay on the beam edge will often not agree with the published beam bearing. They will not even be close in most instances.

c. Explanation of method. Upon encountering the beam, continue straight through it, noting the heading. When the first opposite off-course signal is received, start a standard rate turn to the left. Continue this turn until back to the edge of the beam (provided, however, that this turn must not exceed 180°). Upon re-encountering the beam edge note the heading and immediately start a standard rate turn to the right. Continue this turn until the first off-course signal on the right of the beam is again picked up. Upon this first off-course signal, again start a turn to the left. The heading which first took the aircraft into the beam and the heading noted upon again encountering the beam are the original brackets, except in the case where the first turn is 180°, as in figure 26A, in which case the second and third headings are used. Somewhere between the two is the heading which will maintain the beam edge. Continue the left turn to a heading which reduces the bracket by about 25 per cent; then hold this heading until the beam is re-encountered. Upon reaching the beam edge, promptly start a turn to the right to a new heading which will reduce the right-hand side of the bracket by about 25 per cent. Continue this process, reducing the bracket by about 25 per cent with each turn. It will be noted that each pair of turns cuts the size of the bracket in half. The process should be continued until the brackets are reduced from 3° to 5°.

d. Procedure. Upon encountering a beam, note and hold the heading. While riding thru the beam compute the reciprocal heading, since the ensuing left turn must not exceed 180°. With this value in mind, consider it as a barrier beyond which the turn will not be continued, but not as the object of the turn. The object of the forthcoming left turn is to get back to the beam. (A glance at figure 26A will make clear why the turn should not be more than 180°.)

e. With the barrier heading fixed in mind, the student must hold his heading and wait for the first opposite off-course signal. To take a specific example, assume the heading is 180°, and that in entering the beam an N was left behind. Upon the first A received, start a standard rate turn to the left. Listen sharply to the radio signals and as the beam is again just barely reached, note the heading and at the same time start a standard rate turn to the right. Say the heading at this instant is 20°. (The first barrier in this case was 0° and was not reached.) It will be noted that a turn of 160° was made and the headings of 180° and 20° are the original brackets (see fig. 26B). In this turn the size of the brackets must be reduced approximately 25 per cent. One-fourth (25 per cent) of 160° is 40°, so instead of turning to a heading of 180° turn only to 140 (180–40). Upon reaching this new heading, hold it until the first A is reached. Upon hearing the A, start a turn to the left. Since it is desired to

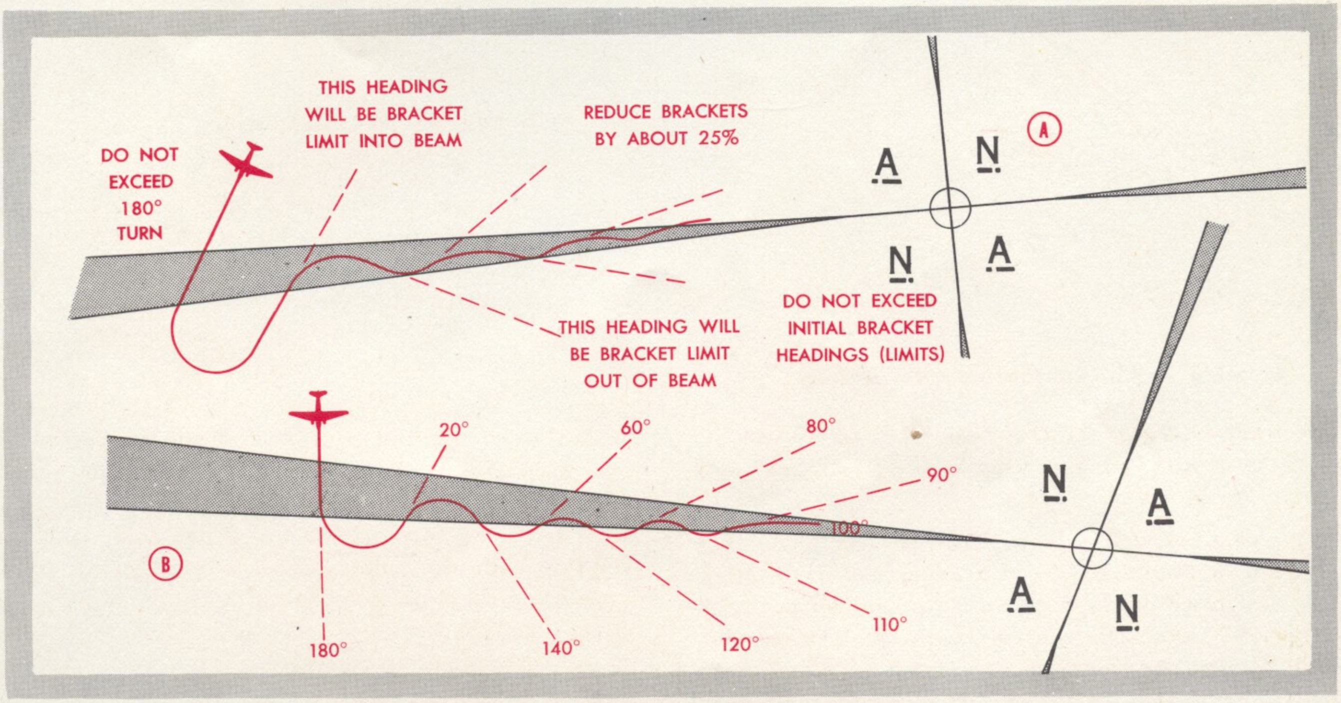


Figure 26—Bracketing an Unknown Beam

reduce the left side of the bracket the same amount as was just done to the right side, this turn will be continued only to a new heading of 60°. Upon reaching this heading hold it until back to the beam edge. It should be noted that the bracket is now reduced from a spread of 160° to a spread of only 80°, or half the original amount. Upon reaching the beam edge, immediately start another turn to the right. The spread of the bracket now being 80°, one-fourth of it will be 20°, so 20° is taken off the heading of 140°, which was the previous right-hand side of the bracket, and the turn continued only to a heading of 120°. This heading is held until the first off-course A is again received. Upon hearing the A, start turning left to a new heading of 80°. (This is stopping the turn 20° before reaching the previous inbound heading of 60°.) Note that the bracket is now reduced to a spread of 40°.

f. Continuing in the same manner to reduce the bracket further, the heading is held until again back at the beam edge when another turn to the right is immediately started. Again take off one-fourth (one-fourth of the 40° spread being 10°). This turn to the right will be continued to a new heading of 110°. (The previous outbound heading was 120°.) Upon again receiving the A, turn left, this time to a heading of 90° (10° before reaching the previous heading of 80°). Repeat the process again, reducing the bracket by 5° on each side (the spread now being 20°), and the bracket is down to only 10°; once more it is reduced to 5°, and the final reading is found to be 100°.

g. From the above description one might make the mistake of assuming that the beam heading is always the mean of the first brackets. This would be true only if the pilot could make mathematically perfect turns, and if his ear were a delicate electrical instrument subject to no error, if the beam were not interrupted approximately one-fifth of the time for identification signals, and if no drift existed.

h. If the pilot is slow in recognizing the off-course signal, or if an identification signal occurs at the instant of running off or into the beam a sawtooth bracket will result (see figure 27). For example, while turning to the right to find the edge of the beam for either reason given above, the turns which determine the original bracket are often carried too far in that direction. Or if the error occurred while going into the beam the turn to the left would be too great and the bracket "lopsided" in that direction. This condition can be readily recognized when it occurs. The effect is shown in figure 27.

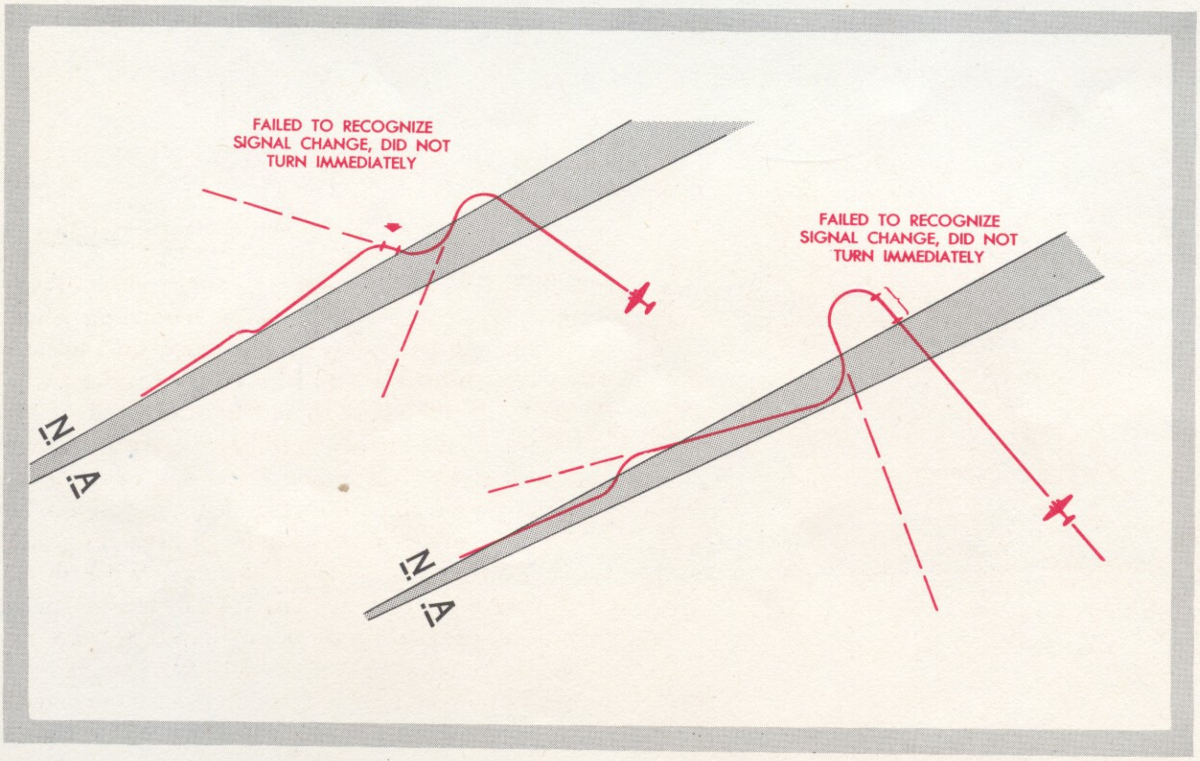


Figure 27—"Sawtooth" Bracket

i. The method of bracketing a beam just described is termed "mechanical bracketing". The pilot who has mastered the method can reduce the amount of turning and the time required to obtain a narrow bracket on the beam heading by anticipation and making use of the changing signals. This is particularly true when working within a few miles of the station where the signals are sharp and the changes rapid and distinct. For example, when making a left turn to get back to the beam as in mechanical bracketing, and an obvious increase in the strength of the background indicates that the beam is getting closer, it is not necessary to turn farther to the left. As soon as the background is definitely increasing, the turn to the left should be stopped and the heading noted and held until close to the beam. Then, instead of waiting until the actual beam edge is intercepted, the turn to the right should be started just before the beam edge is encountered. In this manner, the original bracket can easily be cut in half; a pilot who is really skillful at bracketing can very often judge the change in signals well enough so that even if approaching the beam at extreme angles his first bracket will be only 15° to 20° (figure 28).

Before attempting to anticipate, the mechanical method should be thoroughly understood. It is better to anticipate too little and depend more on the mechanical method than to overdo it and lose the beam.

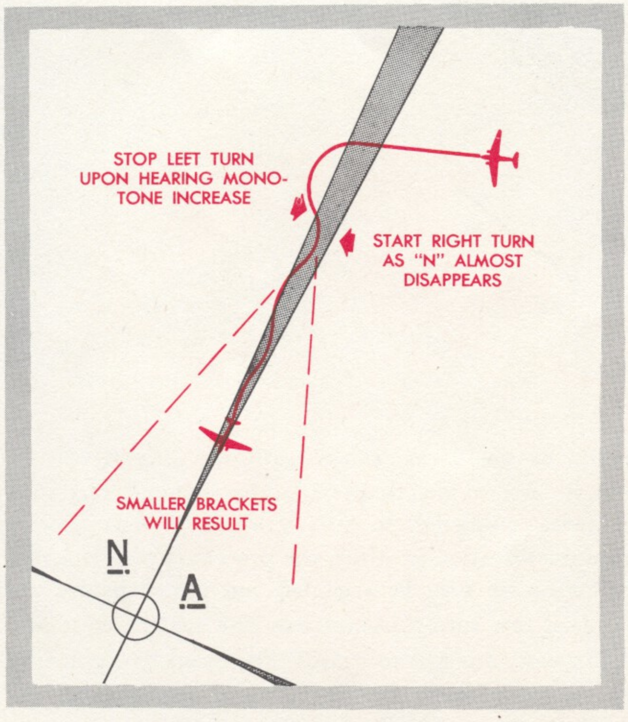


Figure 28—"Anticipation"

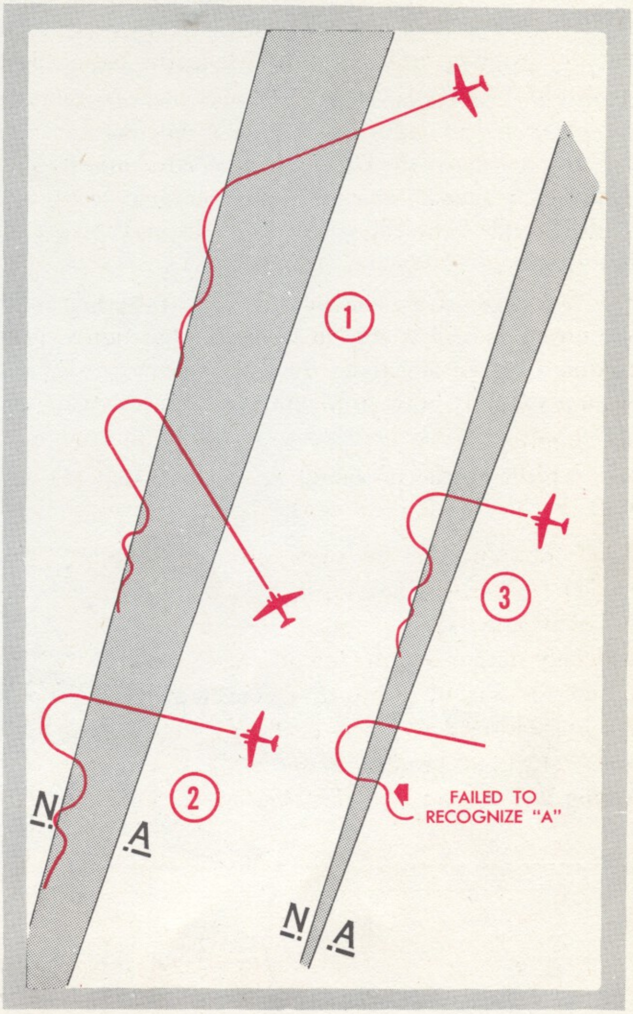


Figure 29—Typical Trainer Exercise

j. Using an Instrument Trainer chart, the purely mechanical method of beam bracketing should be taught and thoroughly understood by the student before he is permitted to "anticipate." The wider part of the beams on the chart should be used at first. Without regard to the trainer heading, the recorder should be turned so that the inking wheel will cross the beam at an angle of about 45° (see fig. 29, position No. 1). The first two or three attempts at bracketing should be made with this easy angle of attack. When the student demonstrates that he has a clear conception of the process of mechanical beam bracketing, the recorder should be set so that the more difficult angles of attack are employed, such as position No. 2. As soon as the student is able to cope with these difficult angles of attack, he should then be put on a narrow part of the beam such as position No. 3.

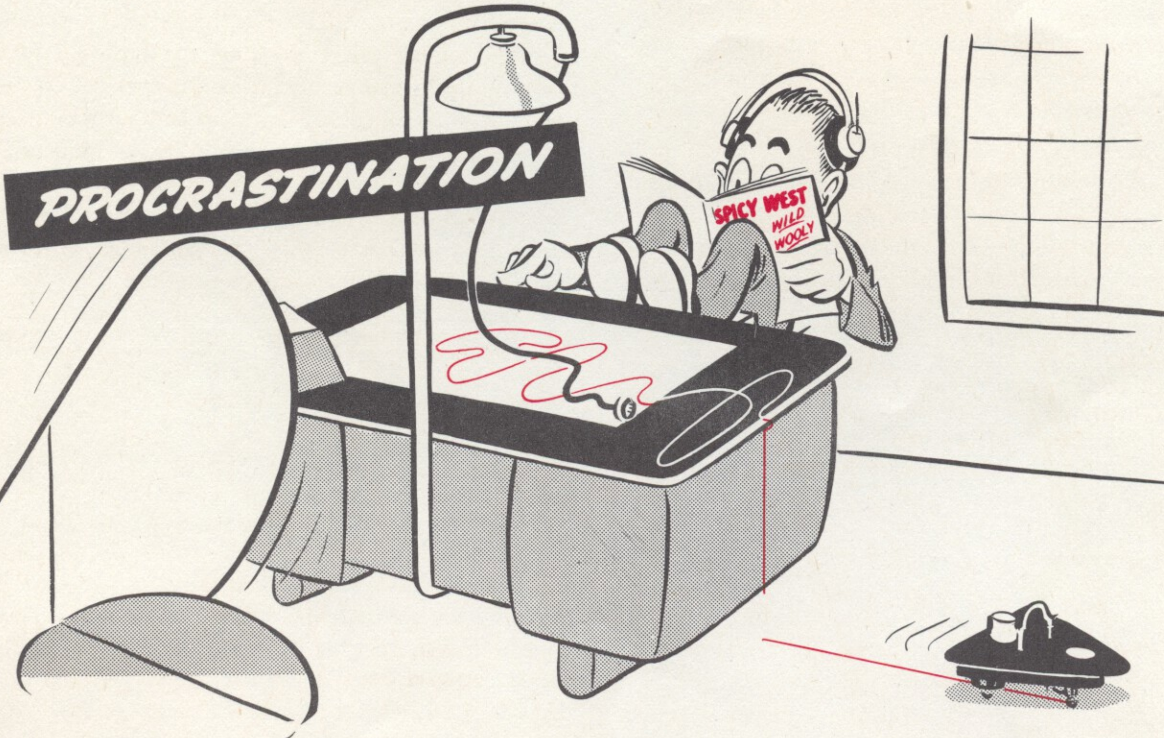
The recorder should then be set so that it will cross the beam at approximately 90°. The first right-hand turn to get out of the beam following the first left-hand turn should carry the student back across the beam into the original off-course signal. He will then often fail to recognize that it is the wrong signal and that he is on the wrong side of the beam and will start turning left. This is a tendency which will be found in nearly all students and should be corrected in the early stages of beam bracketing practice.

k. As soon as the student can successfully bracket a narrow beam and is able to recognize, but not become confused by the signal on the left, his practice should include not only beam bracketing but also following the right-hand edge of the beam to and over the station.

l. At this point it should be stressed that the instructor must remember to keep the A & N mixture control moving smoothly when simulating signals. Care must be taken with the rate at which the mixture control is moved. The solid on-course signal should not be given before the inking wheel arrives at the beam edge. It is even more important not to be late with the signal, that is, to let the inking wheel get into the beam before the solid on-course is given.

m. Whenever the inking wheel is moving toward or away from the beam, the mixture control must be moved toward or away from the zero.

n. The beginner on radio range flying will invariably make large corrections when he hears the loud signal close to the station. He must be taught to stay in his brackets, making only small corrections.



5. PROCEDURE TURNS.

This term is used to describe the standardized maneuvers performed to reverse the direction of an aircraft when flying on a beam. It is used in holding procedures, low approaches and instrument landings. The aircraft is flown off-course for 45 to 60 seconds at an angle of 45° to the beam. Then a standard rate turn of 180° is started and the resulting heading maintained until the beam is reentered at an angle of approximately 45°. It should be noted that theoretically the aircraft will fly straight toward the beam after the standard rate turn has been completed. In case of winds of high velocity from the direction in which the procedure turn is made, the on-course may be regained and passed before the standard rate turn is completed. The student must not, in this case, attempt to "catch" the beam by tightening the turn, but must continue through the beam at the standard rate until he has reached a heading toward the beam just crossed. Thence he will proceed toward the station. Never tighten turns on instruments. Exercises in this maneuver may be practiced on any of the AAF Instrument Trainer Charts. Because procedure turns are necessary to many problems, the student must be able to execute these turns satisfactorily before going on to the next exercise.

6. CLOSE-IN PROCEDURE.

a. When the rapid change of signal strength indicates that the student is close to the station, it is necessary that he follow a simple plan to prevent his becoming confused as he proceeds from one off-course quadrant to another. When the student realizes he is close to the station, he need not work an orientation problem, since he knows his approximate location. He need only intercept the leg which he desires to use in the approach procedure. The most satisfactory method of achieving this result is described below. If he becomes confused when reaching a point near the station, the close-in procedure will provide a solution to his problem.

b. The aircraft is turned to a compass heading paralleling the outbound heading of the beam on which it is desired to make the initial approach on the station. This heading is held and the changing signals ignored until a fade is obtained. The signal received will indicate on which side of the beam the aircraft is flying. A turn of 45° toward the desired beam is then started. This heading is held until the beam is crossed and the aircraft is 45 seconds beyond the beam. A 180° turn away from the station is now made to get back to the beam and the heading toward the station bracketed in the usual manner. (See fig. 31.)

c. Selecting an instrument trainer chart, the instructor will start the recorder in any of the quadrants, close to the station. The student will be provided with a radio facility chart showing the station. When the radio range is turned on and the recorder is started, the student will immediately turn to the outbound heading of the beam he desires to intersect. As soon as he has proved the fade, returned to and passed over the station, the problem is completed. At a later stage of the student's instruction, this problem may be combined with an approach or holding procedure.

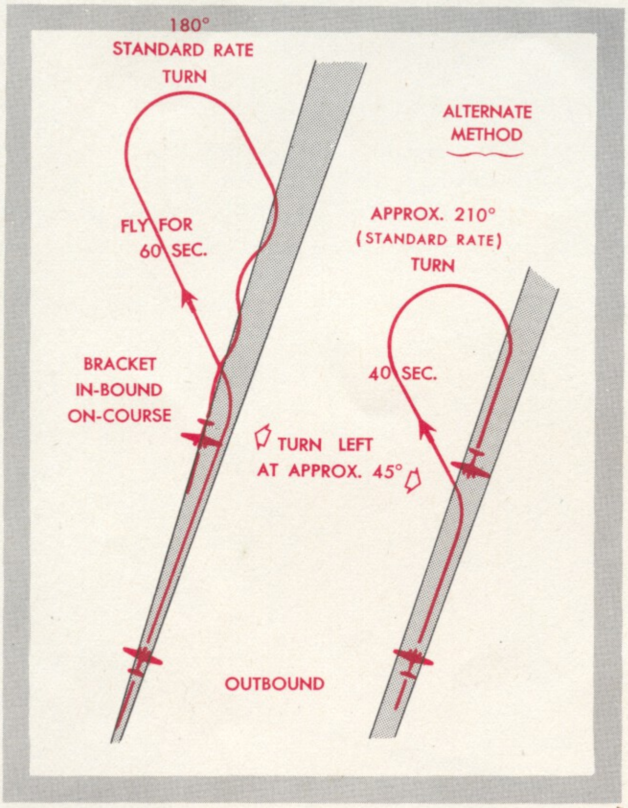


Figure 30—Procedure Turn

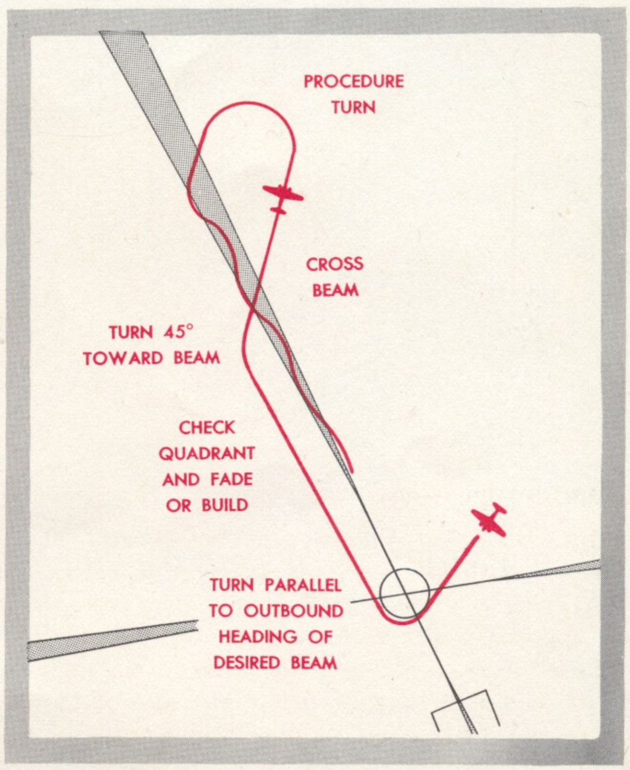


Figure 31—"Close-in" Procedure

7. AVERAGE BISECTORS.

Practically all orientation is based upon the use of the average bisectors of the quadrants or upon the perpendiculars thereto for the original heading of the aircraft. A method for determination of their values for use when these figures are not otherwise available is as follows: Add the sum of the inbound magnetic bearings of the radio range station and divide the result by four. This will be the magnetic bearing of one of the average bisectors. Add or subtract 180° to find the reciprocal of this bearing for the opposite average bisector. Add or subtract, whichever is most convenient, 90° to or from either of the two bearings thus found to determine the two remaining bisectors. Because the average bisectors are 90° apart, the average bisectors of the N quadrants will be perpendicular to the average bisectors of the A quadrants. A simple method of determining perpendiculars and reciprocals of heading is as follows: To find the two perpendiculars, add 100 and subtract 10 or subtract 100 and add 10 and to find reciprocal headings, if the original bearing is larger than 180°, add 20 and subtract 200. If the original bearing is smaller than 180°, add 200 and subtract 20. For practical purposes, however, an estimate of the bisector is sufficient. This may be approximately determined from the two known headings of the beams that bound the quadrant being used.

8. TRUE FADE-OUT METHOD OF ORIENTATION.

a. The basis for this method is very simple. When the radio range signals are received, the student will turn to a heading parallel to either of the approximate bisectors of the quadrant. The volume of the signals received should be adjusted to as low a level as is consistent with clear reception. He will hold this heading and if the signal strength is fading, he will turn 180° and hold this heading until a beam is intercepted. If the signal strength is increasing on the original heading, he will readjust the volume control and continue flying on the bisector heading until a beam is intersected.

b. Upon reaching a beam, he will fly through it and on the first opposite off-course signal he will turn left and bracket the beam in the usual manner. He will recheck the fade or build. If the signal strength is increasing, he will continue on to the station. If the signal strength decreases, indicating he is flying away from the station, he will make a procedure turn and continue toward the station.

c PROCEDURE.

(1) Upon starting the problem, turn the radio volume as low as possible and still read the signals. This is important as the lower the volume the easier it is to detect small changes in volume, and the less

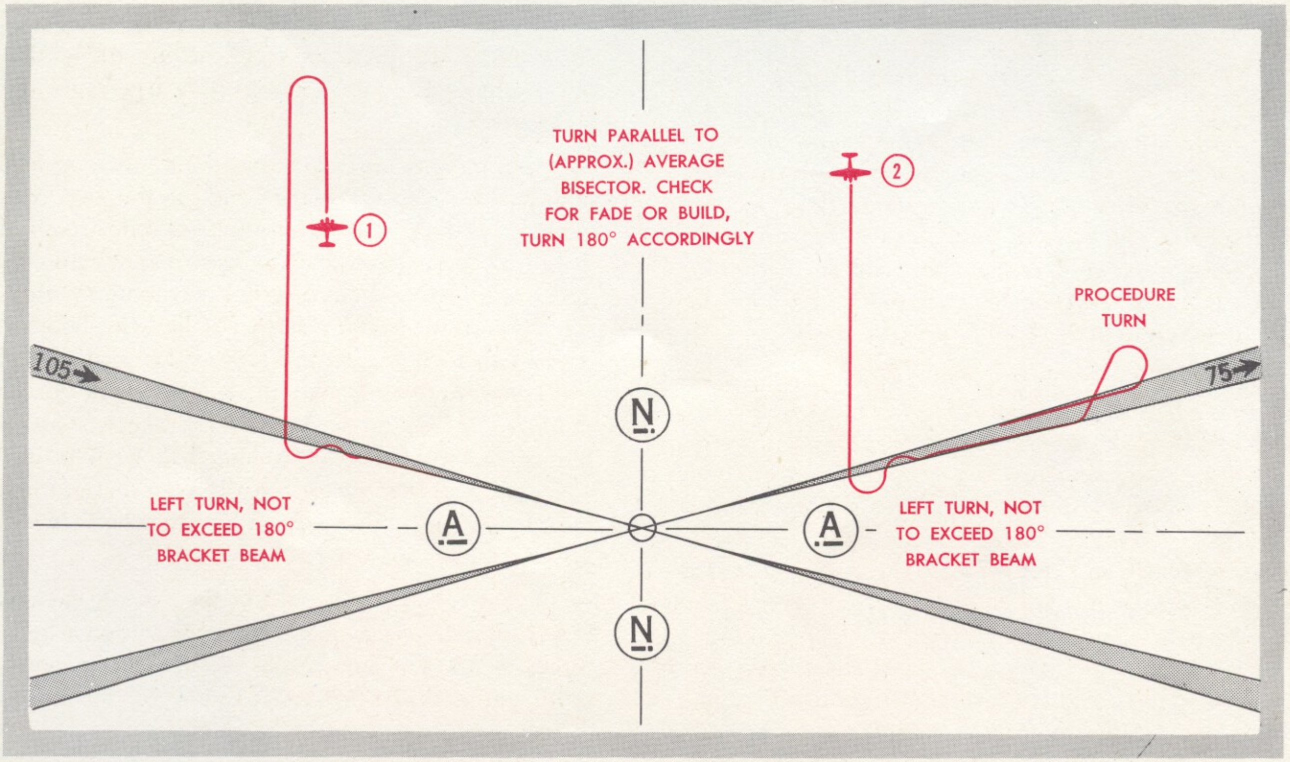


Figure 32—True-Fade Orientation

time will be required to complete the problem. Turn to the nearest of the two approximate bisector headings of the quadrant being received. Hold this heading until there has been a definite change in volume. If the signal is building, continue until a beam is intersected. If the signal strength appears to be fading, make sure that it is really fading before assuming the station is behind and a 180° turn is in order. False fades sometimes occur. If over mountainous country it is advisable to make a second check of the fading before turning around. During such a check small fades and increases may have occurred, but the average volume is what must be considered. It is better to spend a few extra minutes at this point making sure of the facts than to turn too early and then worry whether the signal actually had been fading and perhaps be led into turning around again and possibly winding up becoming hopelessly confused. It is a peculiar fact that after a fade has been proved and a turn made so the pilot is headed toward the station he will usually need to fly two to three times as far toward the station before he can recognize the increase in signal strength as he had to fly away to get the fade. This failure to be able to recognize the build in signal strength has worried many pilots into turning away from the station and wasting valuable time reworking the problem. Make sure of a fade before turning around and then do not worry if the increase in volume does not occur as soon as expected.

(2) The success of this method depends on close judgment of signal strength, not signal characteristics. In a wide open quadrant the signal characteristics can be of some aid. If at the start of the problem a background was heard and this background faded, it would indicate that the plane is going away from the station. Therefore, if in an open quadrant and the background faded it would be probable that the station is behind, but the build or fade should also be checked.

(3) Upon reaching a beam, fly through it and on the opposite side turn left and bracket the beam edge. After the brackets have been narrowed down to only a few degrees, turn the volume down and check for fade or build just as was done in identifying the sector. If the volume increases, the leg is identified as the one which was on the right of the station as the bisector was being flown toward the station. If the volume fades, the leg is identified as the one on the left and the aircraft as going away from the station. Do a procedure turn and follow the right-hand edge to the station. If the compass heading and the published bearings of a beam happen to agree approximately, do not think the beam is definitely identified.

(4) To illustrate the reason for the above, refer to figure 32. The pilot naturally does not know whether he is in position No. 1 or No. 2. He has no way of knowing which beam he is going to intersect. Assume he is at No. 1 and has a strong north wind. When he intersects the beam, he turns left and brackets it. He finds that to stay on the beam he must hold a heading of approximately 75°. He does not know about the drift. The compass heading agrees with the published beam bearing and he has an A on his right, so obviously (he thinks) he is on the northeast leg and turns around. Suppose he has been in position No. 2 with a strong south wind. After bracketing the beam he finds it necessary to hold a heading of approximately 105° to stay on course. Comparing this compass heading with the published beam bearing, he assumes he is on the northwest leg and is probably quite happy about it all. The compass agrees and there is the proper A on the right. The chances are excellent that he will be planning the things he is going to say to somebody about the way his radio keeps fading out long before he realizes just who is wrong.

(5) The leg can be identified. In the example above while following the beam with an A on the right and signal fading (going away from the station), the ship could only be on the northeast leg. The only other position with an A on the right and going away from the station would be on the southwest leg. Approaching from the north quadrant (approaching the station on the southerly bisector heading) this leg would not be intersected.

(6) As was previously mentioned, it is sometimes desirable to choose a certain one of the two possible bisector headings. For example, if the pilot received an A and his map shows that the west A quadrant extends out over a lake or mountain, it is advisable to select the easterly bisector heading so that if he is in the east sector he will be flying toward land. When using a station which has a crowfoot pattern, it is advisable to choose the inbound bisector heading of the largest sector. The rate of change of signal strength will be slow in such a large sector. If the pilot actually is in that open quadrant, the several minutes spent proving the fade will be taking him toward the station.

(7) Explain to the student that, should he have to orient himself on an unknown range station where the bisectors are not known, he should use a north or south course as the bisector if in an "N" quadrant and east or west course as the bisector if in an "A" quadrant. This is an adaptation of the "true fade" system using an arbitrary heading as a bisector.

d. This method will work on any station pattern (square, scissor, etc.). It is not appreciably affected by drift. In most cases it can be completed in considerably less time than other methods. It is the only range orientation method that can be depended on in wide-open quadrants.

e. Without considerable practice it is difficult for the pilot to recognize small changes in signal strength. During heavy static it is difficult for even experienced instrument pilots to recognize the changes in a reasonable time.

f. TRAINER INSTRUCTION.

(1) In teaching the true fade-out method of orientation, a scissor station pattern should be selected. The recorder should then be placed in one or the other of the large open sectors. It is desirable about two-thirds of the time to select the position for the inking wheel so that after the student has intersected the beam and bracket it, he will be going away from the station. This will give him further practice in checking the fade and also in maneuvering on the beam. Particular care must be taken by the instructor to insure that the student is not identifying the beam by the compass heading. It is not sufficient to ask the student how he identified the beam; rather, a condition should be created in which identification of the beam by compass heading alone will result in a wrong identification. In placing the recorder for true fade-out problems, it should be placed far enough from the center of the sector so that the student will encounter a beam far enough from the station to have plenty of room to bracket it down. Throughout this method or in any other method involving the student's checking a fade, it is essential that the volume control be handled smoothly and with extreme care in order to give the student the right kind of information.

(2) To demonstrate the fact that beams or radio ranges should not be identified by their published bearings in the case of wide-open quadrants, use the Chattanooga instrument trainer chart. Star the problem in the east A quadrant, setting the recorder so that the southeast on-course will be intercepted about 10 miles from the station. Apply a wind: 260°, 60 mph. After the student has intercepted the southeast on-course, made his left turn, and bracketed the beam, the heading necessary to maintain the outbound edge of the beam will be approximately 182°. This heading is halfway between 203°, the published inbound bearing the northeast course, and 160°, the outbound bearing of the southeast beam. It should be obvious to the student that the heading of 182° on which he is now flying does not tell him which of the two possible beams he has intersected. The recorder may also be set to intercept the northeast course; in this case the wind must be applied from 80° to produce a heading of approximately 185° when following the northeast beam toward the station.

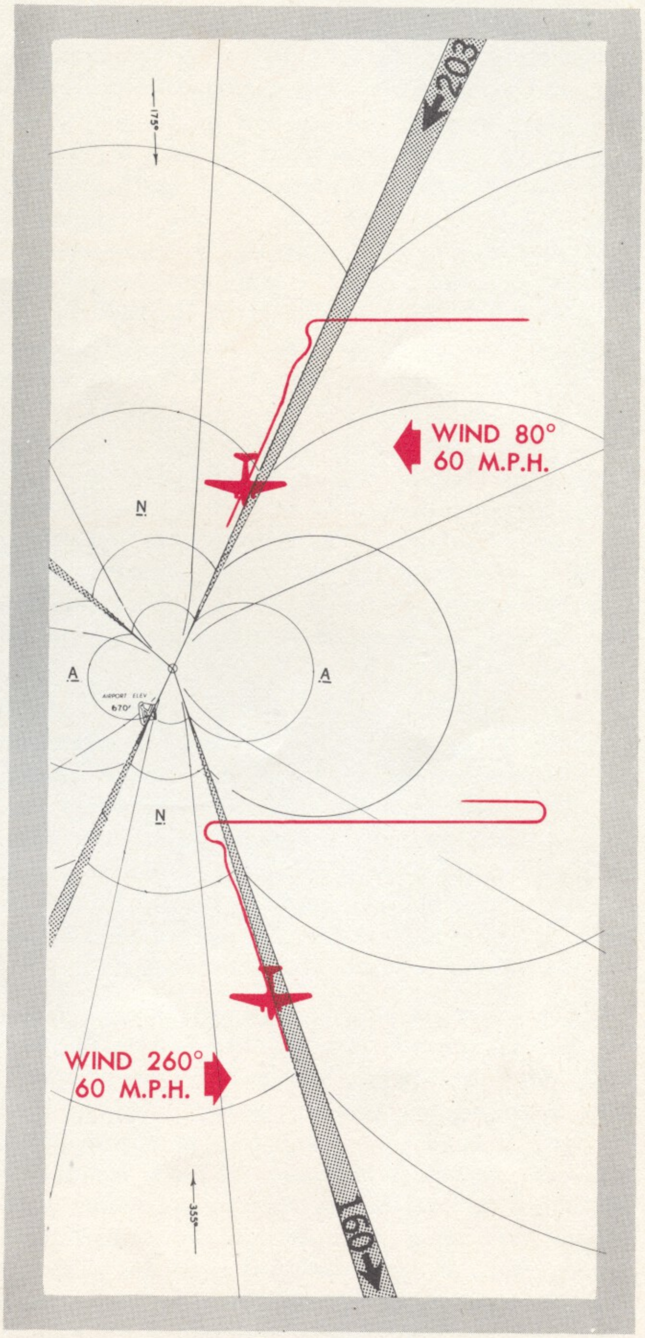


Figure 33—True-Fade on "Scissor" Range

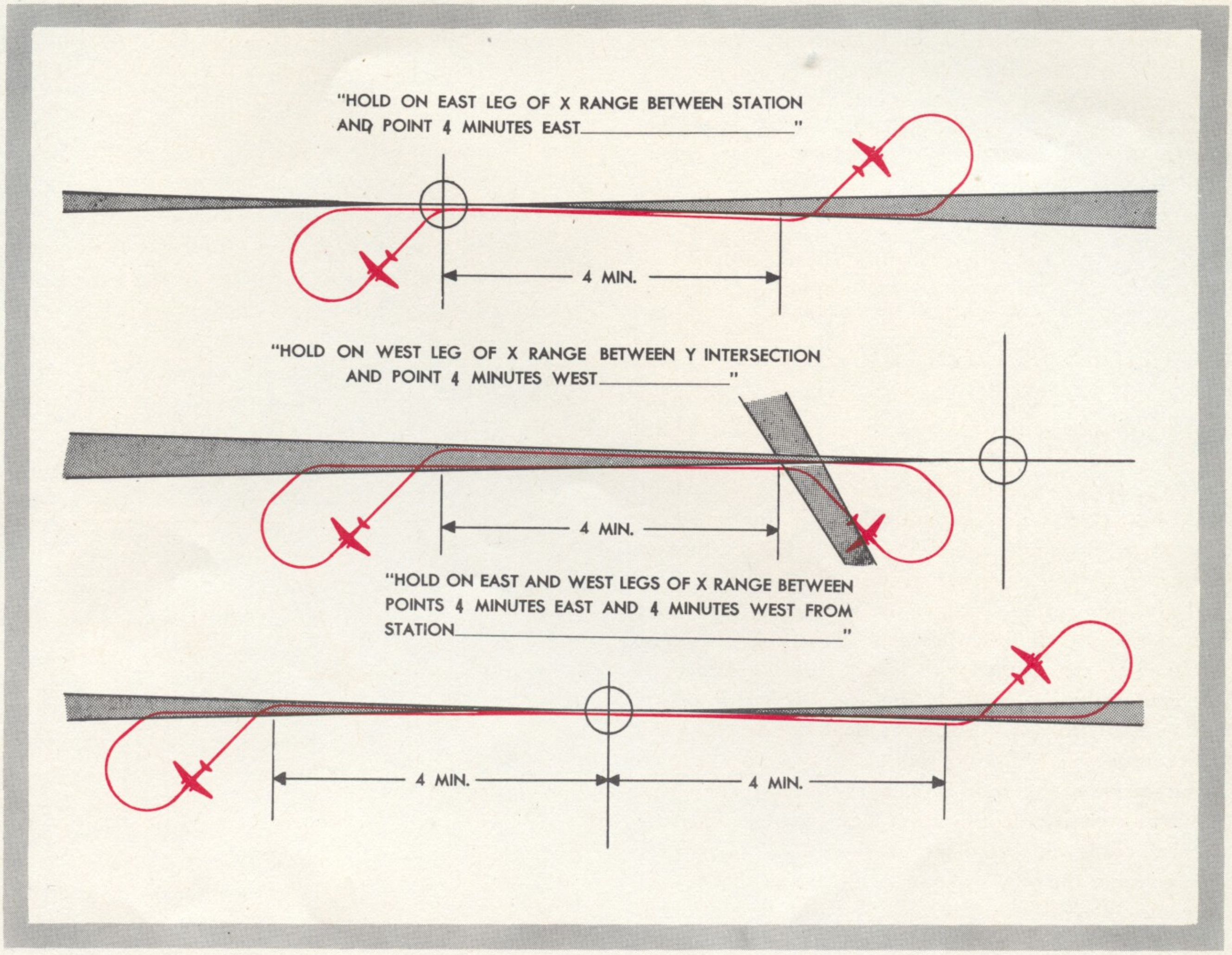


Figure 34—Holding

9. HOLDING PROCEDURES AND THE PULL-UP.

a. In airways traffic control it is frequently necessary to hold aircraft over given points particularly when a number of aircraft approach the same airport for a landing under instrument flight conditions. Holding procedures will be conducted under Airway Traffic Control (ATC) instructions. The point on which to hold will be specified by ATC, and may be the intersection of two radio range legs, a fan marker or some other radio fix. For instance the instructions may be "Hold 4 Minutes East of station, at 5000 feet". When the aircraft arrives over the airport, it may be placed in a landing sequence, in which case an altitude will be assigned to the pilot. He will not change this altitude except when directed to do so by ATC. When instructed to hold, the pilot will receive the following directions: "You are number 3 to land, hold at 4000 feet on the west leg of the radio range. Expect approach clearance at 2240." As soon as the preceding aircraft lands he will be instructed to descend to 3000, when he becomes number two to land. When the next preceding aircraft has landed, he will be number one to land, and will be cleared to approach and to the tower frequency for landing instructions.

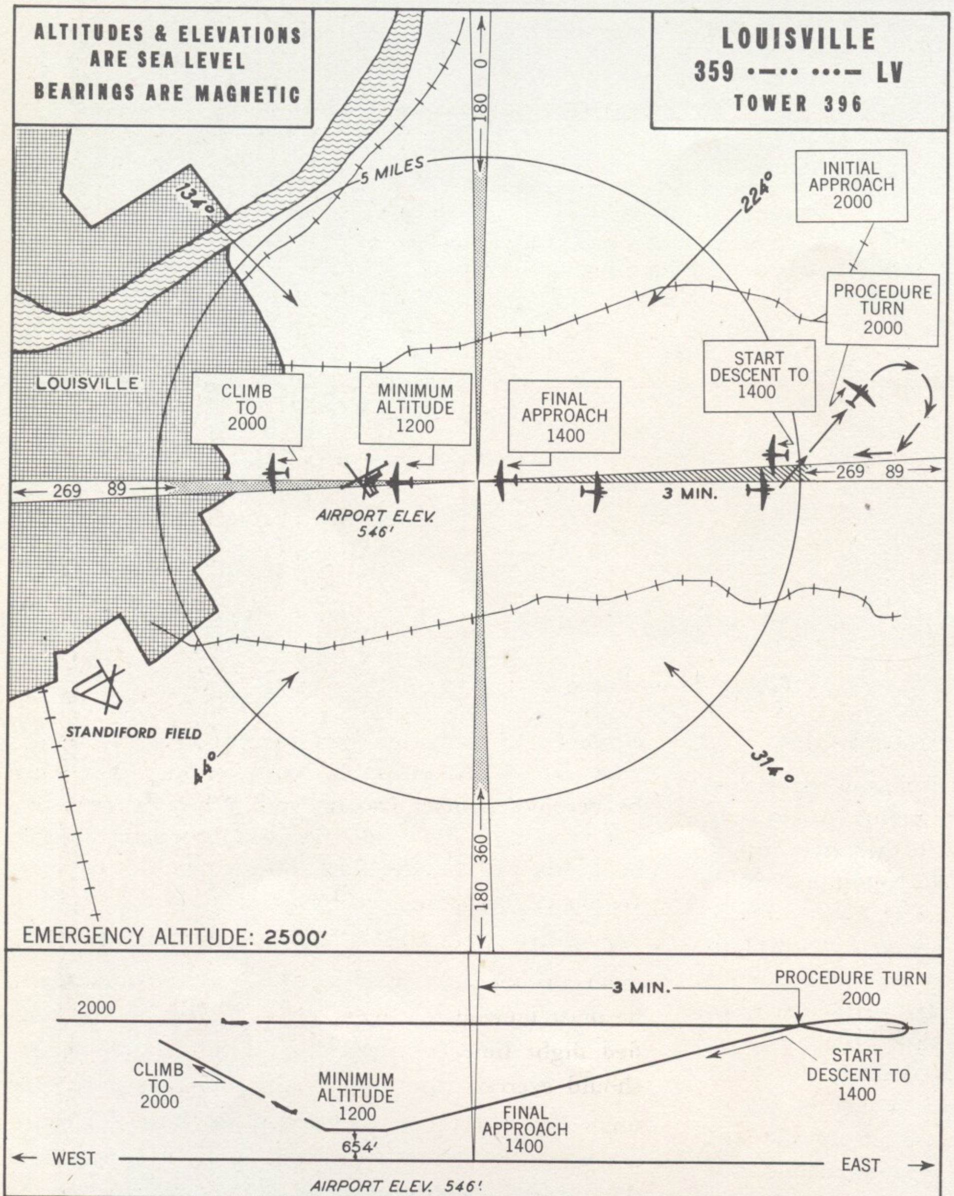
b. If the pilot fails to see the ground at the minimum altitude authorized for the instrument approach, he must immediately upon the expiration of the specified flight time from the cone execute a pull up. He should exercise care in the pull-up if flaps have been used. This pull-up may differ with the type of aircraft, but in general the following will apply: Keep and hold the airspeed constant while adding climbing power. As soon as constant airspeed-climb has been established, raise landing gear. If flaps were used, use care in raising them at low altitudes.

10. INSTRUMENT APPROACH PROCEDURES.

This descriptive term is used to describe a series of maneuvers necessary to bring an aircraft over a radio range station and down through the overcast into conditions of ceilings and visibility permitting a contact landing. It is emphatically not a landing procedure. The reason for this limitation is the fact that the on-course signal of a radio range does not provide exact localization of the flight path of an aircraft.

a. Ceilings and visibility at the airport must therefore be high enough to permit the completion of the landing under contact conditions. Because the pilot must know the ceiling and visibility of the airport, and because he must set the altimeter of the aircraft to the local altimeter setting, he will call the airport "Radio" or "Tower" for this information before arrival over the cone of silence. He must also maintain his airway flight altitude for safety until he has proven his position over the station, and by regulation until he has been cleared for an approach by Airways Traffic Control. After the pilot has proven his position and has received clearance for an approach, and after he has set his altimeter, he will begin the approach procedure.

b. The flight from the cone to the procedure turning point is normally timed. The time-distance interval should be determined beforehand and must not be exceeded. The pilot will approach the cone and cross it headed toward the procedure turn at the initial approach altitude. This altitude is high enough to insure at least a 1000′ terrain clearance within 25 miles of the range station. From this point on, the pilot follows the altitudes and directions prescribed on the approach procedure chart for the range and airport concerned. This chart will be found in T. O. No. 08-15-3. Level flight at the altitude at which it is desired to cross the cone on final approach must be established prior to reaching the cone on the final approach.



TIME-DISTANCE STATION TO FIELD 1.6 MILES

110 M.P.H.	120 M.P.H.	130 M.P.H.	140 M.P.H.	150 M.P.H.	160 M.P.H.
0 MIN. 52 SEC.	0 MIN. 48 SEC.	0 MIN. 44 SEC.	0 MIN. 41 SEC.	0 MIN. 38 SEC.	0 MIN. 36 SEC.

LOUISVILLE LOUISVILLE

Fig. 35—Louisville Approach Procedure

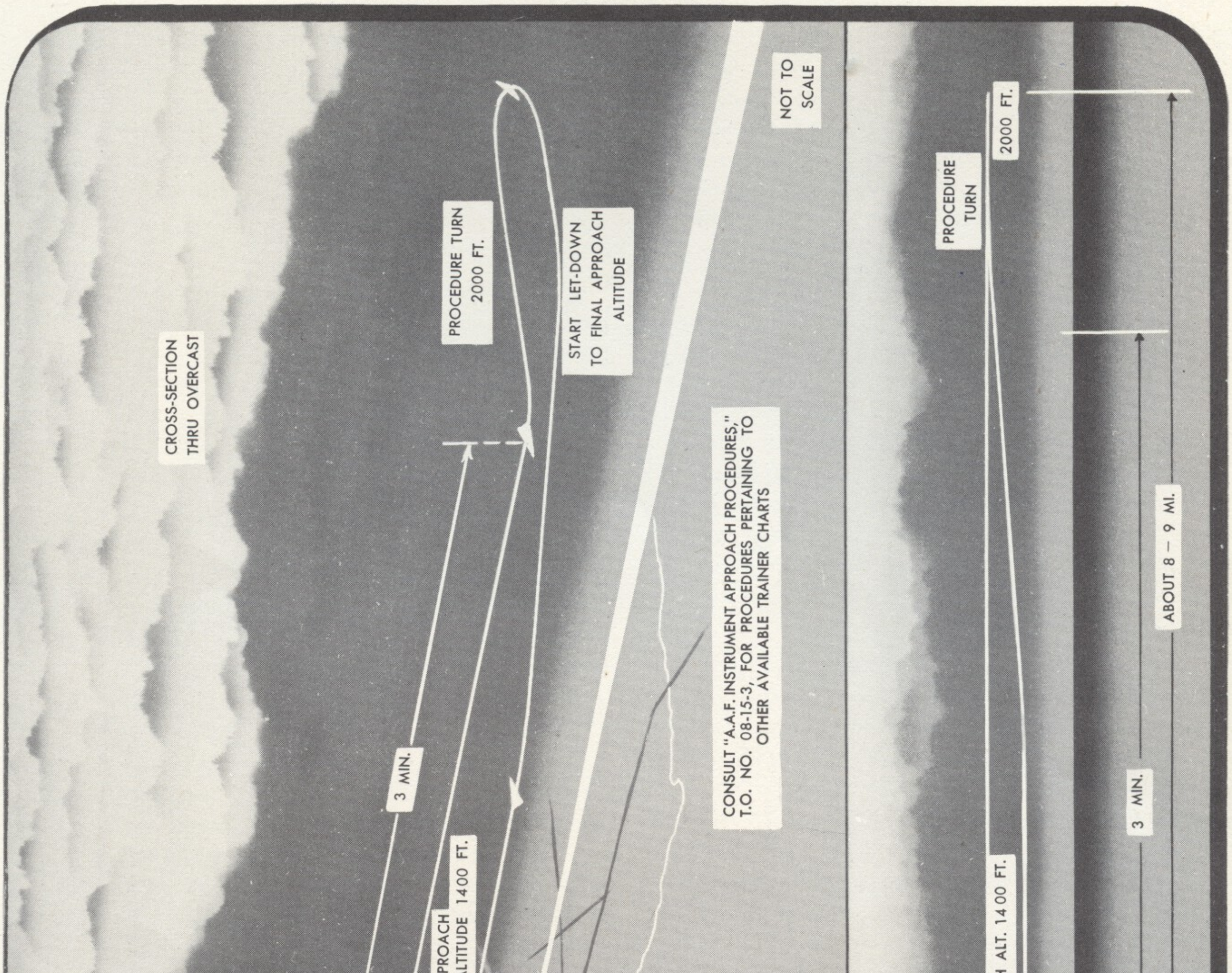


Figure 36—Instrument Approach (Louisville)

c. The conditions of flaps, propeller setting, power, airspeed, etc., of aircraft will differ with each type and possibly with the loading of the aircraft. Pilots should become thoroughly familiar with these conditions for slow cruising speed, safe maneuvering speed, and minimum speed. They should also be prepared to execute a pull-up if visual ground contact is not made at the minimum altitude. If climb is necessary—first, airspeed—second, more power—third, climb—fourth, gear up—fifth, bring flaps up slowly.

d. Trainer Instruction. These points are included for the instrument trainer instructor's information. When a student is to practice an instrument approach procedure, the instructor will select a suitable Instrument Trainer chart and will be prepared to enact the role of the "Radio" and "Tower" operators. The student will be required to call for altimeter setting, weather and approach clearance before the approach is commenced. Since the details of the approach are adequately covered in T.O. No. 08-15-3, the instructor will not experience any difficulty.

e. Supposing the instructor has selected the Louisville Instrument Trainer recorder chart. He will explain the procedure to the student, using the introductory notes in the first pages of T.O. No. 08-15-3 for reference material. The student's attention should be invited to the importance of obtaining the altimeter setting for the airport, the ceiling and visibility at the airport, and approval to make an instrument approach. The student will then be given the following problem: He is at 3000′ en route from Indianapolis to Louisville on an instrument clearance. He is in the vicinity of the west leg of the Louisville radio range, about 10 minutes out, and is ready to call the Louisville radio for an instrument approach clearance. Have the student then take his seat in the cockpit of the trainer. He will close the hood and climb to his assigned altitude. The recorder will be placed in the position previously described. The student upon reaching 3000′ will call: "Hello, Louisville Radio this is Army 1-234, over". Inst.: "Hello, Army 1-234, this is Louisville Radio, over." Student: "This is Army 1-234, 10 minutes west of Louisville, at three thousand feet, request clearance for instrument approach, over." Inst.: "This is Louisville radio, you are cleared for approach, you are number one to let down: ceiling seven hundred feet, visibility one-half mile, wind east 5 miles, altimeter setting 985, call tower when contact, over". Student: "Roger, out". The instructor will now start the recorder and the student will set course to intercept the west leg of the Louisville range. After intercepting the beam and being headed toward the station, the student will descend to the initial approach altitude of 2000′ over the cone. Intercepting the cone he will time three minutes and at the end of this period make a procedure turn. After the procedure turn has been completed and the student is again headed toward the station he will descend to the final approach altitude of 1400 feet and cross the cone at this altitude. This last descent should have been made at a reduced airspeed. After passing the cone he will further descend to the minimum altitude of 1200 feet.

f. Assuming the pilot can see the airport as the minimum altitude is reached, the student should call the tower as follows: "Hello, Louisville Tower, this is Army 1-234, over." Inst.: "Army 1-234, this is Louisville Tower, over". Student: "This is Army 1-234, contact over the field, landing instructions, over." The problem is now completed.

g. The use of the landing gear, flap and propeller control switches will be used in these problems when the student shows proficiency. At later problems moderate cross winds may be also introduced. More difficult procedures such as the Philadelphia, Brownsville, and Phoenix procedures may also be used.

11. NOTES ON OTHER METHODS OF ORIENTATION.

Over the years a number of "systems" of orientation on radio ranges have been developed, each of which was useful under a special set of circumstances. In view of the limited time available for training, only one method which will provide the student with a solution to the problem of locating his position when using the range will be taught.

> If the student is trained to the point where he thoroughly understands and can apply the principles of the true fade-out method of orientation, he will have acquired a sufficient basis for finding himself if he is not sure of his position. It is also probable that the pilot of most tactical aircraft will have the automatic radio compass available in flight. This equipment, when operating, will eliminate any necessity for working any range orientation problem, provided the pilot is able to make proper use of this type of equipment. Any time which may be available to the student for "flying" the trainer can be used to better advantage in reviewing the true fade-out, radio compass, low approach, and instrument landing procedures. **The notes on other "systems" of orientation are therefore included for information only.**

a. PERPENDICULAR TO BISECTOR METHOD.

(1) As soon as the signals are heard, check the identification signals to be sure which station is being received. Then listen for a background from the other quadrant. If only a clear A or N is heard, turn the volume up to an uncomfortably loud level and note whether any background is heard. If a background can be heard, remember that fact and turn the volume down again to as low a level as can be clearly heard and understood. With as little loss of time as practical, a standard rate turn should be made to a heading 90° to the average bisector of the two possible quadrants. If a background was present at the start of the problem, note whether it is growing louder or disappearing. If the background was noted at first only when the volume was turned to a high level, the volume should be again turned up after 2 or 3 minutes and the increase or decrease of background noted. If the background was present and is fading, it is obvious that the aircraft is going away from the nearest beam, and a 180° standard rate turn should be made to a heading which is the reciprocal of the previous one but still perpendicular to the average bisector. This heading should then be held until a beam is intersected.

(2) If no background was noted at the start of the problem, the first heading perpendicular to the average bisector should be held until a beam is intersected. Do not change course merely on a suspicion or assumption that there might have been a background. Inspection of figure 37 will show that starting at X, two of the four beams (west and south legs) cannot possibly be intercepted, as they are behind. The only problem remaining is which of the two beams in front (the north or the east) will be encountered. The heading is held until a beam is crossed. The 90° identifying turn to the right is started on the first opposite off-course letter heard. While it takes a little longer to ride on through the beam to the opposite side before turning, it will tend to eliminate confusion resulting from trying to work an orientation problem on a false or multiple beam.

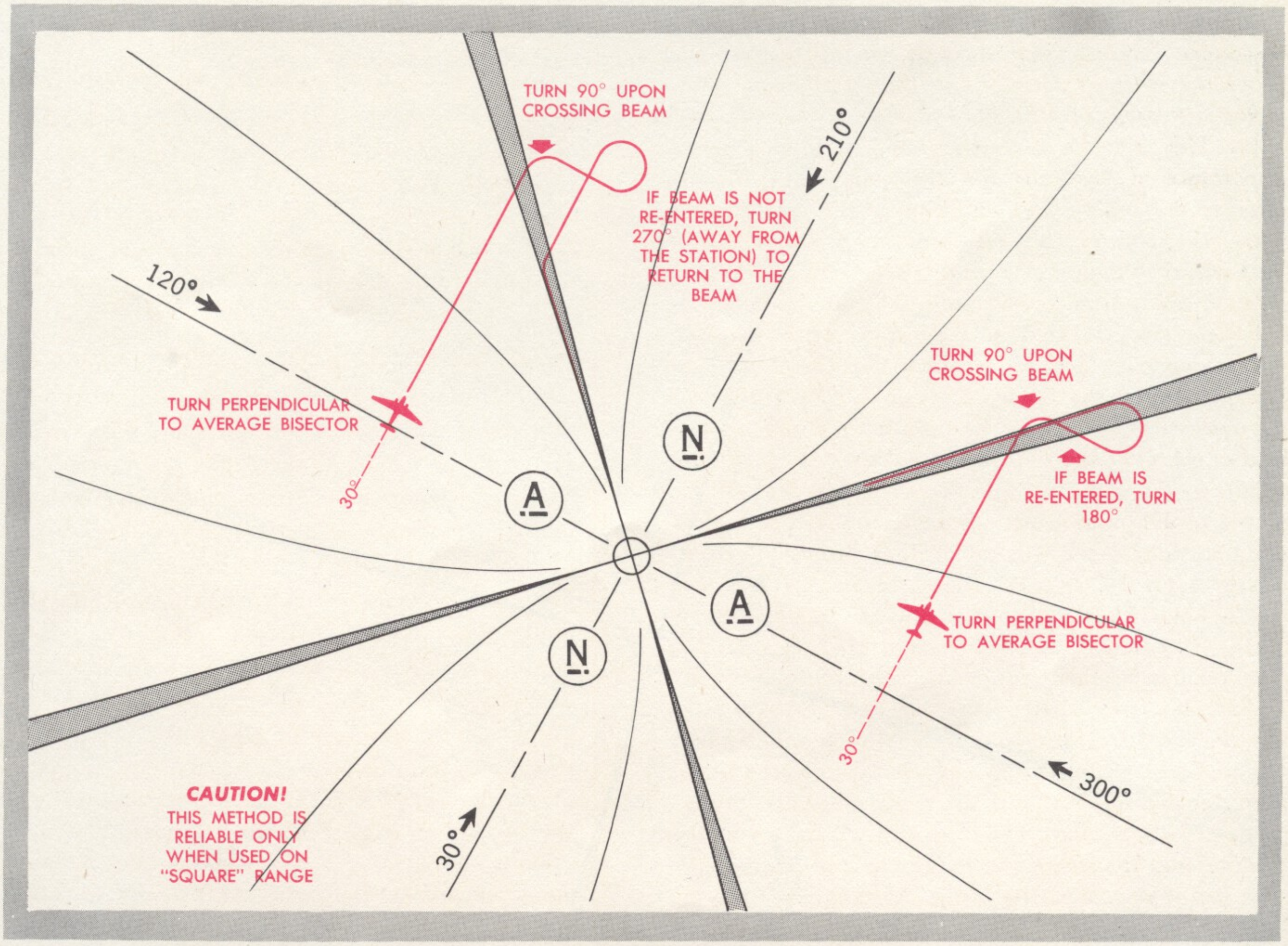


Figure 37—Perpendicular to Bisector Method

(3) After completing the 90° turn to the right, the heading is held and the signal change noted. If the problem started in an A quadrant, an N will be heard after passing through the beam. If this N becomes increasingly distinct after the 90° turn is made, the quadrant and beam are definitely identified. Inspection of figure 37 will show that if the aircraft had started in the other A quadrant the new heading, after the 90° turn, would have taken the aircraft back through the beam and back into the N, thus definitely identifying the (in this case) northeast leg.

(4) After the beam is definitely identified, orientation is accomplished and finished. The remainder of the problem is simply a matter of getting on the right-hand edge of the beam and following it to the station.

(5) When the identifying turn brings the aircraft back to the on-course, the identification is definite, but the heading should be held for not less than a minute after reentering the beam before making the 180° turn, so that the turn may be completed before arriving back at the right-hand edge of the beam. This is particularly important with beginners in range flying, as they are very likely not to notice the change in signal while concentrating on making the turn, and will pass out of the beam without being aware of it. By allowing room to complete the turn the student is permitted to do one thing at a time, and so is much less likely to become confused. If the beam is not reentered after the 90° right turn, the 270° turn should be started as soon as identification of the leg is definite. The sooner this turn is started the better the results will be. Delaying this turn results sometimes in getting back to the beam too close to the station. (See figure 38.) After completing the 180° or 270° turn, the heading is held until the far side of the beam is reached. As soon as the first off-course signal is heard, the right-hand edge of the beam should be bracketed down in the approved manner as previously described.

(6) This method is almost entirely mechanical and so can be learned quite easily. It has a further distinct advantage of not depending for its success on changes in signal strength. It can, therefore, be used successfully on range stations where false fades and builds in signal strength are prevalent to an extent that would prevent the use of any fade-out system.

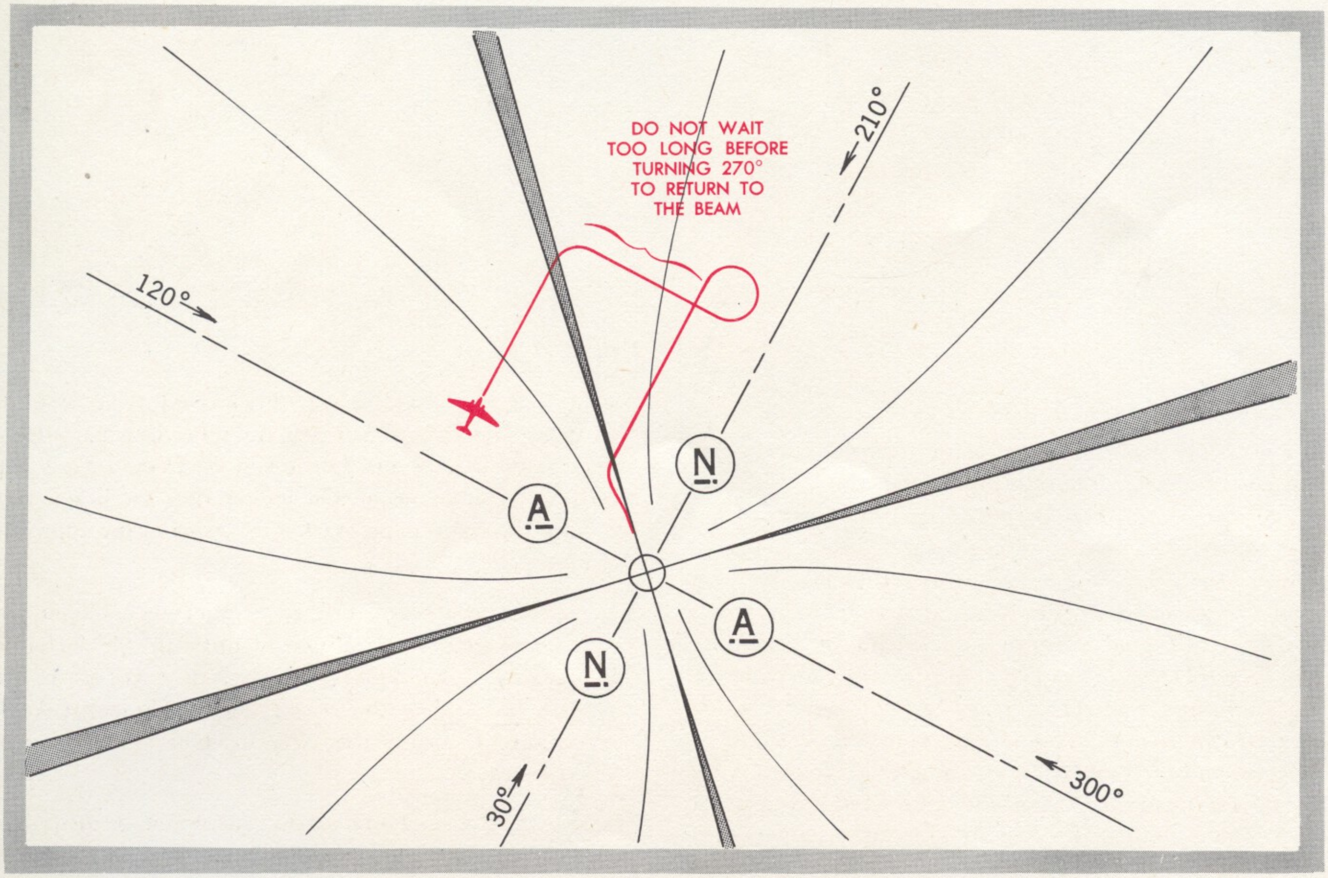


Figure 38—Perpendicular to Bisector Method

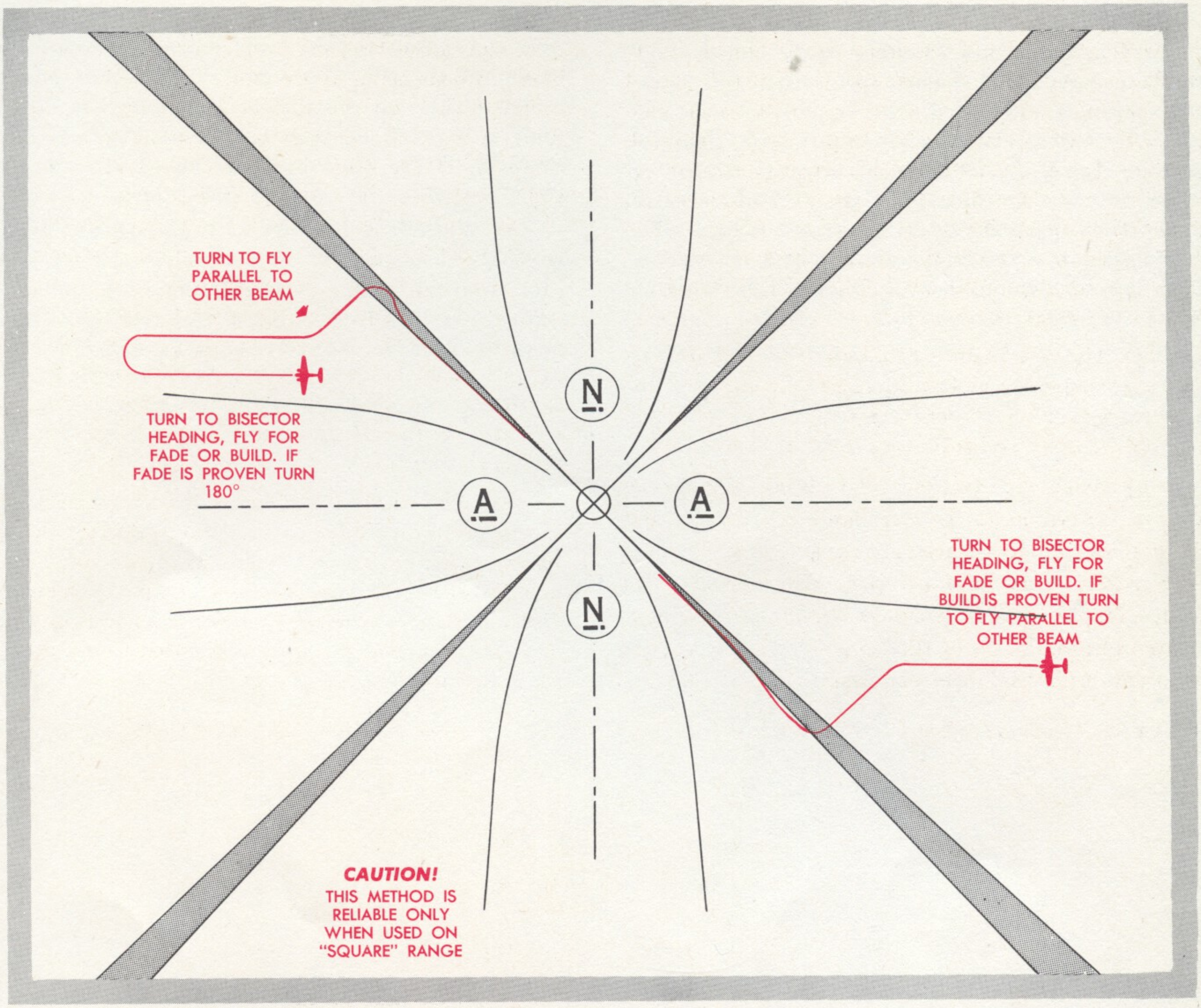


Figure 39—Parallel Method

b. PARALLEL METHOD.

(1) The basis for the parallel method is very simple and similar to the true fade-out method. When the range signals are received, turn to a heading parallel to the average bisector of the quadrant signal being received. Turn the volume as low as can be clearly heard and check, over a period of at least five minutes, whether the signal strength is increasing or decreasing. For example: assume an A is being received from the station in figure 39. The average bisector is either northeast or southwest. Assume the southwest heading is selected and the volume fades. The aircraft is then in the southwest quadrant. If on the southwest heading and the volume builds, the aircraft (in this example) is in the northeast quadrant. If the volume fades, turn to the reciprocal heading and fly toward the station for the same length of time as was flown away from it while checking the fade. Then assume a heading parallel to one of the two beams that are in front in order to intersect the other beam. On intersecting the beam, turn toward the station and bracket the beam in the approved manner.

(2) This method is easy to remember. Under certain conditions it simplifies identifying which leg is intercepted. In conditions under which it will work, it is a little faster than the true fade-out. Under workable conditions, it allows the pilot to choose which leg he will intercept.

(3) This method is easily disrupted by drift and cannot be relied upon under conditions of unknown drift and on stations other than square.

c. FADE-OUT 90° METHOD.

(1) The quadrant is identified by the fade-out and parallel methods. The inbound bisector heading is flown until a beam is intersected. The beam is crossed and upon receiving the first opposite off-course signal a 90° turn is made. (This turn may be made either way without affecting the efficiency of the method, but it is recommended that it be made to the left for the sake of standardization.) When headed toward the station on the bisector heading there is a beam on the left and one on the right. If the 90° turn to the left brings the aircraft back into the beam, the right one was intercepted. If the identifying turn takes the aircraft deeper into the opposite quadrant, the beam intercepted was the one on the left. (See figure 40.) As soon as the beam is identified, a turn is made to get back to the beam. If the beam on the left was intercepted, the turn should be of 180° to the left. If the right beam was intercepted simply follow it to the station.

(2) When it will work, it is quicker and easier than some other methods. Its best use is in a squeezed sector to avoid having to bracket the beam and then identify it by the fade as is the true fade-out, but it cannot be depended upon in an open quadrant.

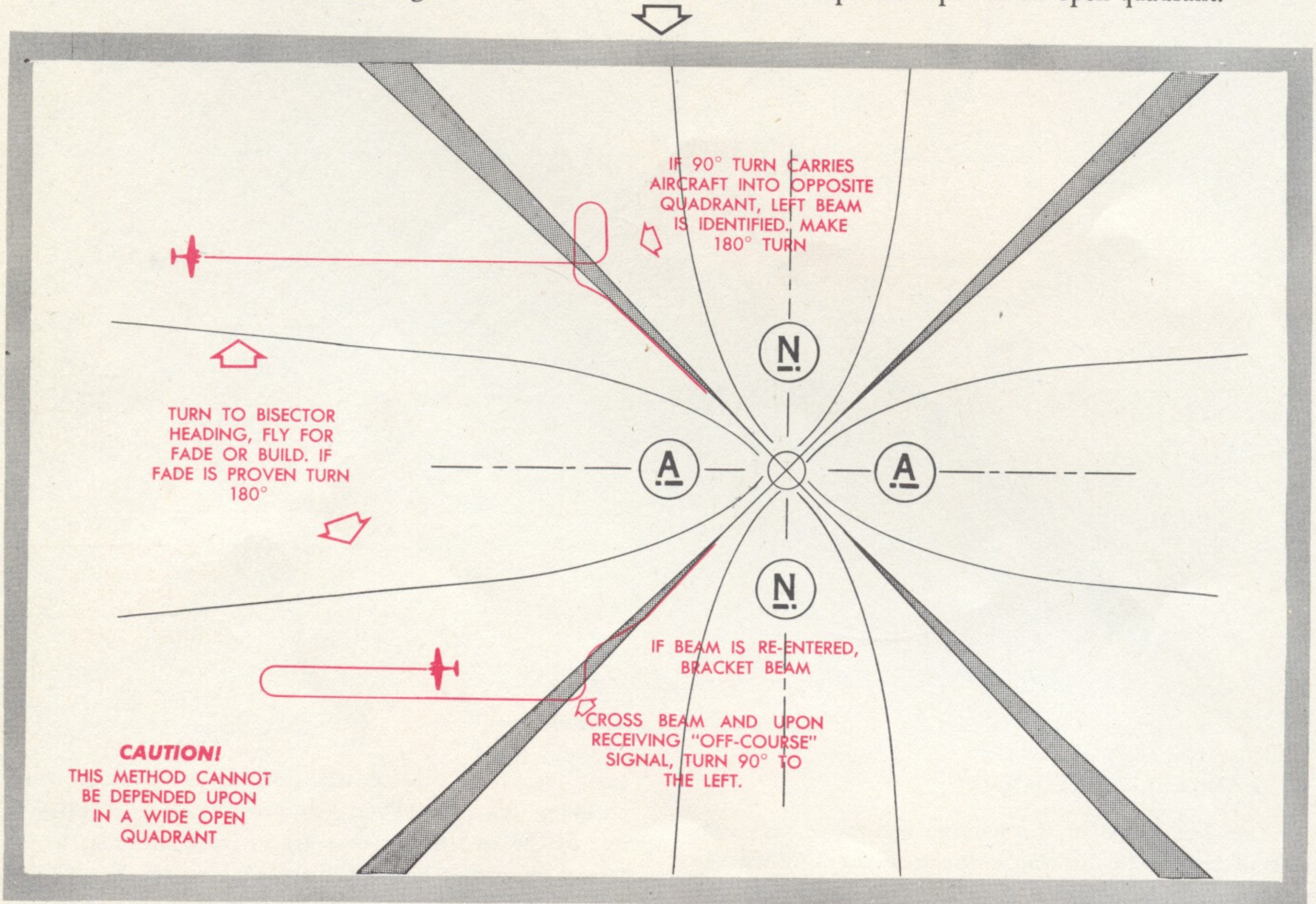


Figure 40—Fade-Out, 90° Method

d. ON-COURSE ORIENTATION — There will be cases when the student, upon tuning to the station, receives the monotone of one of the four on-course signals. In this case the orientation problem is practically solved. It is only necessary to identify the beam and to follow it to the station.

(1) On a "square" station the student will turn to the nearest one of the four bisector headings. When the first off-course signal is received he will turn 90° to the left. This turn will either take the trainer (aircraft) back into and across the beam or into the off-course. This identifying turn, with the bisector heading selected, will definitely identify the particular beam. Upon proving the position the student will bracket the beam on into the station, making a turn away from the station to do so if necessary.

(2) On a station having an irregular or extremely squeezed pattern, the student will turn to the nearest of the average bisector headings to the left of his original heading. This heading is held until the edge of the

beam is reached. (If the edge is not reached within 3 or 4 minutes, he will turn 90° to the left to the next bisector heading.) When the first off-course signal is heard, the student must turn left to regain the beam and bracket, using the unknown beam bracketing procedure. The on-course must then be checked for fade or build. If a fade is proven, the student will make a procedure turn to return to the station. If the pilot upon turning to a station receives a strong background tone (if he can distinguish the identification signal sent in the other A or N quadrant), he will fly the perpendicular to either of the two possible bisectors. If the background now increases, the student will hold the course until the beam is intersected. If the background decreases, he will turn 180° and hold his heading until the beam is intercepted. Thence he will make an identifying turn of 90° to the left to identify the intercepted beam. This method is not useful in a wide-open quadrant unless a check for fade or build is made on course.

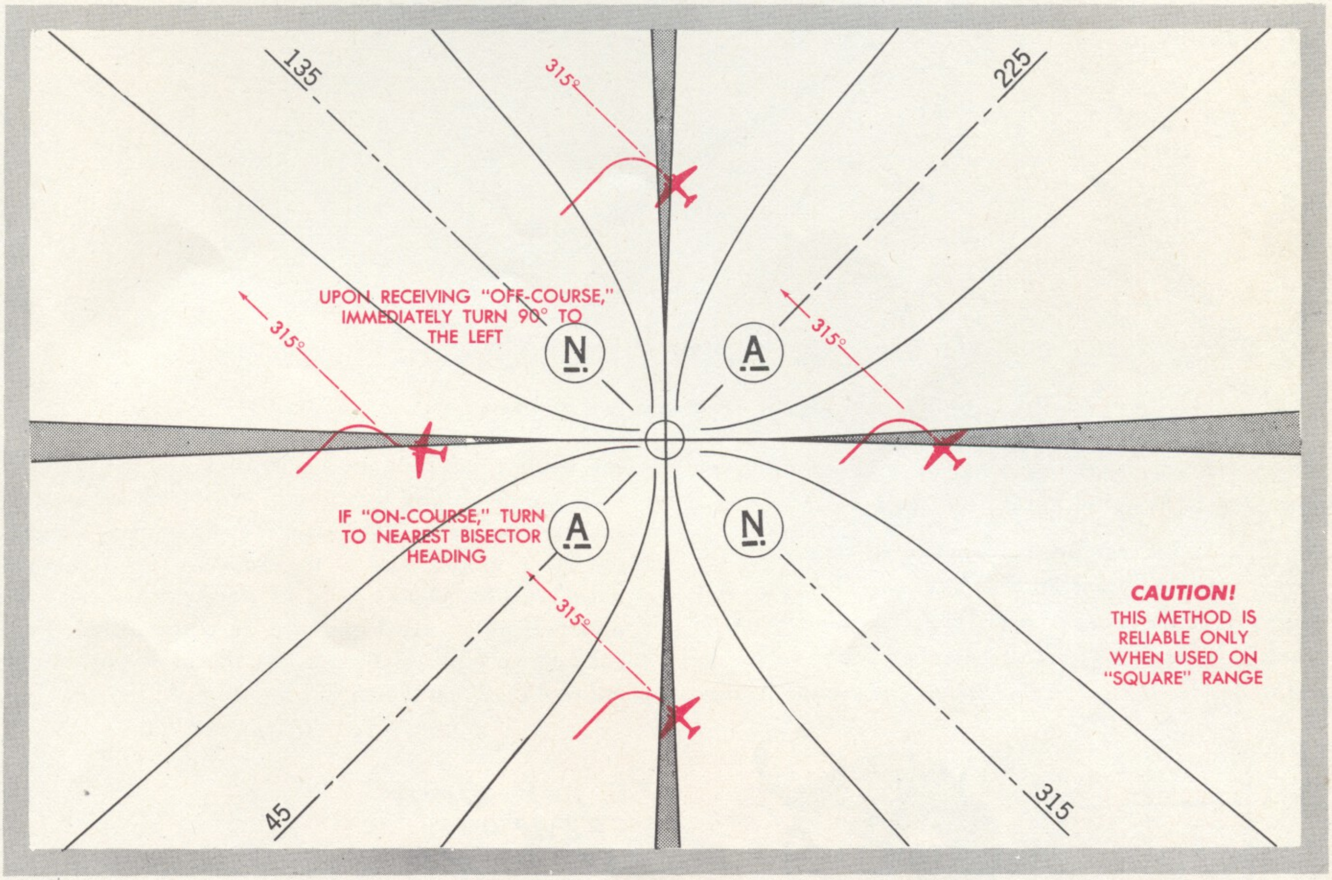


Figure 41—On-Course Orientation

e. BEAM INTERCEPTION.

(1) When the student has identified the station by the station identification signal, he will fly the bisector heading of the quadrant to prove the fade or build of the A or N signal being received. After he has definitely determined the bisector toward the station, he must decide which of the two adjacent beams bounding the quadrant will bring the aircraft to the station. The beam which will permit the student to assume a heading toward the initial approach leg for a let-down procedure should be chosen where practicable. Or, if the pilot intends to proceed to another station, he will choose the leg which will bring him to the station at a heading to continue the flight.

(2) After the fade or build is proven, the student turns perpendicular, that is, at right angles, to the beam he has decided to intercept.

When he reaches the background signal he will note the time elapsing until he reaches the monotone of the beam. As the student reaches the monotone of the on-course he will turn to cross the beam at an angle of 30° to the inbound bearing of the beam. Then he brackets the beam as in the method for a known beam heading. He will keep his volume at minimum distinguishable

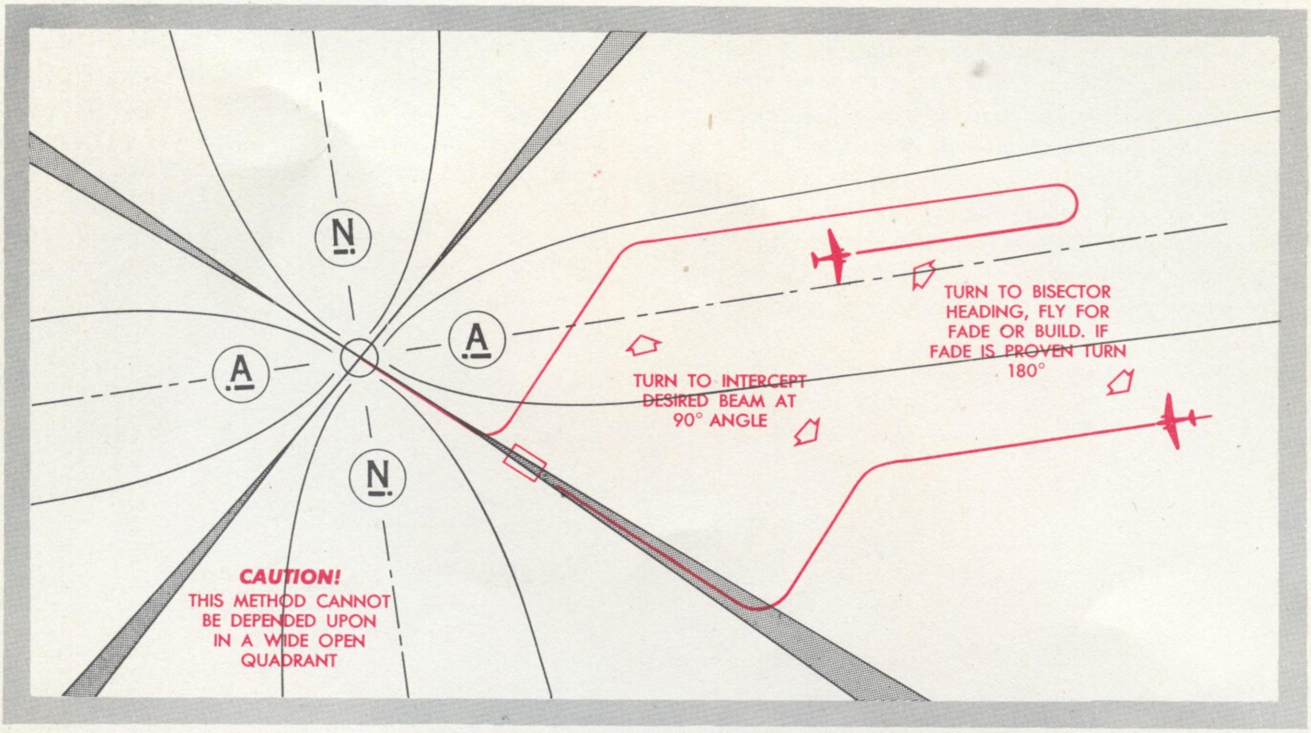
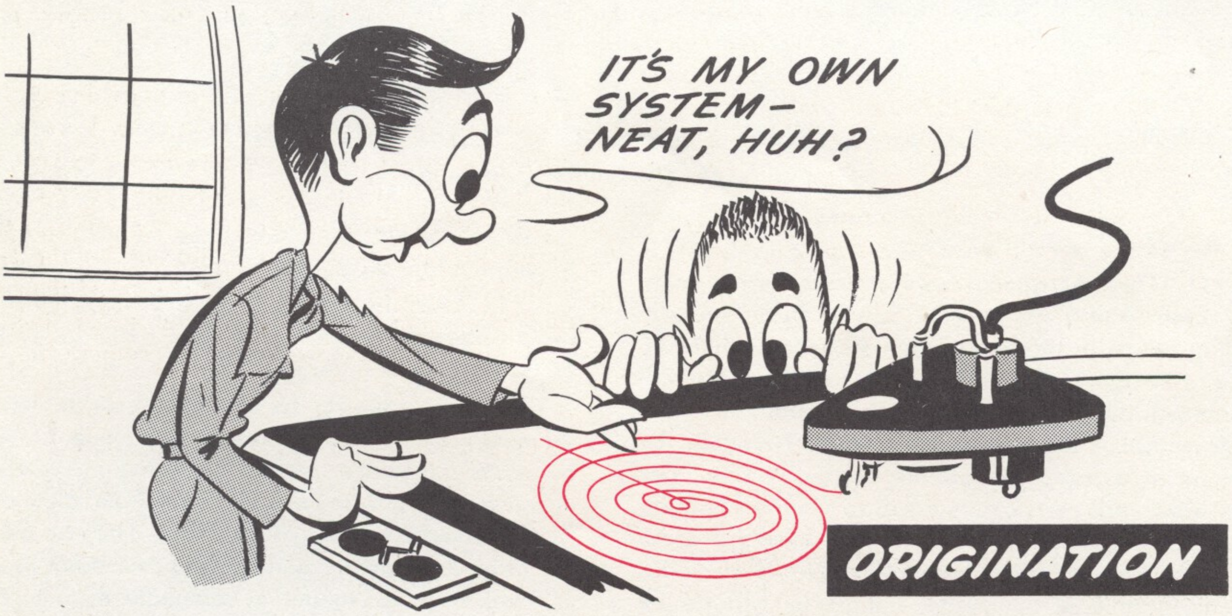


Figure 42—Beam Interception

signal strength thereby proving, by the increasing volume, that he is going toward the station.

(3) The foregoing will work in all cases except in a wide open quadrant. In this latter case there is a possibility that the undesired leg may be intercepted, or that the aircraft may intercept either beam very close to the station. If close to the station, the rapidly increasing volume will indicate this position and the pilot will then proceed, using the close-in procedure. When intercepting the beam adjoining the wide-open quadrant not close to the station, the student must realize the existence of the possibility of having intercepted the undesired beam. An identifying turn and a close check for fade or build as he brackets the beam will quickly indicate the beam which was intercepted.



SECTION IX
RADIO COMPASS TRAINER EXERCISES

1. GENERAL.

The radio compass installations at present available to the Army Air Force pilot may be classified in three types. These types are developments of the first radio compass which provided the pilot with a left/right indication when the aircraft was headed toward the station. This fixed loop installation is still in service in some of the older aircraft and because its employment is similar in some respects to the newer types, will be covered in this text. The next development was the direction finding equipment, employing a left/right indicator plus a rotatable loop antenna. This equipment too is being replaced by the automatic radio compass. This modern equipment includes a bearing indicator placed on or near the pilot's instrument panel. The dial of this indicator is graduated in degrees, and the needle of the instrument points to the relative bearing toward the station being received.

a. All radio compasses employ as a fundamental principle the fact that certain types of antennas are highly directional. These antennas are built in the form of a loop having maximum response when the plane of the loop is in line with the transmitting station. Minimum response occurs when the axis of the loop is lined up with the station.

This minimum signal strength is described as the aural null when the equipment is used without the visual indicator. All AAF equipment in current use includes a visual indication of the relative position of the radio station from the aircraft by a left/right indicator or, in the case of the automatic radio compass, by a bearing indicator. Aural null procedures being important in certain cases of malfunctioning of this equipment, the student pilot should be acquainted with the principles of aural null direction finding and/or homing.

b. The signals emitted by any radio station may be used with these radio compasses and direction finders, provided the frequency of the stations is within the frequency bands covered by the receiver. It should be noted however, that the frequencies beyond 1000 kcs are not as satisfactory for radio direction finding as the lower frequencies used by the established navigational facilities. For short distance homing all radio stations can probably be used unless severe interference is present.

c. The navigator is primarily concerned with the use of this equipment for direction finding. A discussion of radio navigational direction finding is beyond the scope of this text and personnel interested in this phase are referred to applicable technical orders and existing texts on air navigation. The employment of the left/right indicator, the aural null, and the use of the automatic radio compass for homing and to fix lines of position can be demonstrated and practiced in the Instrument Trainer.

2. LEFT/RIGHT RADIO COMPASS.

The left right type of radio compass employs the fixed or rotatable loop antenna. Care must be exercised when turning to a commercial broadcasting station to make certain that the desired station is received. Due to the infrequent announcement of the station identification it may often be impracticable to wait for the station announcement. With the fixed loop, if the position of the aircraft relative to the radio station is not known, the sensitivity of the set is turned to maximum. A slow turn to the right is now executed. The turn will be continued until the needle of the indicator swings from full right deflection back to zero. The aircraft will then be headed toward the station, and a turn now made toward the right will result in a deflection toward the left and vice versa. If the needle *follows* the turn, the aircraft is *headed away* from the station.

a. The pilot may then determine the direction toward the station by referring to the directional gyro or to the magnetic compass. The radio compass will not keep the aircraft on a beam, nor will it keep the ship on a straight course toward the station. Drift will become apparent by comparing the indications of the left/right indicator with the compass. Drift may be compensated for by holding heading off to one side or the other of the station.

b. To offset drift determine the wind drift by noting the change in magnetic compass (or directional gyro) reading over a period of time, while homing with the radio compass. A decreasing magnetic bearing indicates a wind from the left. An increasing magnetic bearing indicates a wind from the right.

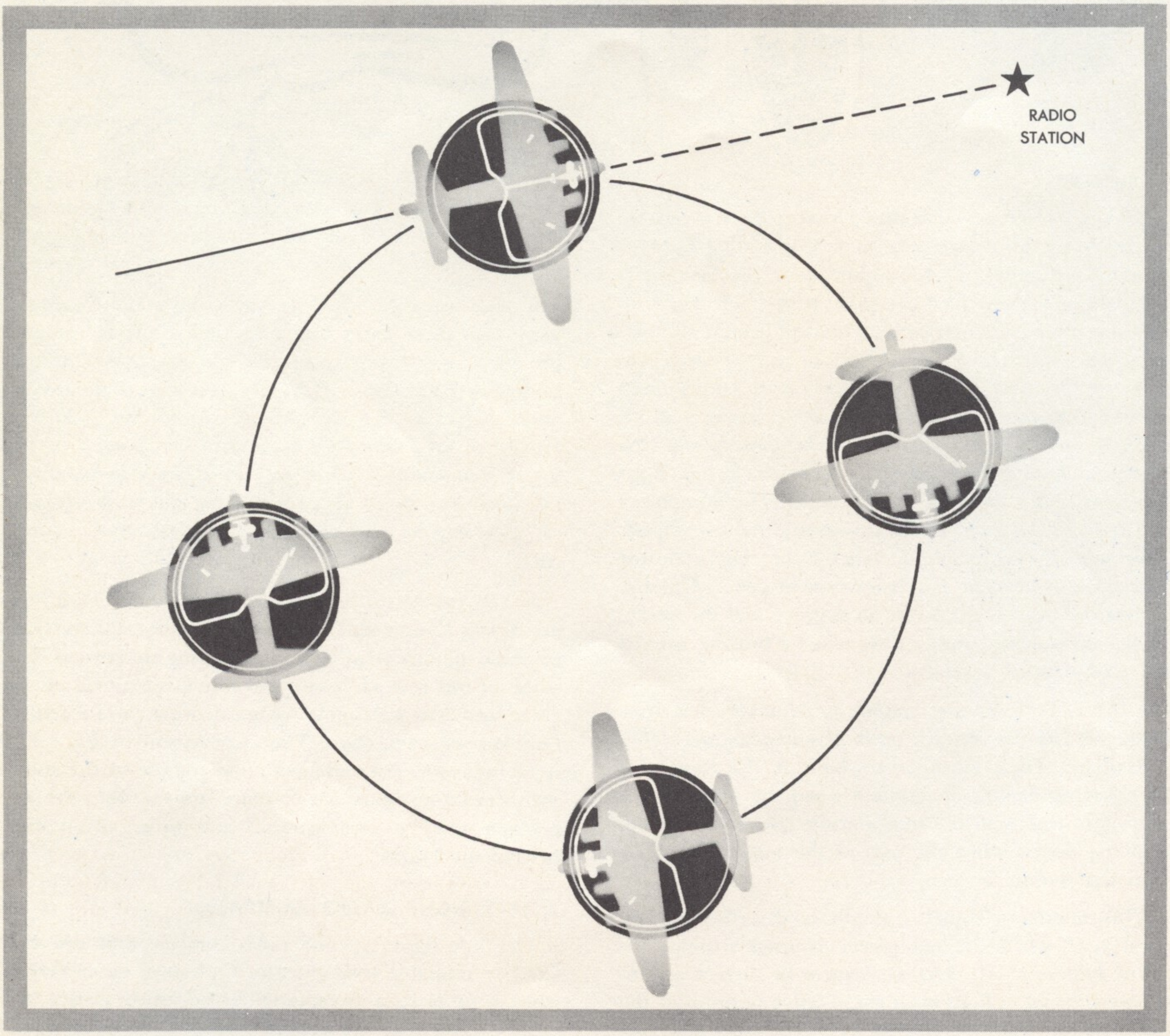


Figure 43—Indications of L/R Indicator

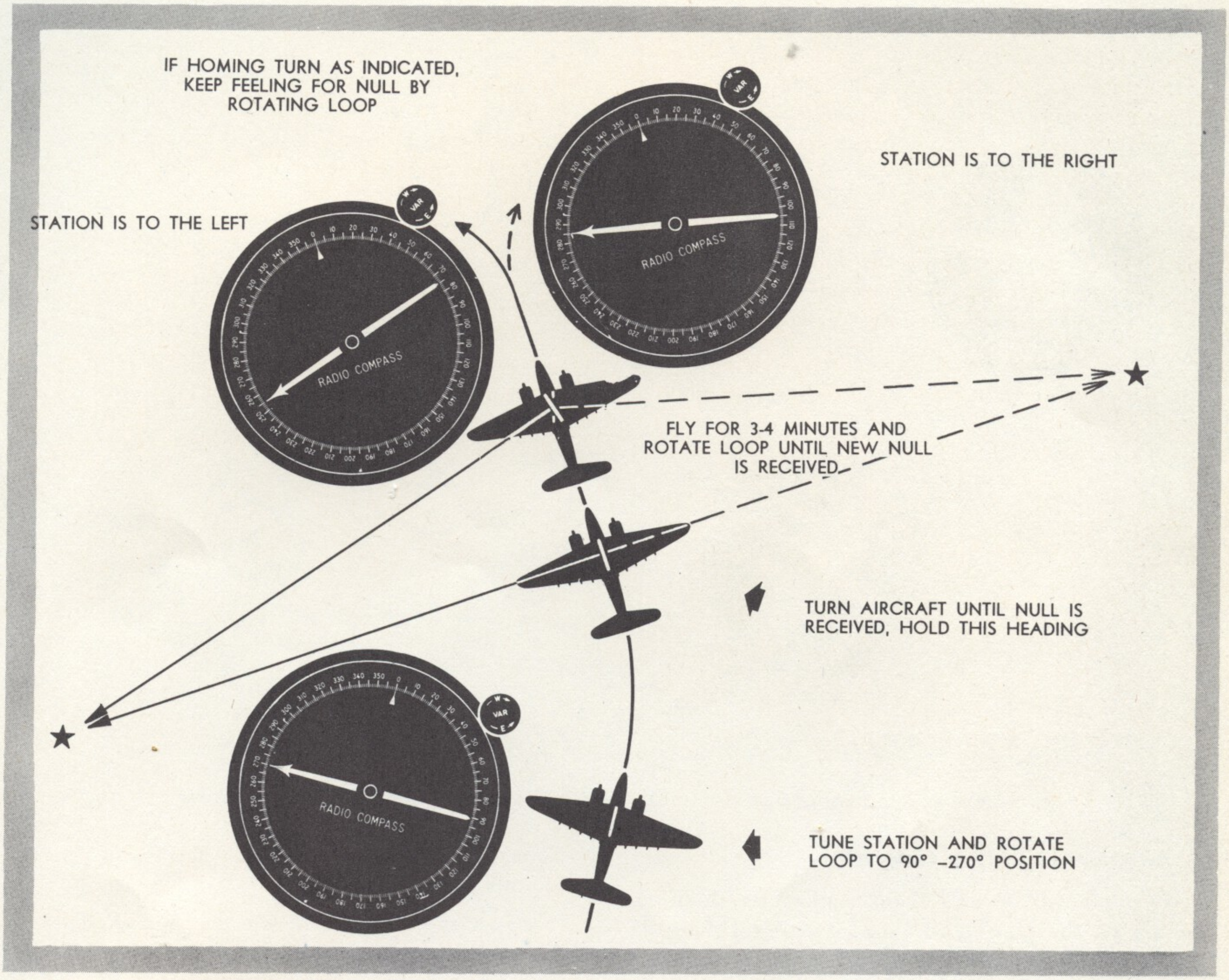


Figure 44—Wing-tip Null Procedure

3. ROTATABLE LOOP RADIO COMPASS.

These radio sets are an improvement over the fixed loop type radio compass in that they allow the taking of bearings without changing the heading of the aircraft. When a rotatable loop radio compass is used as an aural null direction finding device, a standard procedure must be followed to determine the direction toward the station.

The term aural null describes the minimum signal strength received when the loop is rotated so that the pointer on its dial is in line with the station to which the set is tuned.

Wing tip null procedure. The pilot tunes in to the station (which may be either a radio range or other radio station) on the receiving antenna and identifies it.

He switches to the loop antenna and rotates the loop until the pointer on the dial is parallel to the wings of his aircraft (on either 90° or 270° on the azimuth scale).

The pilot listens carefully to the signals received and turns slowly either way until the signal dies out. He now knows the station is either directly to his right or to his left.

A straight course is held on the D/G until the null is passed and the signal becomes fairly strong; the null is now relocated by rotating the loop. In the case illustrated the second null occurs when the pointer was removed toward the left rear of the aircraft, and the pilot knows that the station is behind him and to the left. After locating the station the pilot rotates the loop to homing position; that is, he lines up the indicator needle with the longitudinal axis of the aircraft (0° on the azimuth scale), and turns left until the null is again received. The station will now be directly ahead.

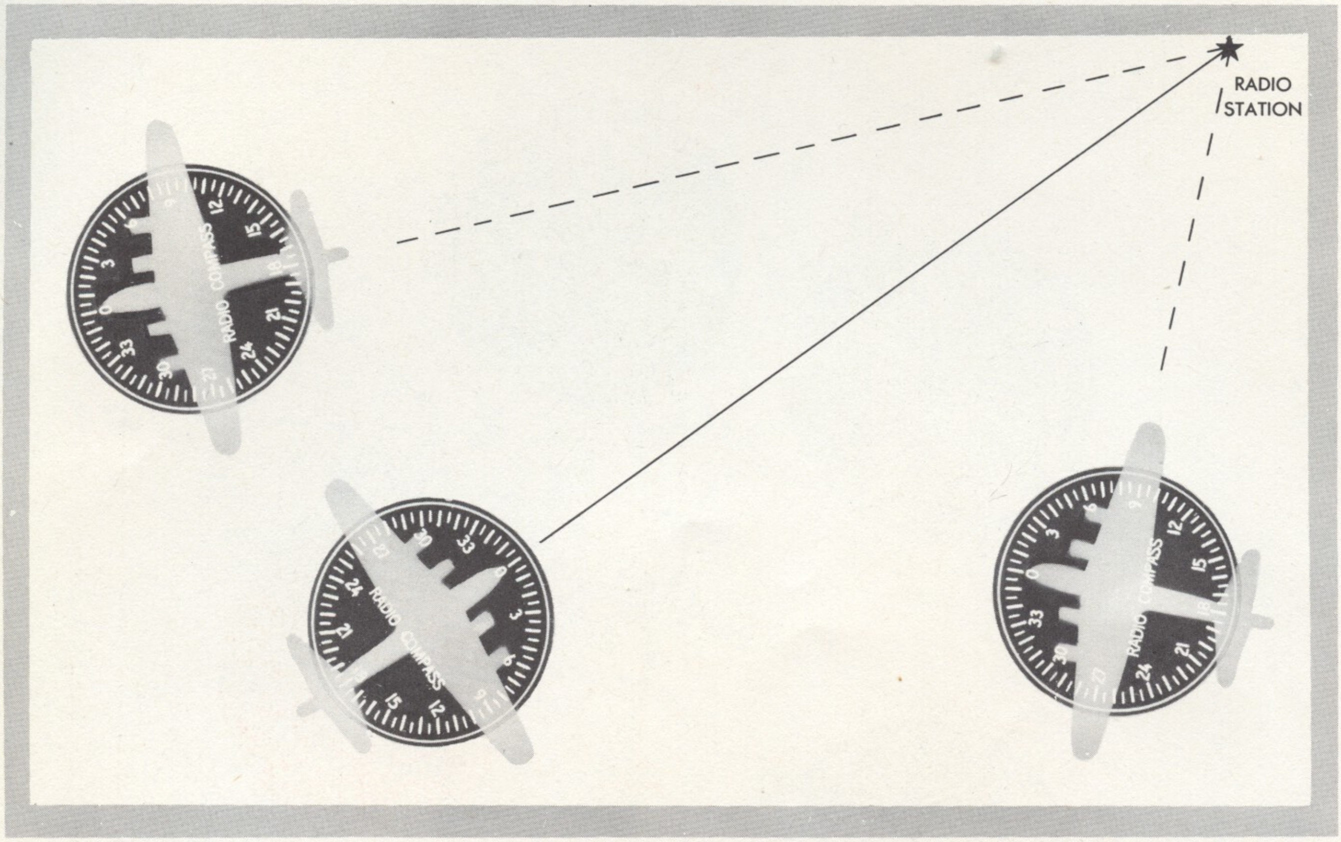


Figure 45—Indications of Automatic Radio Compass. Pilot's Bearing Indicator

4. AUTOMATIC RADIO COMPASS.

When tuned to any radio station the indicator pointer on the pilot's instrument panel will point directly toward the station. It is not subject to the 180° ambiguity, and no calculations are necessary to orientate. The pilot simply turns in the direction requiring the shortest turn until the pointer indicates that the station is directly ahead, that is, the pointer of the indicator points to zero on the azimuth scale. Drift may be corrected for by noting the change in magnetic compass reading, as in paragraph 2, *b,* above.

a. The automatic radio compass is affected by the peculiarities of radio waves as are all radio receivers. If in doubt about any indication, tune to another station as a cross check. Slight fluctuations of the needle are not unusual. For instance, a slight pulsation of the needle will be noted, synchronized with the A and N, when tuned to a radio range station.

b. Holding procedures with ARC. A holding procedure, when required, must be executed as previously described. The ARC simplifies the procedure considerably, because the pointer always shows the direction to the station, and only the position relative to the leg is determined aurally.

c. Low approaches. Letdowns may be executed where the terrain permits, (where mountains do not prohibit this) with the indications provided by the ARC. The pilot must of course know the distance and bearing from the radio station to the airport, and the terrain.

5. TRAINER EXERCISES.

a. THE LEFT/RIGHT RADIO COMPASS.

To operate the left right indicating compass in the Type C-3 trainers, turn on the radio compass switch on the control panel. Rotate the movable dial of the radio compass control on top of the recorder with reference to the fixed pointer thereon, to the figure corresponding to the recorder position on the lines radiating from the radio station on the chart in use. This will keep the movable dial on top of the recorder pointed toward the radio station, without necessitating sighting down the inking wheel. The left/right indicator will point to zero when the trainer is headed toward the station. The operator must continue to vary the movable dial as required by the recorder track.

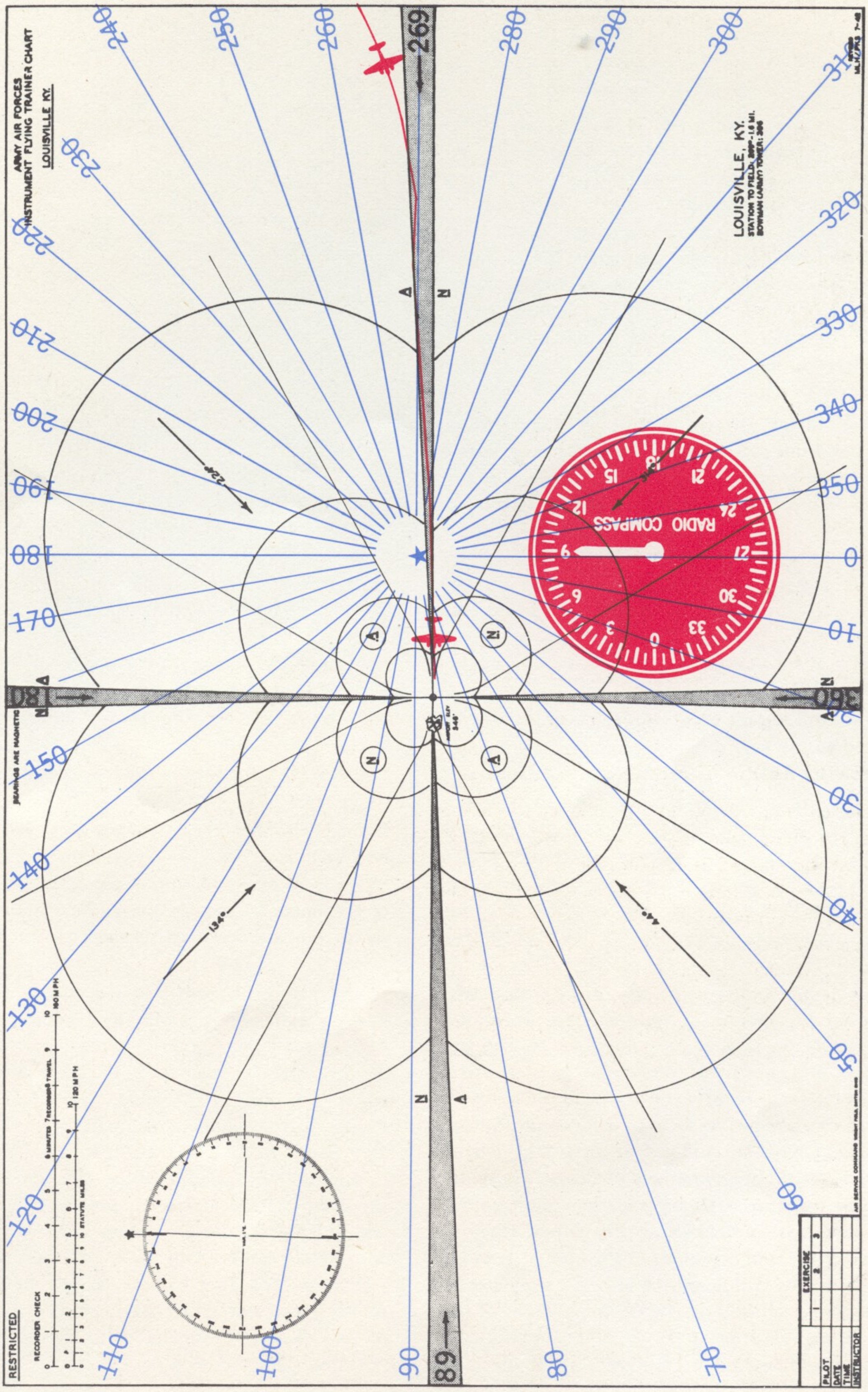


Figure 46—Typical Automatic Radio Compass Exercise

b. THE AUTOMATIC RADIO COMPASS.

(1) The appearance of the Automatic Radio Compass bearing indicator on the instrument panel of the trainer is identical to an aircraft instrument.

(2) The bearing indicated by an aircraft Automatic Radio Compass is a relative bearing. It depends upon the heading of the aircraft as well as on the actual bearing of the radio station with relation to the position of the aircraft. These two variable factors are introduced into the simulated Radio Compass system of the trainer and the result is shown by the pointer of the indicator. The operator provides the bearing from the radio station to the position of the aircraft (recorder) by rotating the knob of the Radio Compass Bearing control.

(3) The only adjustment required is the synchronization of the Pilot's Indicator with the desk Radio Compass Bearing control. To make this adjustment the knob of the Radio Compass Bearing control is rotated until the pointer reads "ZERO." The trainer is then headed North and the driving gear at the base of the spindle is unmeshed. The driving gear is then rotated left or right until the pointer of the Pilot's Radio Compass Indicator reads "ZERO." The driving gear is then replaced.

(4) To operate the automatic radio compass it is only necessary to keep the radio compass bearing control knob pointed to the bearing on the azimuth scale which is the same as the bearing from the recorder to the station. The pilot's indicator pointer will then indicate the relative bearing from the trainer to the radio station. The pointer will be at zero degrees when the trainer is headed directly toward the station. To assist the operator, guide lines marked with the magnetic bearing toward the station are included on the Instrument Trainer Charts.

(5) To demonstrate one of the uses of the ARC, use the Louisville instrument trainer chart. Have the student fly into the station on the east leg of the range. Advise him that if he were flying an aircraft he should switch the automatic radio compass to "COMP" after tuning it to station WHAS. In the trainer this action will be simulated by the student reporting "I have tuned in to WHAS." The instructor will then turn the control of the automatic radio compass to indicate the bearing toward station WHAS, which will be close to 270°. The proper A and N signals of the Louisville radio range are meanwhile continued, because the student will be flying the range aurally on the "Command Set of the aircraft". As the recorder nears a point opposite to WHAS, the automatic radio compass control must be changed toward zero as the track progresses. When the student reads 90° on his indicator (zero on the radio compass control because the trainer is headed due west), he will know that he is directly south of WHAS; thus he has obtained an accurate fix.

(6) In flat terrain, instrument approaches may be made with the automatic radio compass. Using the QDM or Radio Compass Chart, the instructor will advise the student of the bearing and distance of the radio station to the airport. The instructor will operate the automatic radio compass controls as above, and the student will "fly" the following procedure:

Initial approach from any direction, but preferably on or near the heading of the airport to the station. (The reciprocal of the station to airport bearing).

A standard rate turn is made in the shortest direction to reciprocal of station to field course (this is not necessary if the station is intercepted on this heading).

Heading is held while two-third of excess altitude is lost, i.e., if initial approach is made at 4000 feet and final approach over the radio station is to be made at 1000 feet, 2000 feet must be lost on the outbound course. (The pilot must be thoroughly informed of the obstacles in the surrounding terrain.)

A level procedure turn is made to homing heading (0°) on the automatic radio compass. This heading is held on the compass and remaining excess altitude is lost.

When the station is passed, course is changed if necessary, to the gyro heading—the radio station to airport, and altitude is lost to the safe minimum over the airport.

(7) When only one radio station is available, an approximate fix may be determined with the automatic radio compass, while the aircraft passes the station at a distance.

The station is tuned in, identified and the pilot's bearing indicator is noted. The heading of the aircraft is held until the station is directly to the right or left of the aircraft, that is, until the relative bearing is either 90° or 270°. Then, while maintaining this course on the magnetic compass or directional gyro, a 20° change in ARC bearing is timed. This time interval in minutes multiplied by three will equal the time from the radio station at the airspeed at which the aircraft was flown while the 20° change in bearing was obtained. This result can be converted to statute miles with any computer. The approximate fix can be determined by plotting the last ARC bearing on a chart and laying off the distance from the radio station on this line of position. (See fig. 48.)

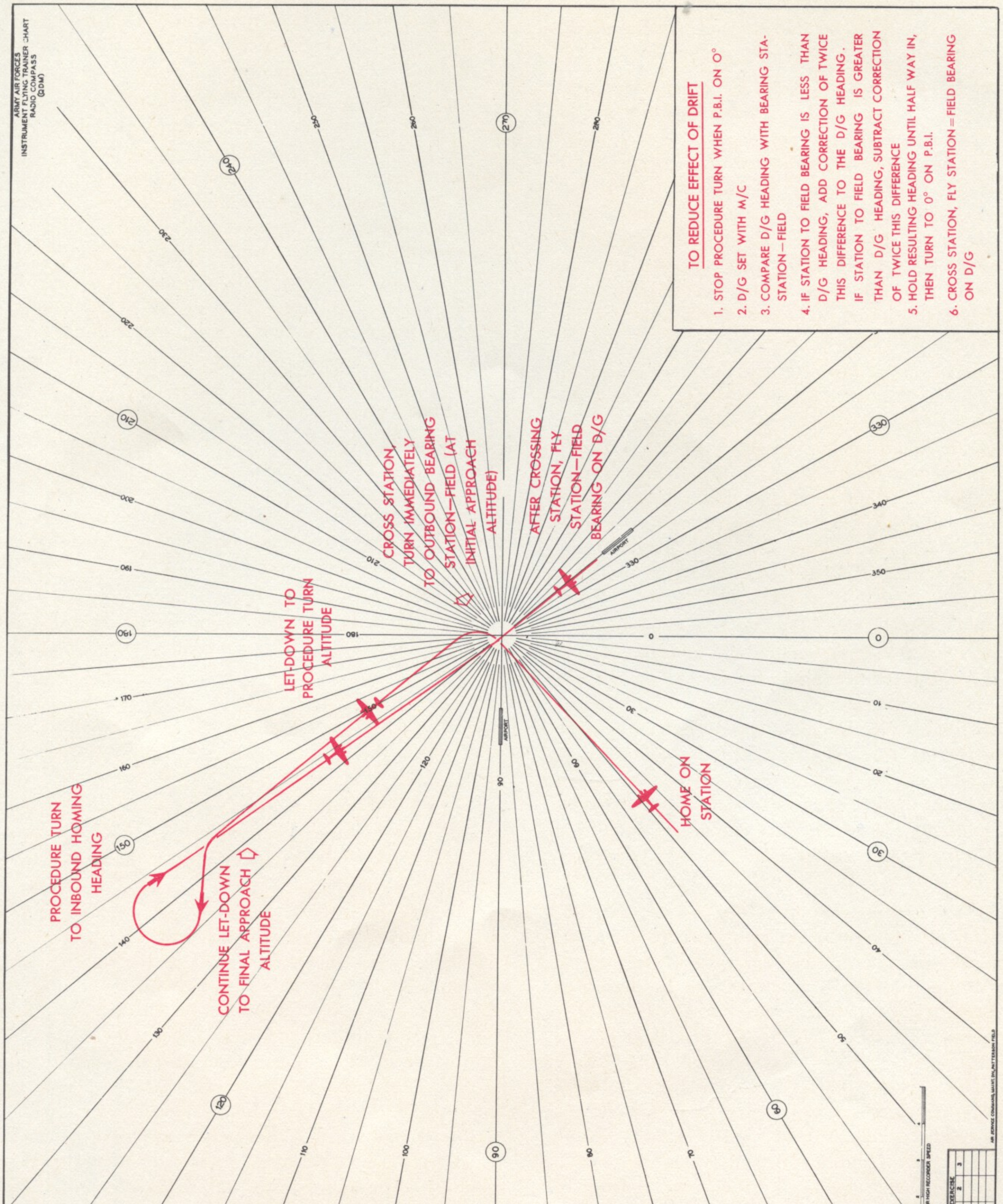


Figure 47—Automatic Radio Compass Instrument Approach

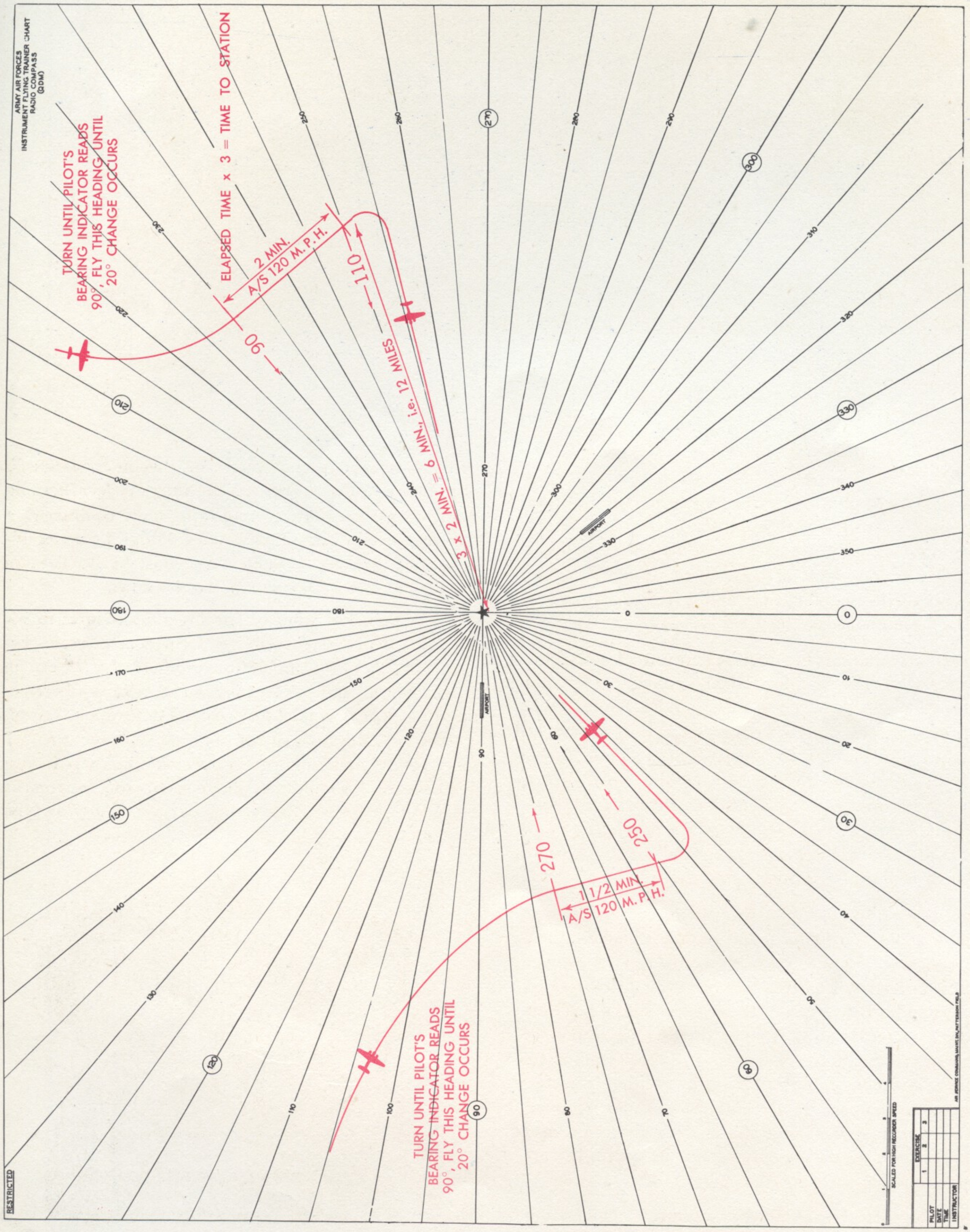
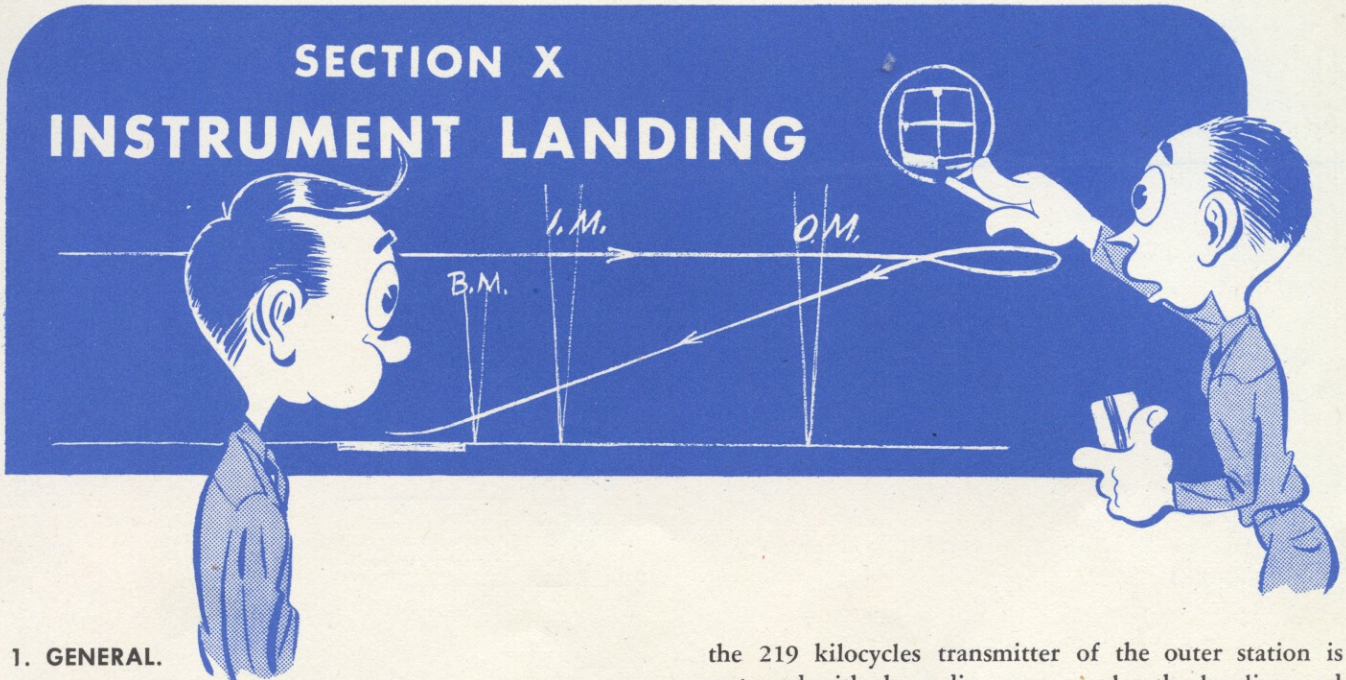


Figure 48—Running "Fix"

SECTION X
INSTRUMENT LANDING



1. GENERAL.

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 British Standard Beam Approach System, also known as the Lorenz, renders let-downs to minimum ceilings of 100-foot practical.

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 100-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 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 Army Air Forces Runway Localizer employs the components of the Modified A-1 System, excepting that the 219 kilocycles transmitter of the outer station is *not* used with the radio compass, plus the localizer and a final clearance marker. Additional radio equipment to receive the localizer signals and a Pilot's Localizer Indicator to give visual indications must be installed in the aircraft before the system can be flown.

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. An Instrument Trainer Chart entitled "Standard Beam Approach and Controlled Descent Through Clouds" scaled for the high recorder speed of the type C-3 and later type Instrument Trainers is also available and should be obtained by the instrument trainer departments instructing personnel in this type of landing.

2. THE MODIFIED A-1 SYSTEM.

a. GENERAL DESCRIPTION. — This 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. If visual contact conditions do not prevail at this minimum altitude, the pilot must commence an immediate climb to the initial approach altitude.

The ground installations for this system consist of a pair of compass locator transmitters, each equipped with a UHF 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.

b. INNER 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 Ultra High Frequency marker beacon signal on 75 megacycles is keyed to transmit six dashes per second in a vertical fan-shaped pattern.

c. OUTER STATION.—This unit is placed 3.5 miles from the Inner Station in a straight line: Runway, Inner Station, and Outer Station. The compass locator transmitter emits its signal, tone modulated at 1100 cycles, on 219 kilocycles. The UHF marker beacon signal on 75 megacycles is keyed to transmit two dashes per second in a vertical fan-shaped pattern.

o. AIRCRAFT EQUIPMENT.—The 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.

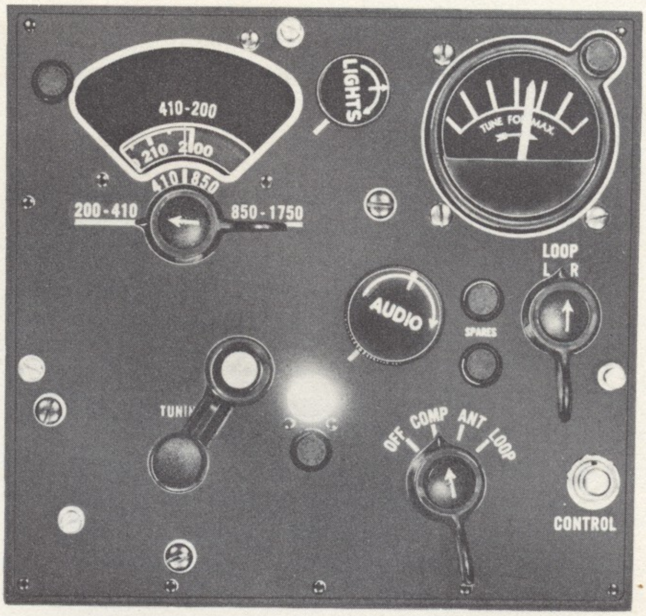


Figure 49—Automatic Radio Compass Control Box

e. AUTOMATIC RADIO COMPASS OPERATION. *(See figure 49.)*

(1) Radio control box switch to "COMP."

(2) Push "Control" switch to operate green light.

(3) "Band Switch" to 200-410.

(4) 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.

(5) Adjust "Audio" for satisfactory head-set level.

(6) The Pilot's Indicator (figure 50) will indicate "ZERO" whenever the aircraft is headed directly toward the radio transmitting station. If the station is to

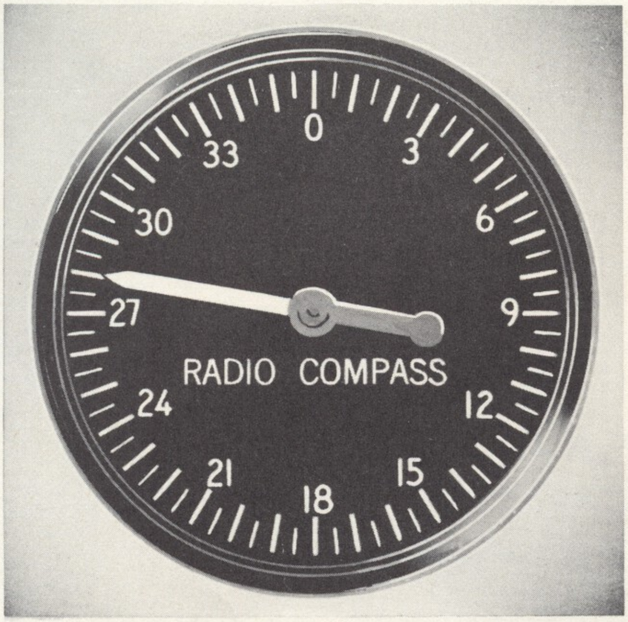


Figure 50—Pilot's Bearing Indicator

one side or the 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).

f. THE COMPLETE FLIGHT PROCEDURE. *(See figure 51.)*

(1) 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 Inner Station. Before the Inner 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 Inner 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.

(2) 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 now be homing on the Outer Station. The accuracy at which the remainder of the problem is flown will largely depend upon the rapid tuning to the Outer Station. The pilot must beware of turn tightening which may result if he tries to regain time lost in tuning to the Outer Station.

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

(4) When the Outer Station is crossed as indicated by the 180-degree swing of the ARC 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 ARC indicator should both read "ZERO." If this is not the case the pointer of the ARC must be flown toward the Outer Station.

(5) 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 Station crossed at that altitude.

(6) Immediately upon crossing the Outer Station, the radio compass is again tuned to 201 kilocycles (the Inner 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 Inner Station must be crossed at an altitude of between 200 and 250 feet above the level of the airport.

(7) After the Inner Station is passed the gyro heading of zero degrees and the rate of descent is held until 100 feet is reached. The airport should now be visible, and the aircraft should be in position to land contact straight ahead. The directional gyro heading, not the indications of the automatic radio compass, must be flown after the Inner Station is passed. If the Inner Station is reached at too high an altitude, an immediate climb must be made and the entire procedure repeated. A new clearance must be obtained in this case.

g. ADDITIONAL NOTES.

(1) 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 condi-

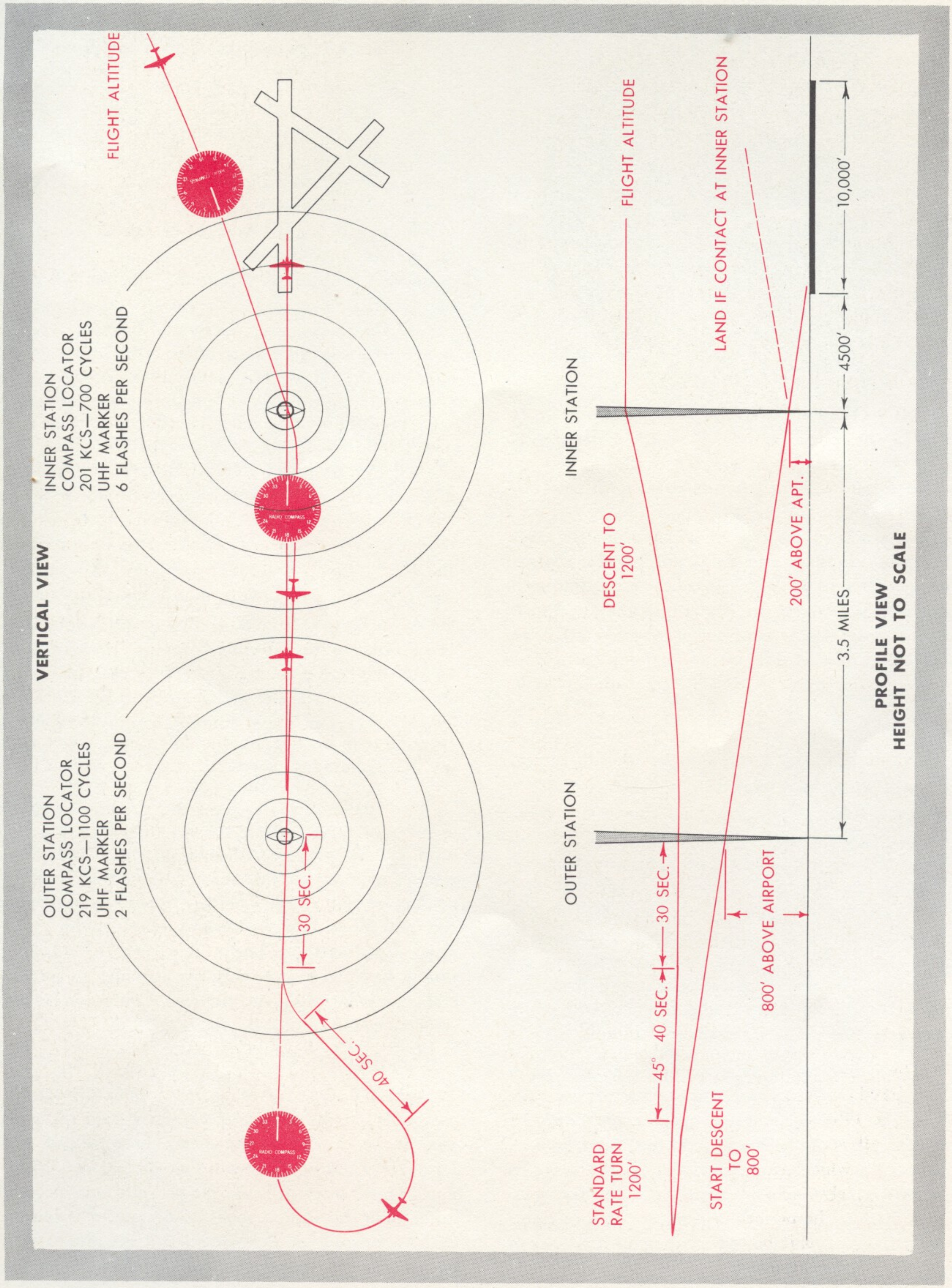


Figure 51—Complete Flight Procedure; Modified A-1 System

tion should be established before the Outer Marker is crossed.

(2) 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.

(3) If, on the initial approach, the Inner Station is reached at a heading close to that to be flown toward the Outer Station, the problem becomes much simpler because no excessive turning will be necessary when tuned to the Outer Station. The initial approach can, with the automatic radio compass, be planned so as to reach the Inner Station on an "easy approach heading."

3. THE RUNWAY LOCALIZER SYSTEM.

a. GENERAL DESCRIPTION.—The addition of the Localizer to the above described Modified A-1 System provides the pilot with an accurate indication of the alignment of the flight path of the aircraft with the runway. The radio compass locator transmitter of the Inner Station is used as in the case of the Modified A-1 System. After passing over the Inner Station the flight is conducted by reference to the Localizer indications, not by tuning the ARC to the Outer Station. The UHF marker beacon indicator flashes when the aircraft passes over the Outer Station and, on the final approach, when the Inner Station is again 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.

b. LOCALIZER.

(1) 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.

(2) 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.

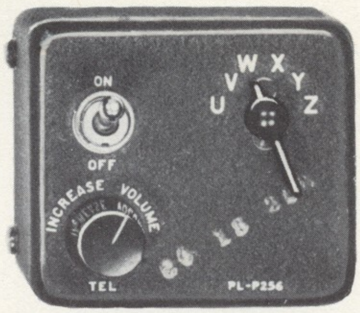


Figure 52—Runway Localizer Control Box

c. AIRCRAFT RECEIVER.

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 52.) 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 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 53) 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, 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:

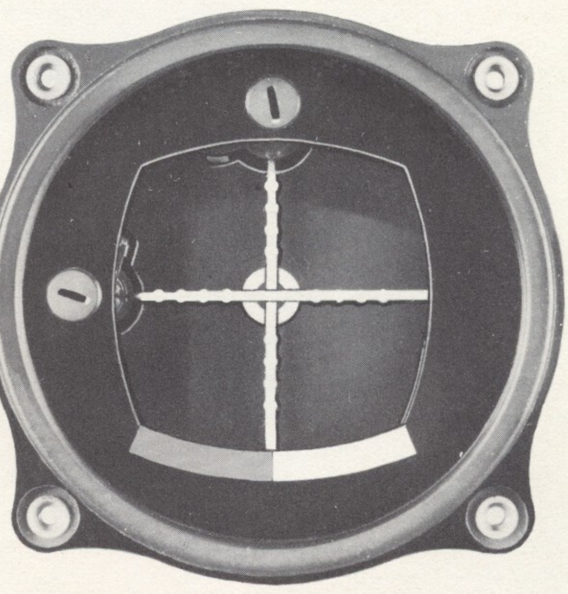


Figure 53—Pilot's Localizer Indicator

tion should be established before the Outer Marker is crossed.

(2) 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.

(3) If, on the initial approach, the Inner Station is reached at a heading close to that to be flown toward the Outer Station, the problem becomes much simpler because no excessive turning will be necessary when tuned to the Outer Station. The initial approach can, with the automatic radio compass, be planned so as to reach the Inner Station on an "easy approach heading."

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(2) 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.

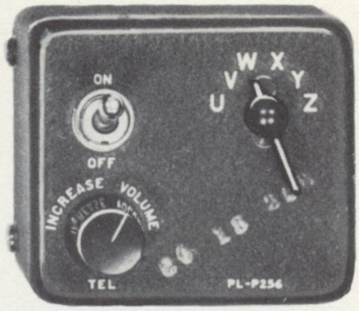


Figure 52—Runway Localizer Control Box

c. AIRCRAFT RECEIVER.

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 52.) 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 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 53) 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, 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:

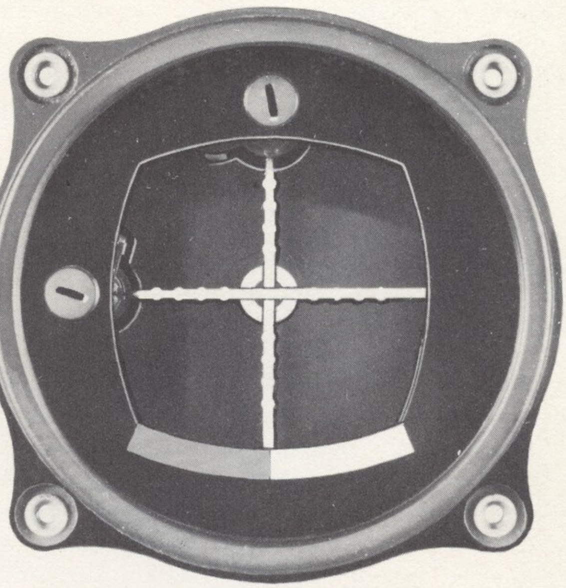


Figure 53—Pilot's Localizer Indicator

(1) When the aircraft is flying on the front beam of 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.

(2) 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.

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

(4) The blue area is on the right of the aircraft when the aircraft is headed *toward the runway on the front beam.* (See figure 54.) 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.

(5) 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.

(6) 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.

d. FINAL APPROACH CLEARANCE MARKER.—An additional UHF 75 megacycle marker is installed 200 feet from the down-wind end of the runway to make the installation complete. This marker is unkeyed and causes the marker beacon light on the instrument panel to light up as the aircraft passes over the transmitter, thus providing a final "Stand-by for Landing" indication.

e. THE RUNWAY LOCALIZER PROCEDURE. *(See figure 55.)*

(1) 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. After having set the altimeter, and being cleared to land, the pilot will set course from the cone of the radio range to the Inner Station.

(2) The approach to the Inner Station is the same as that for the Modified A-1 System. Thereafter, the system varies only in that no further reference to the automatic radio compass is made, the Localizer furnishing on-course indications. After the Inner Station is passed, the localizer indicator needle is flown. On the outbound heading the needle will point to the correct color areas, but sensing will appear to be reversed as explained above. 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."

(3) The heading at which the localizer indicator needle remains within one-quarter scale of center should be established, then the gyro may be reset to 180 degrees. Descent to 1200 feet above the level of the airport is made between the Inner Station and the "Outer Marker," if this altitude was not reached between the radio range and the Inner Station. When the Outer Station Marker Beacon indication is received, course is maintained for 30 seconds. Then the procedure turn is made as for the Modified A-1 System.

(4) 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 Station crossed at that altitude.

(5) 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 Inner Station and the runway are approached. All major corrections to course must be made before the "Inner Marker" is reached.

(6) The altitudes over the "Outer" and "Inner" marker must be 800 feet and 200 to 250 respectively.

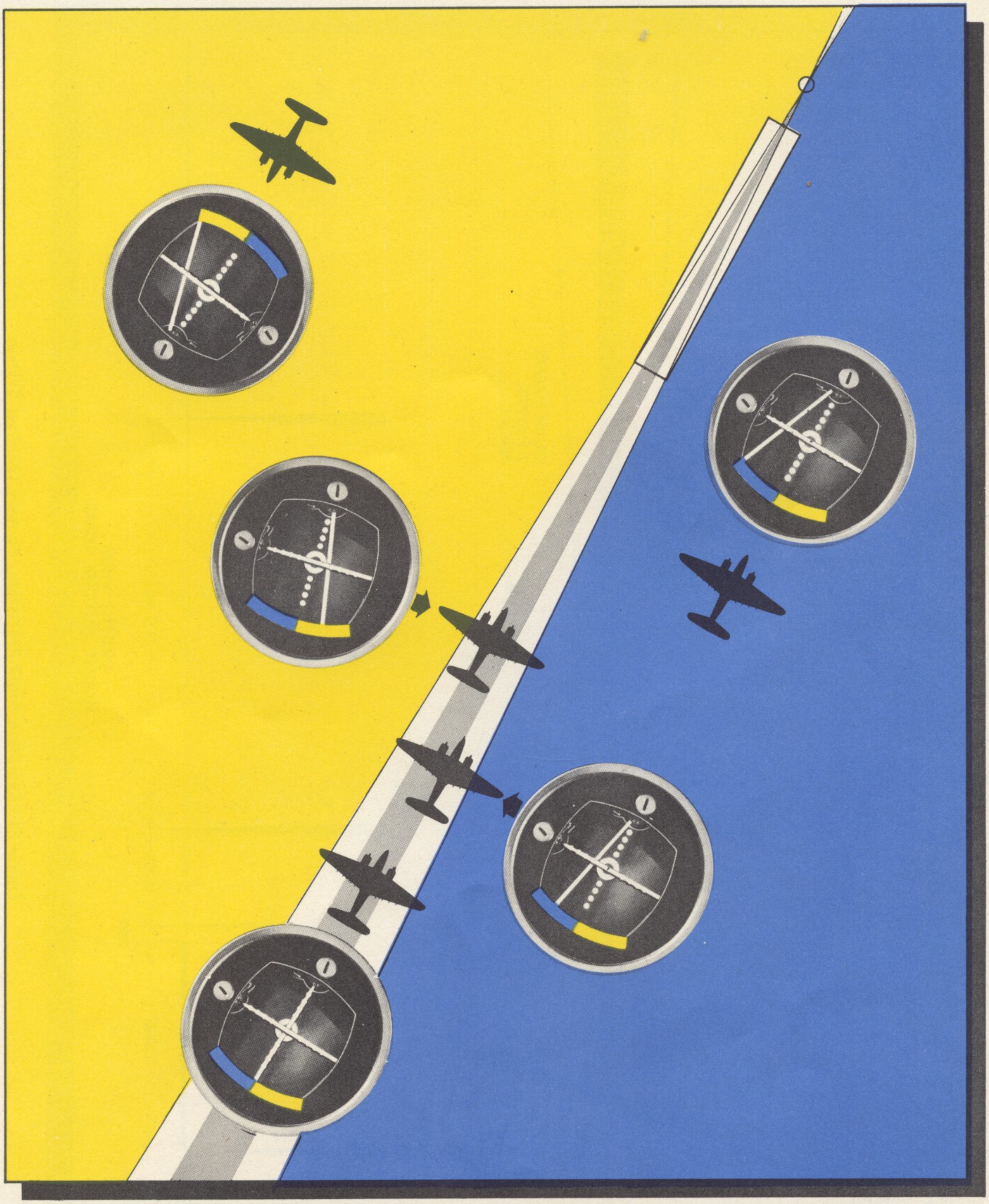


Figure 54—Localizer Indicator Needle Action

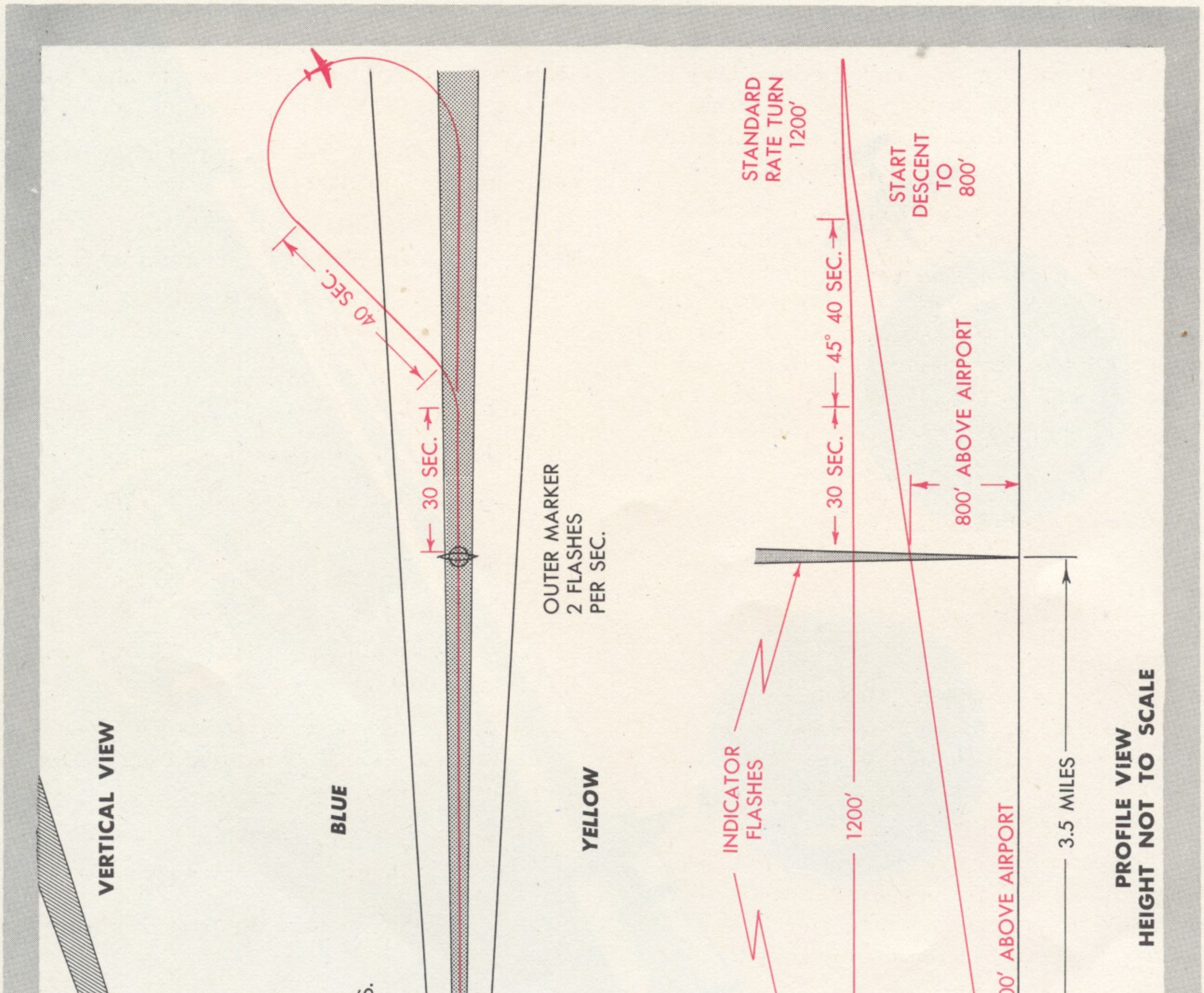


Figure 55—Complete Flight Procedure, Runway Localizer System

If either marker is intercepted at another altitude the procedure must be repeated. The boundary or final clearance marker will cause the marker beacon lamp to light, indicating the safe landing area is just ahead. Landing must not be anticipated, but the normal descent continued all the way to ground contact.

(7) It will be noted that the descent is established by reference to the sensitive altimeter as in the A-1 System. However, glide path transmitters are being procured and will become available at a later date. The horizontal needle of the localizer indicator will be actuated by the glide path transmitter when this equipment is placed into operation. This Technical Order will be revised to include the necessary data at that time.

4. INSTRUMENT TRAINER OPERATION AN-2550-1 (AN-T-18) TRAINER.

a. GENERAL PROCEDURE.

(1) When planning a trainer exercise the procedures will be expained to the student. The Instrument Trainer Chart available for landing exercises includes the data for the Modified A-1 System on one side, while the Runway Localizer is shown on the reverse side. The installations as shown are accurate as to scale for a hypothetical installation.

(2) The appropriate chart will be used to explain the procedure to be flown. The instructor will explain the importance of prompt switching from Inner to Outer Station, the turns to be made, the altitudes, etc., using the foregoing text as an outline. It will be necessary to show the student the functions of the "INNER" and "OUTER" positions on the "Selector" switch, and the "ON-OFF" instrument landing switch.

(3) The student will be requested to enter the trainer and climb to 2000 feet.

b. THE MODIFIED A-1 SYSTEM.—The controls used to simulate the Modified A-1 System are as follows:

(1) INSTRUCTOR'S DESK CONTROLS. *(See figure 56.)*

1 "Master"—"ON."

2 "Keyer"—"ON."

3 "Selector" switch—"ARMY."

4 "Marker Selector" — "INNER," later to "OUTER."

5 "Inst. Land. Marker"—"ON."

6 "Visual Marker"—"ON."

7 "Z-Fan Marker Volume — "O," later to "FULL" as required.

8 "Instrument Landing Marker Volume" — used to simulate distance of recorder from the Inner or Outer Radio Station.

9 "Voice-Range Volume"—about "40."

10 "Circuit Selector"—"RANGE."

11 "Radio Compass Bearing" control (figure 57.)

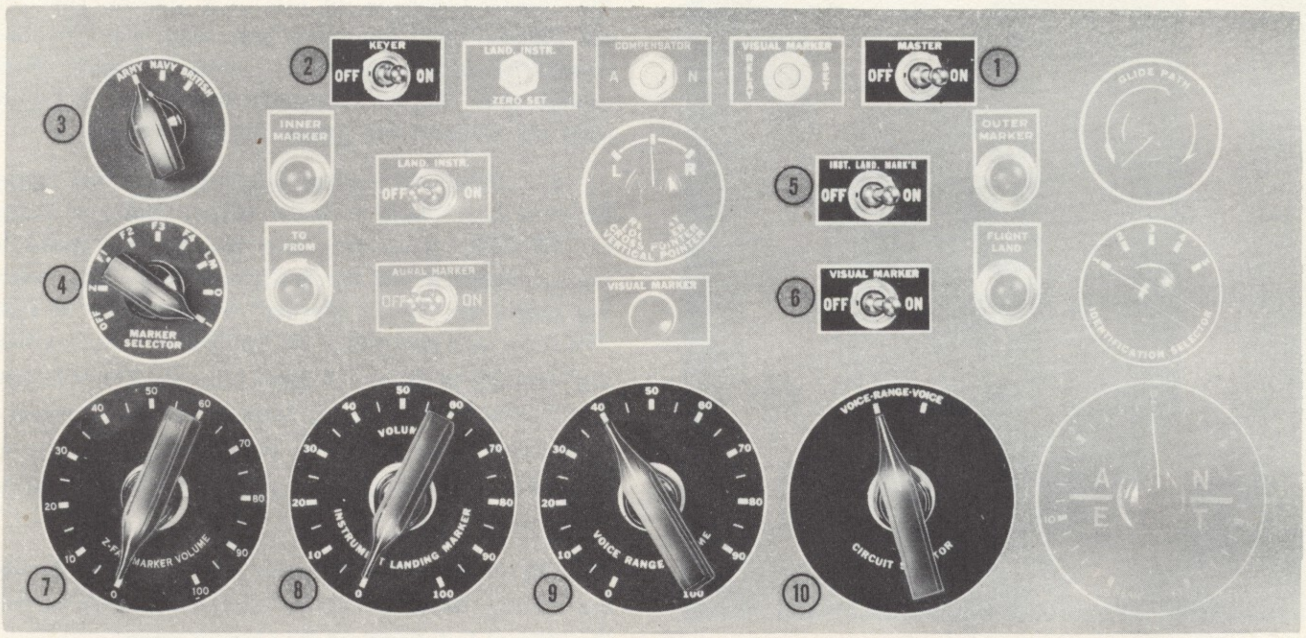


Figure 56—Desk Controls, Modified A-1 System

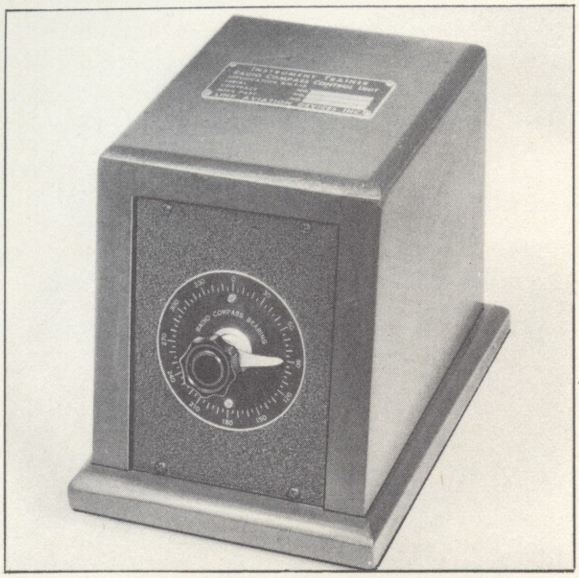


Figure 57—Radio Compass Bearing Control

(2) STUDENT'S TRAINER CONTROL BOX. *(See figure 58.)*

(a) Station Selector switch "INNER" turned to "OUTER" when passing over Inner Station; returned to "INNER" when passing over Outer Station after the procedure turn.

(b) Radio Volume Control turned to comfortable level, reduce volume as the aircraft approaches the station.

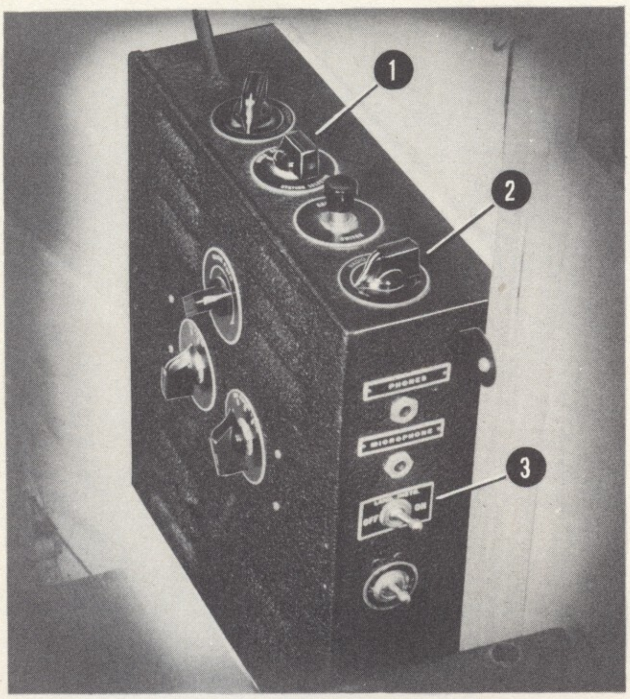


Figure 58—Trainer Control Box

(3) Upon reaching 2000 feet and level flight, the student will call in to the "Trainer Control" and request landing instructions. The instructor will broadcast the altimeter setting and clear the trainer for landing. The recorder, having been previously placed and orientated on the chart, is now started. The student will tune to the Inner Marker transmitter on 201 kilocycles, causing the "Inner Marker" warning light on the control desk to light up. The instructor now turns the Automatic Radio Compass control to the position on the azimuth scale corresponding to the position of the recorder on the radial lines from the Inner Station. For the trainer equipped with the automatic radio compass the instructor will use the outer and larger figures on the radial guide lines printed on the chart. (See figure 59.)

(4) As the recorder crosses the radial lines the Radio Compass control is kept adjusted properly for the position indicated. The indicator pointer in the trainer is thus always indicating the bearing toward the station, which will be zero degrees when the trainer is headed directly toward the station.

(5) The student will be flying toward the Inner Station with the indications of the Automatic Radio Compass. "Instrument Landing Marker Volume" control is used to increase the volume of the 700-cycle tone of the "Inner Marker" as the recorder nears the station.

(6) As the recorder passes over the Inner Station the "Z-Fan Marker Volume" control is used to flash the "Visual Indicator" of the Inner Station. The "Visual Marker" will begin to flash when the "Volume" control is turned beyond 50. (The instructor should change the "Marker Selector" switch to "OUTER" after the recorder has passed the Inner Station.)

(7) When the student flies over the Inner Station he must immediately turn the station "Selector" switch to "OUTER," thus indicating that he has tuned his radio compass to the Outer Radio Station. This switching causes the "Outer Marker" warning light to light. The instructor now will reset the "Radio Compass Bearing" control to the radial lines from the Outer Station. The "Instrument Landing Marker Volume" control is again used to increase the volume of the 1100-cycle note of the "Outer Marker" as the recorder approaches that station.

(8) As the recorder passes over the Outer Station, the "Z-Fan Marker Volume" control is used to flash the "Visual Indicator" of the Outer Station.

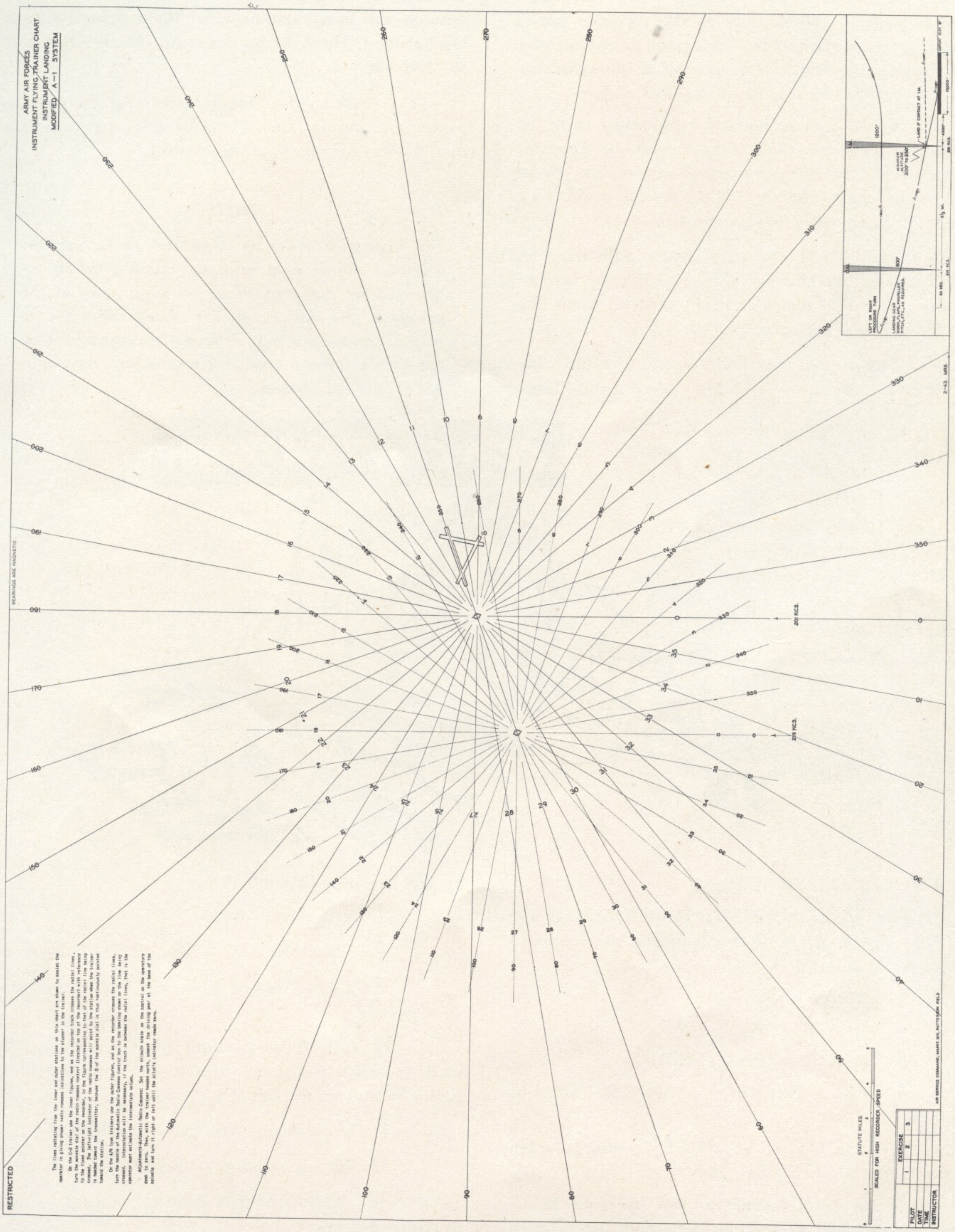


Figure 59—Instrument Trainer Chart, Modified A-1 System

(9) The instructor will turn the "Radio Compass Bearing" control 180 degrees as the recorder passes directly over the station. No ambiguity in the reading of the pilot's indicator will be present if the instructor properly controls the Automatic Radio Compass.

(10) As the student makes his procedure turn, the "Radio Compass Bearing" control must be kept set to agree with the outer figures shown on the radial lines on the chart, and the Pilot's Indicator will then always accurately point toward the station.

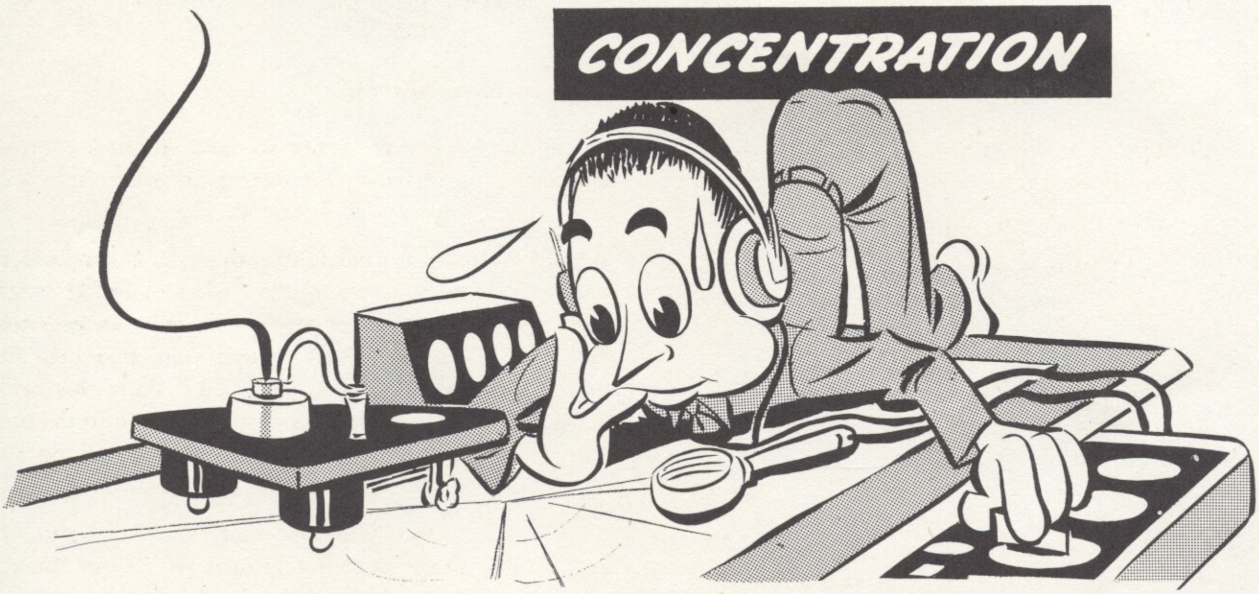
(11) The "Marker Selector" switch still being on "OUTER," the operator will flash the light by increasing the "Z-Fan Marker Volume" control when the recorder passes the Outer Station.

(12) The student must immediately turn the "Station Selector" switch to "INNER," causing the "Inner Marker" warning to light. The instructor will then simulate the Inner Station with "Radio Compass Bearing" control. He will also turn the "Marker Selector" to "INNER."

(13) Flashing the "Inner Marker" as the recorder passes the station, the instructor must again reverse the "Radio Compass Bearing" control.

NOTE

The instructor must be prepared to furnish the weather report and altimeter setting when requested by the student at the beginning of the problem. He must set the desk altimeter to this altimeter setting. Altitude changes will be marked on the recorder track as the new altitude level is reached.



c. THE LOCALIZER SYSTEM.

(1) INSTRUCTOR'S DESK CONTROLS. (See figure 60.)—The controls used to simulate the Localizer System are as follows:

1 "Master"—"ON."

2 "Keyer"—"ON."

3 "Selector" switch—"ARMY."

4 "Marker Selector" — "INNER," later to "OUTER."

5 "Land. Instr." — "OFF," until recorder reaches "Inner Marker," then "ON."

6 Runway Localizer control operated as required to simulate blue-yellow deflection, after Inner Station has been passed.

7 "Inst. Land. Marker"—"ON."

8 "Visual Marker"—"ON."

9 "Z-Fan Marker Volume"—"O," later used as required.

10 "Instrument Landing Marker Volume" — used to simulate distance of recorder from the Inner Radio Station on the initial approach.

11 "Voice-Range Volume"—about "40."

12 "Circuit Selector"—"RANGE."

13 "Radio Compass Bearing" control — used as outlined below.

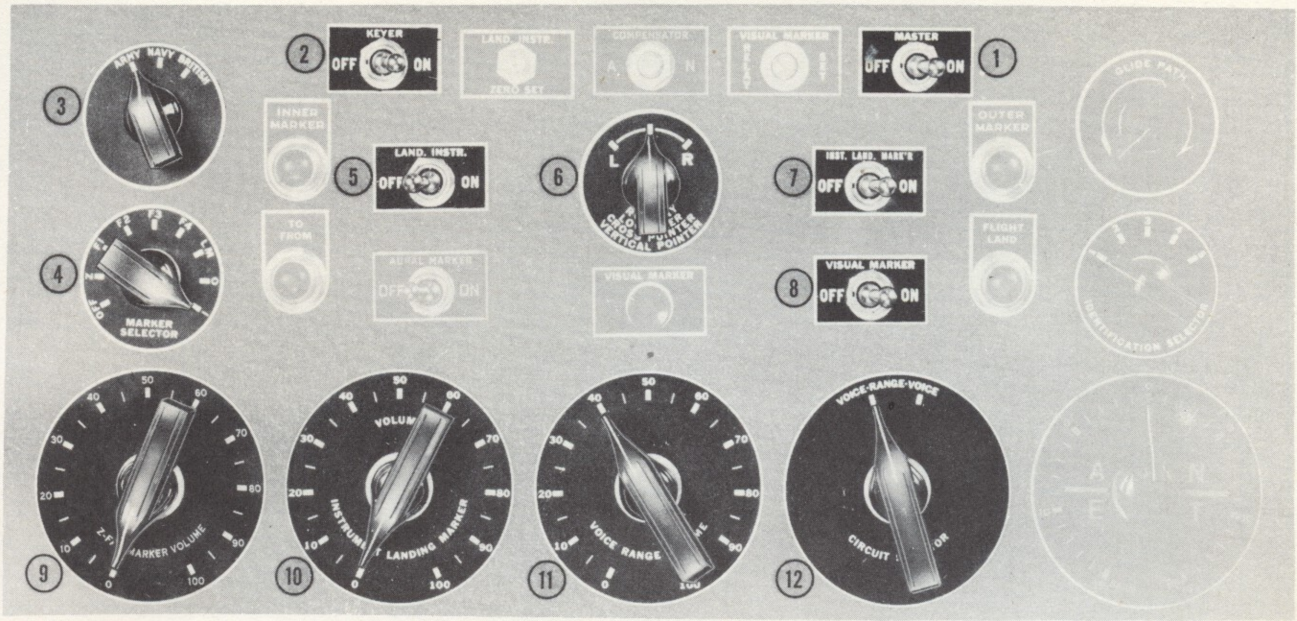


Figure 60—Desk Controls, Runway Localizer System

(2) STUDENT'S TRAINER CONTROL BOX. *(See figure 58.)*

1 Station "Selector" switch "INNER," later switched to "OUTER."

2 Radio "Volume" control to comfortable level.

3 Instrument landing switch "ON" when the aircraft has reached the Inner Marker Station.

(3) Recorder is placed on the Runway Localizer Chart, about 10 to 15 miles from the Inner Station. (See figure 61.) When the student levels off at 2000 feet the recorder is started and the "Radio Compass Bearing" control set to coincide with the position of the recorder inking wheel on the radial lines of the "Inner Marker" radio station. Use the large outer figures shown on the AAF Instrument Trainer Charts. Keep the radio compass constantly orientated.

(4) Student will fly to the Inner Station with the automatic radio compass. "Instrument Landing Marker Volume" control is used to increase the volume of the 700-cycle tone of the "Inner Marker" as the recorder nears the station.

(5) As the recorder passes over the Inner Station the "Z-Fan Marker Volume" control is used to flash the Visual Indicator of the Inner Station. The "Visual Marker" will begin to flash when the "Volume" control is turned beyond 50. (The instructor should change the "Marker Selector Switch" to "OUTER" after the recorder has passed the Inner Station. The desk controls which must be varied by the instructor as the flight progresses are shown under figure 62.

(6) When the student flies over the Inner Station, that is, when he is receiving the dashes of the 75 megacycle marker of the Inner Station, he must immediately turn on the "Land. Instr." switch, and also turn the station "Selector" switch to "OUTER." From this point on, the Automatic Radio Compass is not used in the procedure, directional indications being provided by the Pilot's Localizer Indicator.

(7) When the "Outer Marker" warning lights up, the operator must immediately turn the "Land. Instr." switch to "ON," and give the localizer indication according to the position of the recorder with reference to the localizer on-course.

(8) The localizer indications are to be given in accordance with the color and guide lines on the AAF Instrument Landing Charts. The limits of the shaded area of the beam on the chart represent a half scale deflection of the indicator. The outer limiting lines represent full scale deflection. This is indicated by the drawings of the indicator printed on the chart itself.

(9) The student is now flying toward the Outer Marker on the Localizer. The volume of the "Instrument Landing Marker" is reduced to zero since the radio compass is no longer used.

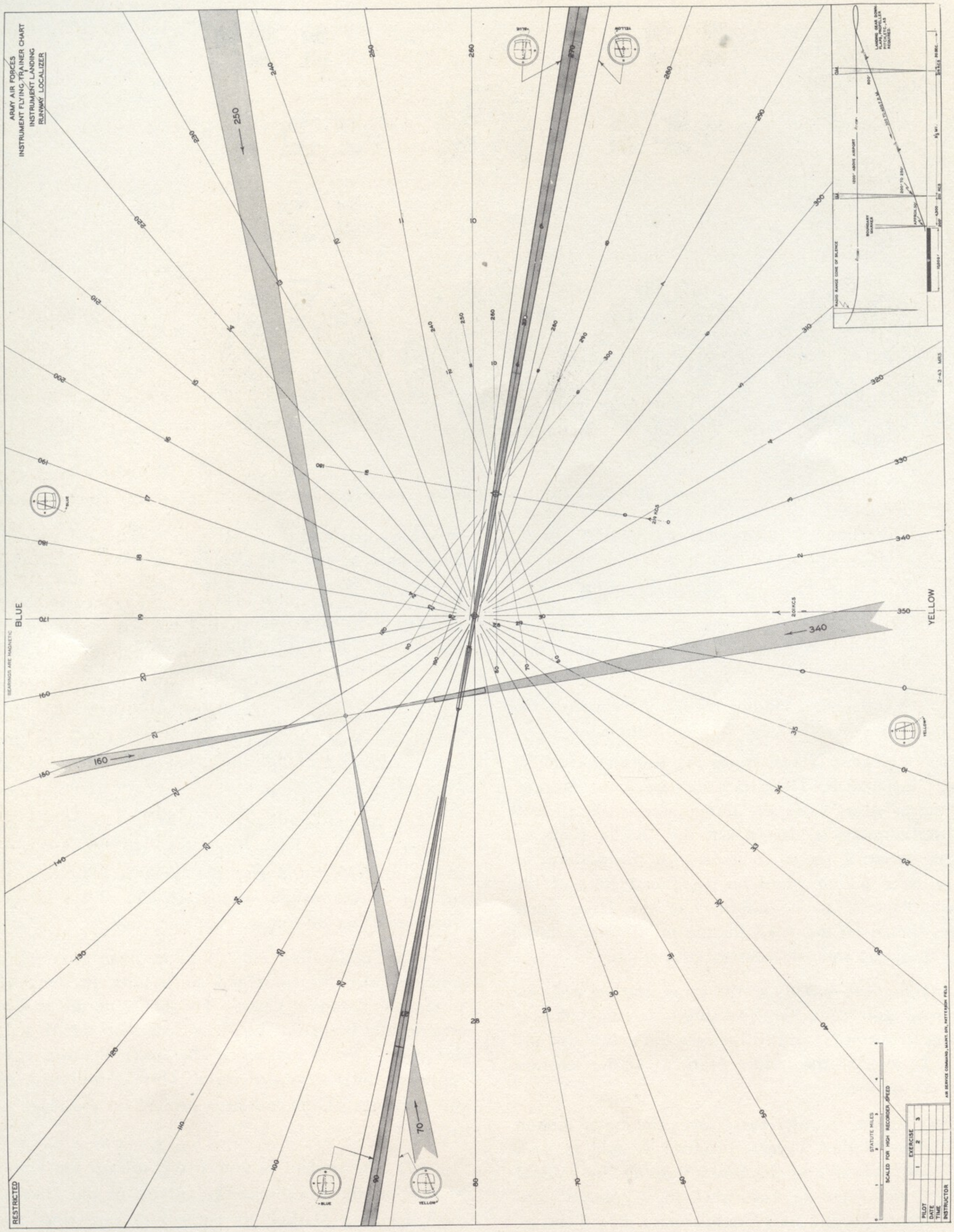


Figure 61—Instrument Trainer Chart, Runway Localizer System

(10) As the recorder passes over the Outer Station the "Z-Fan Marker Volume" control is used to flash the Visual Indicator of the Outer Station.

(11) As the student makes the procedure turn, the instructor must increase the deflection of the localizer needle, depending upon the recorder track.

(12) Upon completion of the procedure turn, the "Outer Marker" is again simulated as the recorder passes over the station.

(13) The student must now immediately turn the station selector switch to "INNER," and the instructor will turn the marker selector to "INNER" as the warning lights up.

(14) Following the new directional indications of the Localizer, the student proceeds toward the Inner Station, losing altitude from 200 to 250 feet as he passes the "Inner Marker." The instructor will give appropriate signal by means of the "Z-Fan Marker Volume" Control.

(15) The final clearance marker will be simulated by depressing the "Visual Marker" push button as the recorder crosses the final clearance marker.

(16) The field elevation altitude should be reached as the recorder track is just within the runway indicated on the charts.

d. THE TRAINER RUNWAY LOCALIZER.

(1) The Runway Localizer Indicator used in the instrument trainer is similar to the localizer indicator installed in aircraft, except that present trainer models do not have the horizontal glide path indicator. The face of the instrument differs somewhat from that of the aircraft instrument. The difference should be pointed out to the student, using the photographs of the aircraft instrument in this Technical Order.

(2) The instrument in the trainer is a zero-center voltmeter, the pointer remaining centered on the scale when no voltage is applied. When a voltage of positive polarity is applied to the plus terminal and a voltage of negative polarity to the minus terminal of the instrument, the pointer will swing to the right. When the polarity is reversed the pointer will swing to the left.

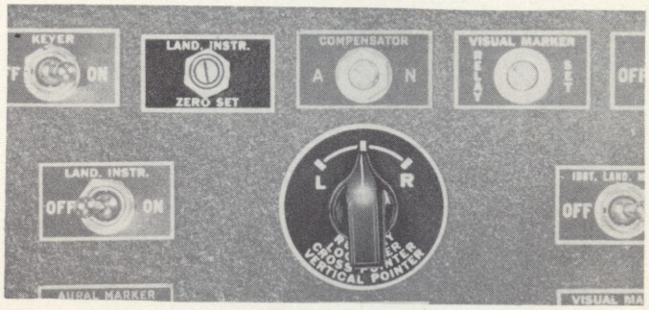


Figure 63—Trainer Localizer Zero Set

(3) The Runway Localizer Indicator is connected to the sliders, or movable tabs, of two potentiometers connected in parallel across a voltage source of approximately 6 volts. One of these potentiometers is equipped with a "Zero Set" to equalize the circuit when the manual control knob of the other potentiometer is centered. As the control knob is moved to the right or left, a positive or negative voltage is applied to the instrument, causing the pointer to move accordingly. The manual control, marked "Runway Localizer," provides the means whereby the instructor may simulate the left/right, blue/yellow, deflection of the Runway Localizer System.

(4) The "Zero Set" must be used to center the needle of the Runway Localizer Indicator while the manual desk control is centered. (See figure 63.)

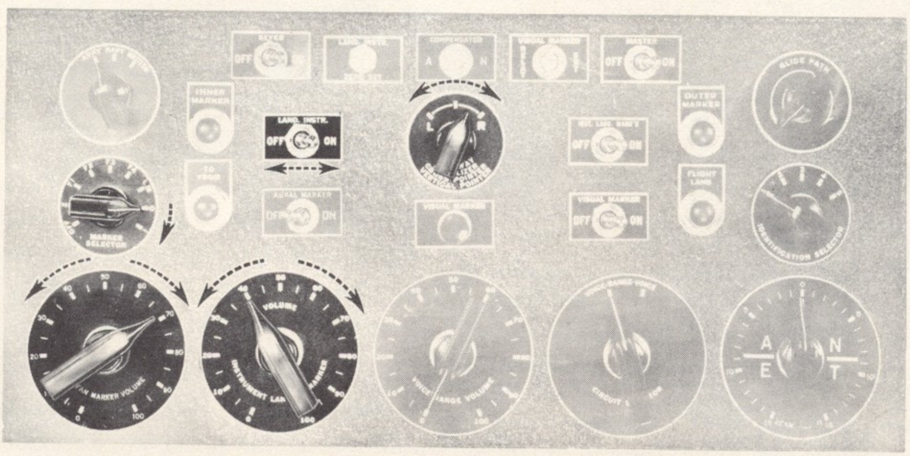


Figure 62—Variable Desk Controls

SECTION XI
RADIO NAVIGATION FLIGHTS

NOTE

Operation of approach control procedures, (THAT IS CONTROL OF INCOMING AIRCRAFT BY THE TOWER ON RANGE FREQUENCY,) temporarily suspended effective May 3, 1943.

1. GENERAL.

The student pilot who has been qualified in the preceding exercises will be ready for navigational flights which may be simulated on the trainer. Complete airway traffic control procedures will be introduced to produce a realistic problem. A description of the "Approach Control" which is being inaugurated at many airports is included here for the instructor's information. A sample trainer exercise on the New York Area Chart, is also furnished in this section. It is intended that this exercise and the phrases under approach control be used by the instructor to set up scenarios for similar exercises. Other Area Charts can be used and the exercises designed to suit the stage of instruction reached by the student.

2. DESCRIPTION OF APPROACH CONTROL.

a. Approach control basically requires that jurisdiction over arriving and departing aircraft at a specified location be delegated from an Airway Traffic Control Center to an Airport Traffic Control Tower operated by the Civil Aeronautics Administration.

b. This delegation of authority is possible wherever the Civil Aeronautics Administration operates an airport traffic control tower and is made practicable through the close coordination between the airway traffic control center and airport traffic control concerned.

c. At airports where approach control is in effect the control tower will operate the voice feature of the adjacent radio range station for all communications with arriving aircraft under all weather conditions. The use of the appropriate radio range voice frequency permits direct communication between the pilot and the airport traffic controller during instrument weather conditions, as well as during contact flight rule weather conditions, and facilitates the issuance of instructions to holding and approaching aircraft, under instrument conditions. At certain designated locations special instrument approach procedures are utilized which reduce the time interval between approaching aircraft from approximately 15 minutes to 5 minutes. These procedures are basically: (a) the holding of aircraft in an approach sequency at a radio fix on the approach leg of the radio range station, (b) the direct communication between the holding aircraft and the airport traffic controller, and (c) straight-in approaches from the holding fix to the airport. Under such conditions succeeding aircraft are authorized to approach at specified time intervals after the preceding aircraft has reported leaving the holding fix on approach to the field.

d. At other locations the radio range station is used as the holding fix for aircraft in an approach sequence. In such cases the time interval between approaching aircraft is longer than when the aircraft are held at a fix on the approach leg since each aircraft must make a complete instrument approach before succeeding aircraft are authorized to start an approach.

e. The pilot has nothing new to learn under these procedures except that direct communication with the controller in the tower will be maintained through the voice channel of the range after receipt of a clearance from the appropriate airway traffic control center authorizing such direct communications, and only this communications channel should be utilized thereafter.

f. Where approach control procedures are in effect under instrument flight rules the aircraft will be cleared to the holding fix (range station or other radio fix), with appropriate holding instructions by the airway traffic control center through appropriate communications facilities. The center will include instructions in the holding clearance for the aircraft to hold "UNTIL FURTHER ADVISED BY THE (Name of Tower) TOWER". This will indicate to the pilot that all subsequent instructions relative to holding, descent, and approach will be issued by the tower on the voice channel of the radio range station, and the pilot is expected to establish communications with the tower on range frequency when he arrives over the specified holding fix. If the radio range station is designated as the holding fix, the pilot is expected to establish communication with the tower on range frequency when approximately 15 miles from the airport. Under contact flight rules the airway traffic control center will clear aircraft to the tower. The pilot is then expected to contact the tower on range frequently when approximately 15 miles from the airport and receive clearance to enter traffic pattern and other necessary information before entering the traffic pattern.

3. COMMUNICATIONS CONTACTS REQUIRED OF THE PILOT.

a. The following communications contacts are required of the pilot under instrument flight rule conditions:

(1) Report to the tower the time and altitude of reaching the specified holding point or fix to which cleared by the airway traffic control center.

(2) Report to the tower when vacating any previously assigned flight level for a new assigned level.

(3) Report to the tower when leaving any assigned holding point.

(4) Report to the tower, on request, when making procedure turn for final approach.

(5) Report to the tower, on request, when over range station on final approach.

(6) Report to the tower, on request, when ground contact is established.

(7) Report to the tower the time and altitude when approximately 15 miles from the airport if the range station is designated as the holding fix.

4. FREQUENCIES GUARDED BY THE PILOT.

a. The pilot will guard the approach control (radio range voice channel) frequency after being cleared to the tower or after being cleared to a holding fix "until advised by the tower". All ground to aircraft communications from the tower will be accomplished on the voice channel of the range until the actual landing is accomplished. Immediately upon completing the landing, and preferably before the landing roll is completed, the pilot should tune to the tower local control frequency (278 kilocycles or other assigned frequency) for taxi instructions.

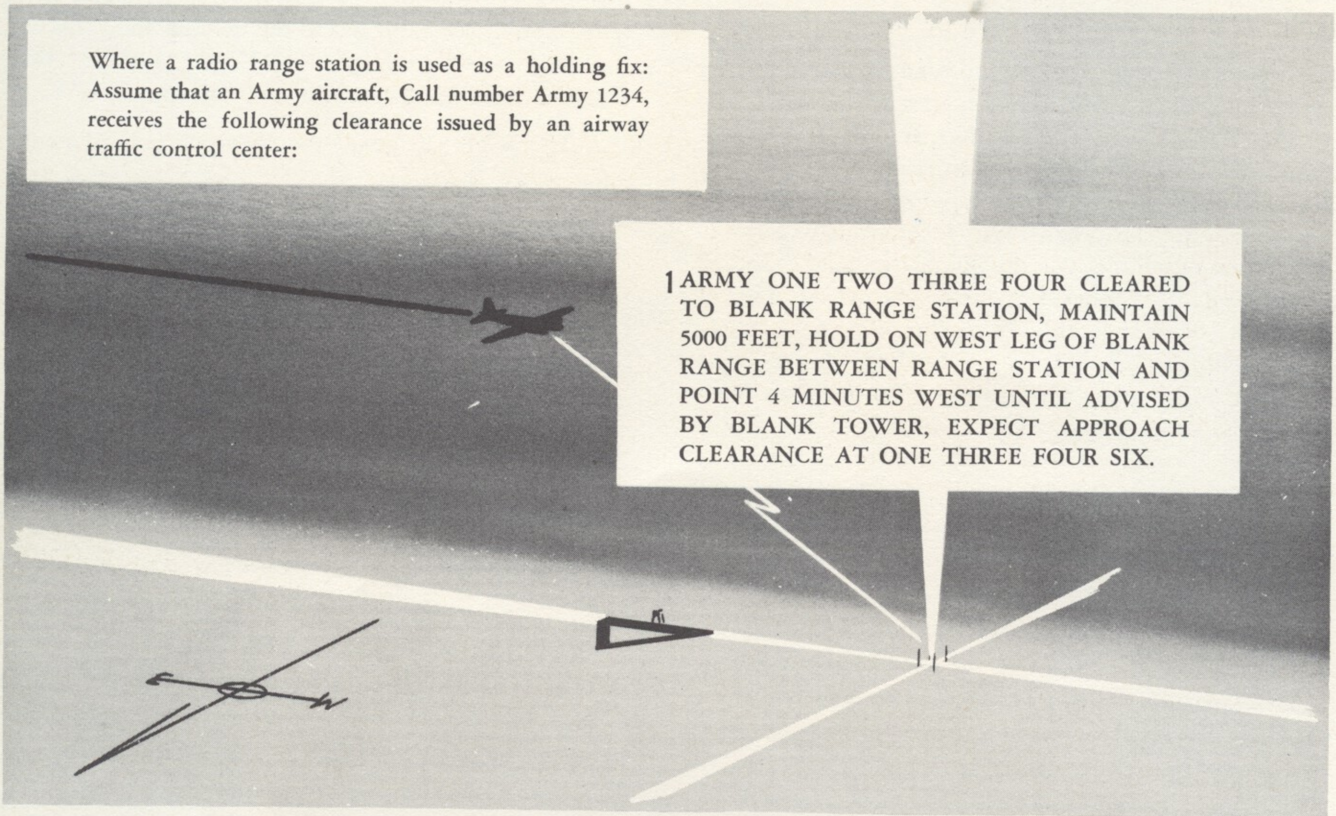
b. If the pilot desires to use the navigational features only to assist in executing an instrument approach, after an approach has been authorized, he may filter out or detune, the voice channel during his approach after so advising the tower. If the tower wishes to contact the pilot during this period, the tower will operate the "attention signal" (series of short dots on range frequency) to indicate to the pilot that urgent instructions follow, whereupon the pilot will tune in the voice frequency. It is thought that such instances will be rare, and the pilot will have, if desired, full advantage of the navigational feature of the range during final approach. All instructions to departing aircraft (taxi instructions, wind direction and velocity, time check, altimeter setting, runway number, airway traffic control clearance, take-off instructions, etc.) will be issued by the tower on local control frequency.

c. In addition to aircraft on the ground communicating with the control tower on local control radio frequency, arriving aircraft in flight operating under contact flight rules may be cleared from the range frequency to the local control frequency at the discretion of the approach controller.

NOTE

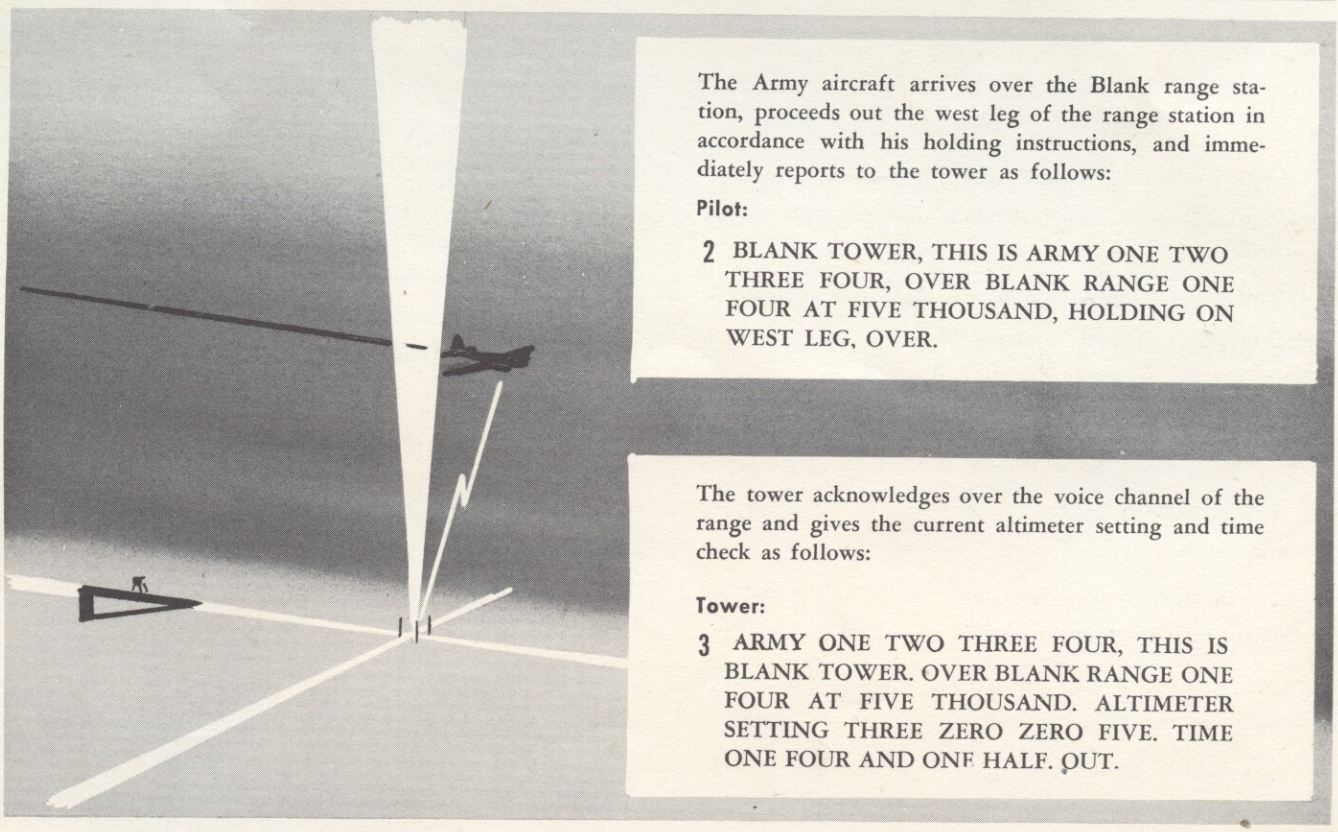
Aircraft operating locally under contact flight rules are expected to communicate with the control tower on local control radio facility.

5. PROCEDURES AND PHRASEOLOGIES, EXAMPLES



Where a radio range station is used as a holding fix: Assume that an Army aircraft, Call number Army 1234, receives the following clearance issued by an airway traffic control center:

1 ARMY ONE TWO THREE FOUR CLEARED TO BLANK RANGE STATION, MAINTAIN 5000 FEET, HOLD ON WEST LEG OF BLANK RANGE BETWEEN RANGE STATION AND POINT 4 MINUTES WEST UNTIL ADVISED BY BLANK TOWER, EXPECT APPROACH CLEARANCE AT ONE THREE FOUR SIX.



The Army aircraft arrives over the Blank range station, proceeds out the west leg of the range station in accordance with his holding instructions, and immediately reports to the tower as follows:

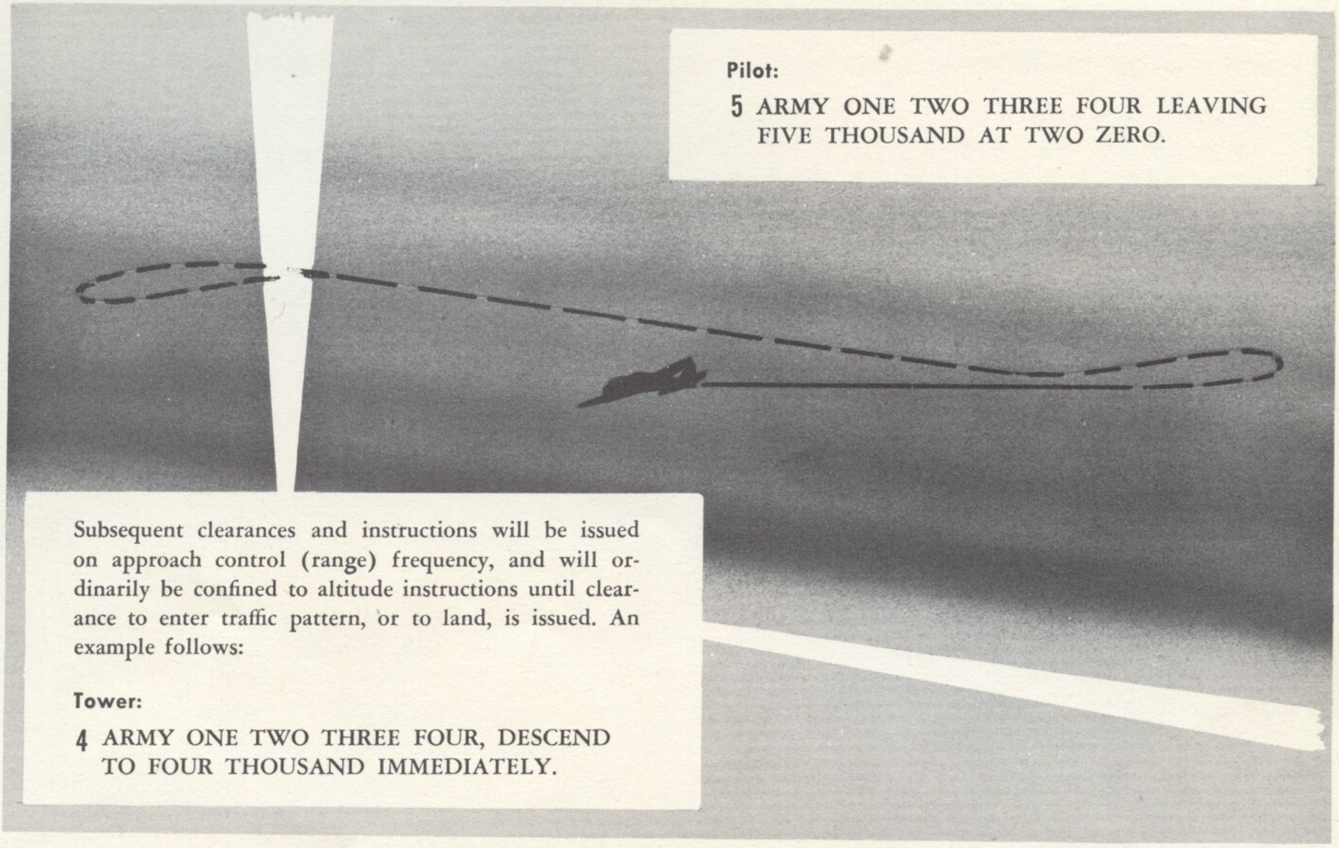
Pilot:

2 BLANK TOWER, THIS IS ARMY ONE TWO THREE FOUR, OVER BLANK RANGE ONE FOUR AT FIVE THOUSAND, HOLDING ON WEST LEG, OVER.

The tower acknowledges over the voice channel of the range and gives the current altimeter setting and time check as follows:

Tower:

3 ARMY ONE TWO THREE FOUR, THIS IS BLANK TOWER. OVER BLANK RANGE ONE FOUR AT FIVE THOUSAND. ALTIMETER SETTING THREE ZERO ZERO FIVE. TIME ONE FOUR AND ONE HALF. OUT.



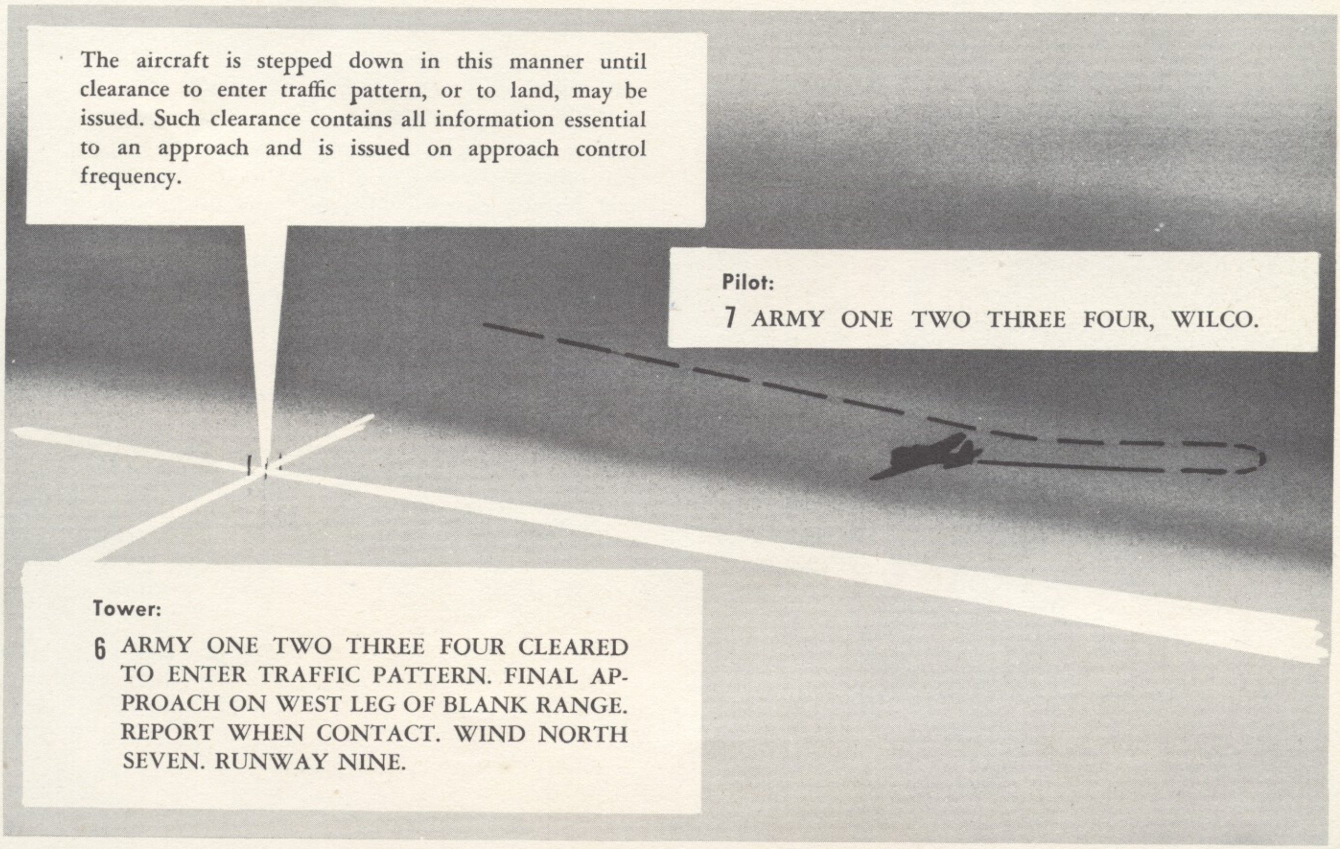
Subsequent clearances and instructions will be issued on approach control (range) frequency, and will ordinarily be confined to altitude instructions until clearance to enter traffic pattern, or to land, is issued. An example follows:

Tower:

4 ARMY ONE TWO THREE FOUR, DESCEND TO FOUR THOUSAND IMMEDIATELY.

Pilot:

5 ARMY ONE TWO THREE FOUR LEAVING FIVE THOUSAND AT TWO ZERO.



The aircraft is stepped down in this manner until clearance to enter traffic pattern, or to land, may be issued. Such clearance contains all information essential to an approach and is issued on approach control frequency.

Tower:

6 ARMY ONE TWO THREE FOUR CLEARED TO ENTER TRAFFIC PATTERN. FINAL APPROACH ON WEST LEG OF BLANK RANGE. REPORT WHEN CONTACT. WIND NORTH SEVEN. RUNWAY NINE.

Pilot:

7 ARMY ONE TWO THREE FOUR, WILCO.

The pilot reports when contact as requested:

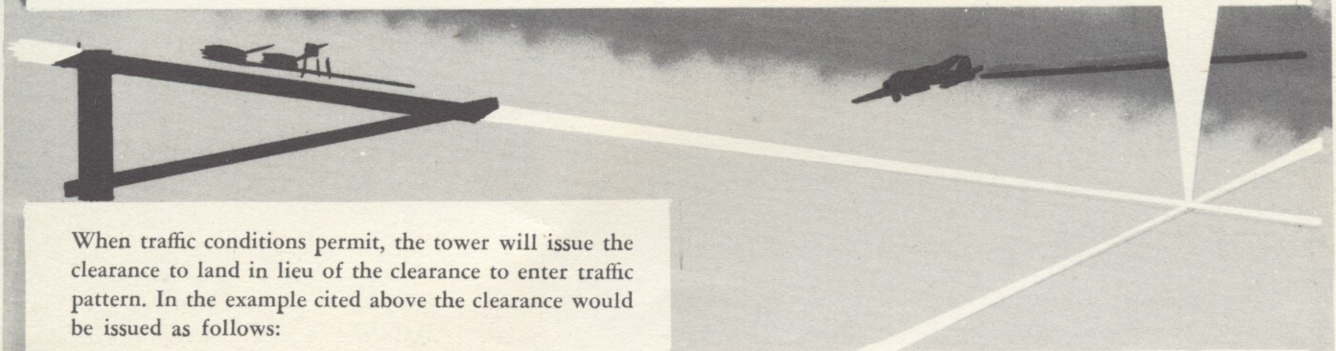
Pilot:

8 ARMY ONE TWO THREE FOUR CONTACT AT EIGHT HUNDRED THREE MILES WEST OF THE FIELD.

The tower then issues clearance to land:

Tower:

9 ARMY ONE TWO THREE FOUR CLEARED TO LAND.



When traffic conditions permit, the tower will issue the clearance to land in lieu of the clearance to enter traffic pattern. In the example cited above the clearance would be issued as follows:

Tower:

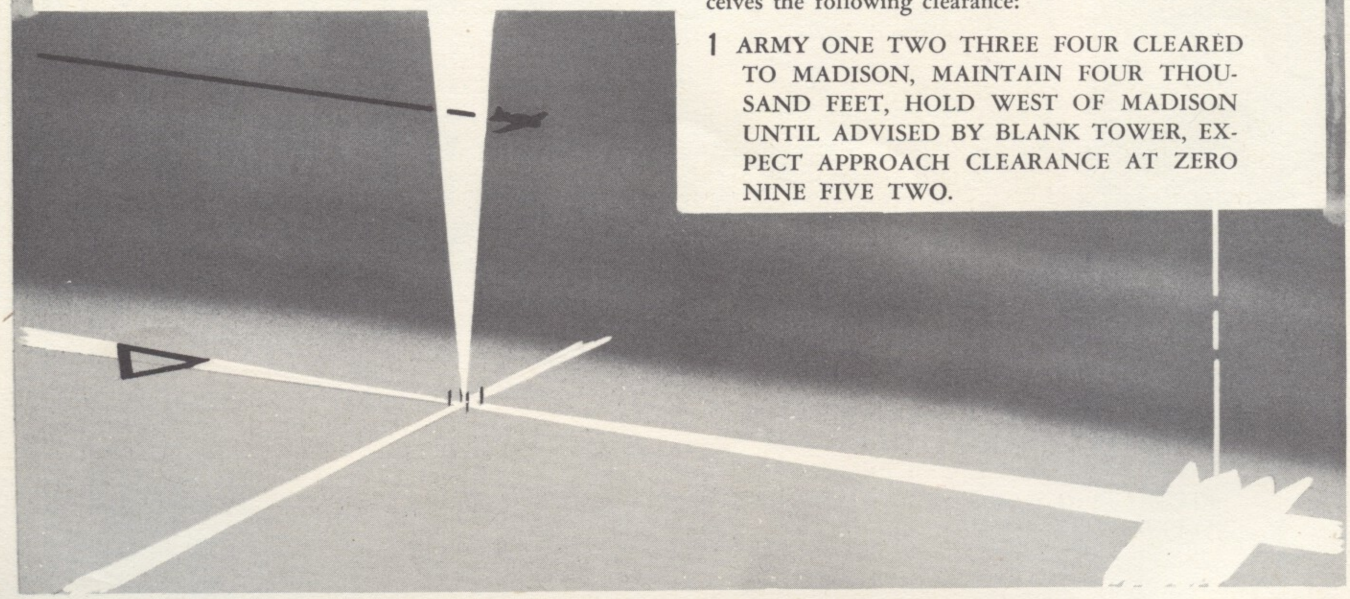
10 ARMY ONE TWO THREE FOUR CLEARED TO LAND. FINAL APPROACH ON WEST LEG OF BLANK RANGE. WIND NORTH SEVEN. RUNWAY NINE.

Normally no further communication between the toer and aircraft is required after clearance to land is issued until the landing has been accomplished. At that time the pilot changes over to local control frequency for taxi instructions.

EXAMPLE 2.

Where a radio fix on an approach leg is used as a holding fix: Assume that the same Army aircraft, Call number Army 1234, referred to in the above example, is destined for another location where approach control procedures are in operation, and at this location aircraft in an approach sequence are held at a radio fix on the approach leg. Assume further that the holding fix is on the west leg of the Blank radio range station and is designated as "Madison," and the aircraft receives the following clearance:

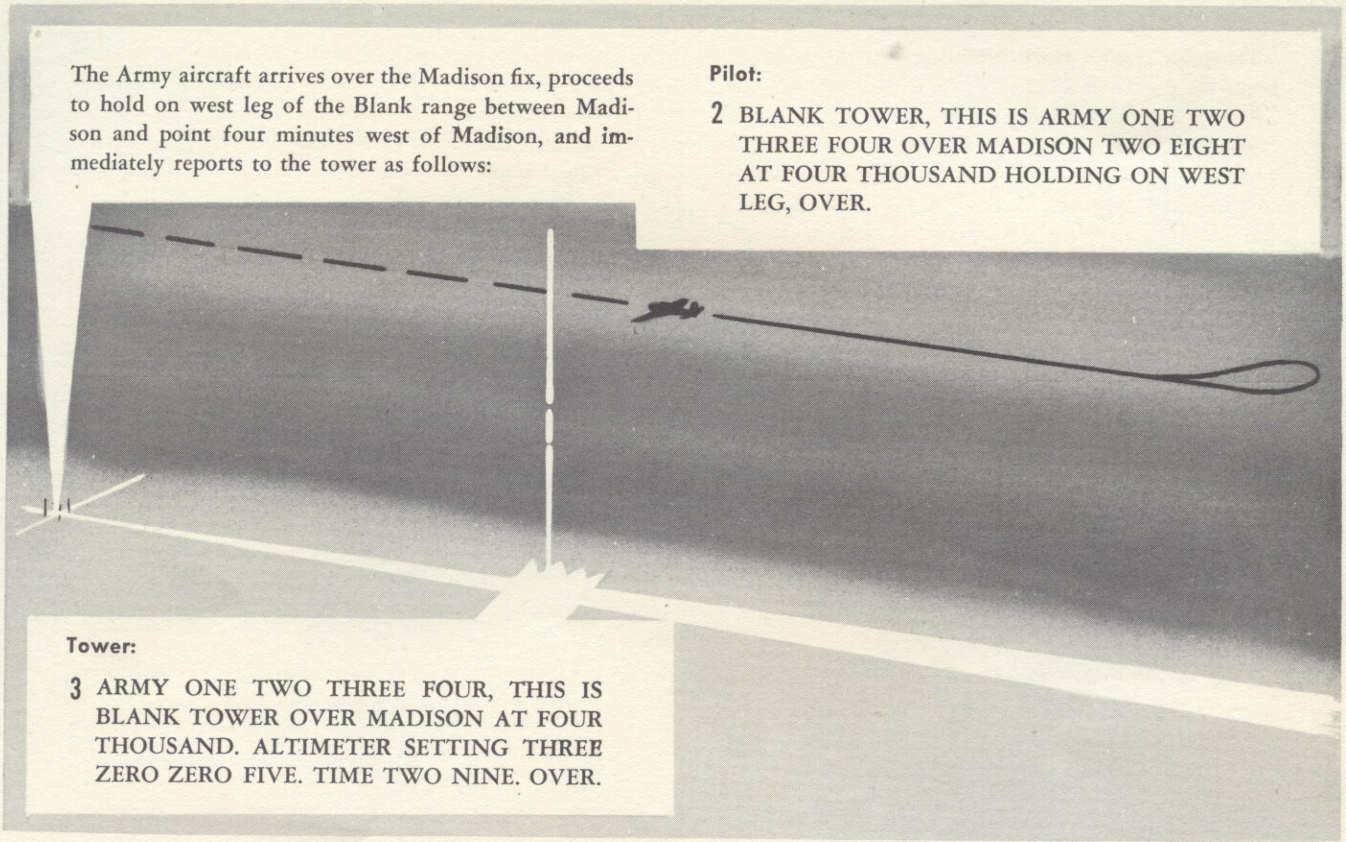
1 ARMY ONE TWO THREE FOUR CLEARED TO MADISON, MAINTAIN FOUR THOUSAND FEET, HOLD WEST OF MADISON UNTIL ADVISED BY BLANK TOWER, EXPECT APPROACH CLEARANCE AT ZERO NINE FIVE TWO.



The Army aircraft arrives over the Madison fix, proceeds to hold on west leg of the Blank range between Madison and point four minutes west of Madison, and immediately reports to the tower as follows:

Pilot:

2 BLANK TOWER, THIS IS ARMY ONE TWO THREE FOUR OVER MADISON TWO EIGHT AT FOUR THOUSAND HOLDING ON WEST LEG, OVER.



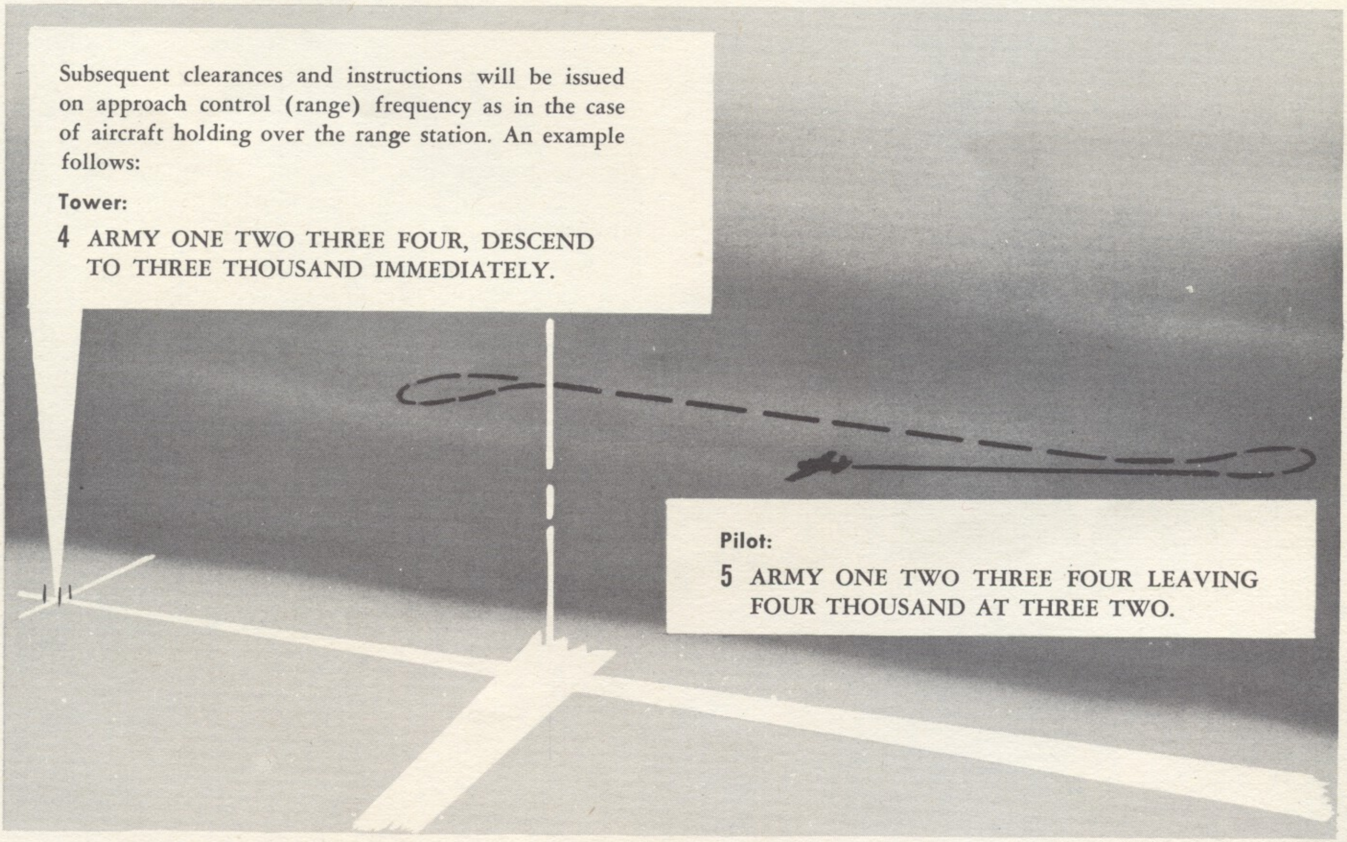
Tower:

3 ARMY ONE TWO THREE FOUR, THIS IS BLANK TOWER OVER MADISON AT FOUR THOUSAND. ALTIMETER SETTING THREE ZERO ZERO FIVE. TIME TWO NINE. OVER.

Subsequent clearances and instructions will be issued on approach control (range) frequency as in the case of aircraft holding over the range station. An example follows:

Tower:

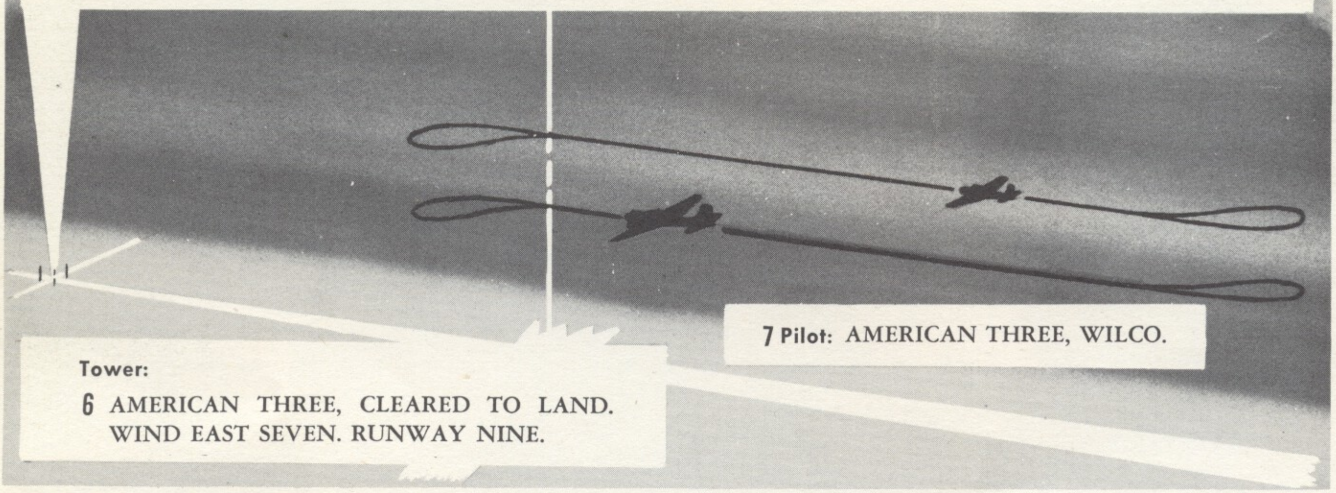
4 ARMY ONE TWO THREE FOUR, DESCEND TO THREE THOUSAND IMMEDIATELY.



Pilot:

5 ARMY ONE TWO THREE FOUR LEAVING FOUR THOUSAND AT THREE TWO.

As in the case of aircraft holding over the range station, the aircraft is stepped down in this manner until clearance to enter the traffic pattern, or to land, is issued. However, in the case of aircraft holding at a fix on the approach leg the succeeding aircraft is cleared down to the initial approach altitude on the *holding* side of the holding fix *after* the preceding aircraft has reported *leaving* the holding fix on final approach. This procedure eliminates that portion of the time delay in descending from an assigned altitude above the initial approach altitude to the initial approach altitude after receipt of clearance authorizing an approach. To illustrate, assume that an air carrier aircraft, American Airlines Flight Three is preceding Army 1234 in the approach sequence and is holding at two thousand feet (Initial approach altitude in this case) west of Madison and that Army 1234 is now holding at three thousand feet. The following clearance is issued to American Three:



Tower:

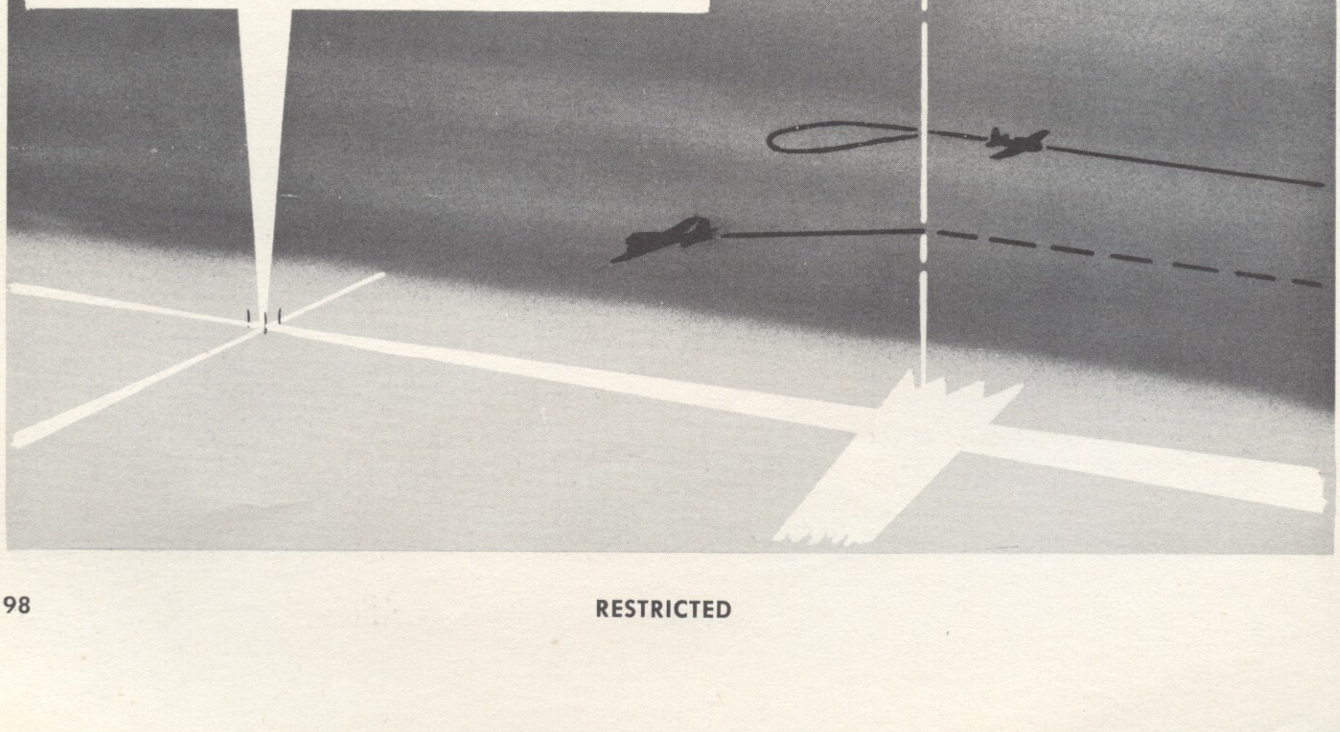
6 AMERICAN THREE, CLEARED TO LAND. WIND EAST SEVEN. RUNWAY NINE.

7 **Pilot:** AMERICAN THREE, WILCO.

American Flight Three then starts his final approach, crosses the Madison fix, descending from two thousand to final approach altitude (altitude crossing the range station) and reports:

Pilot:

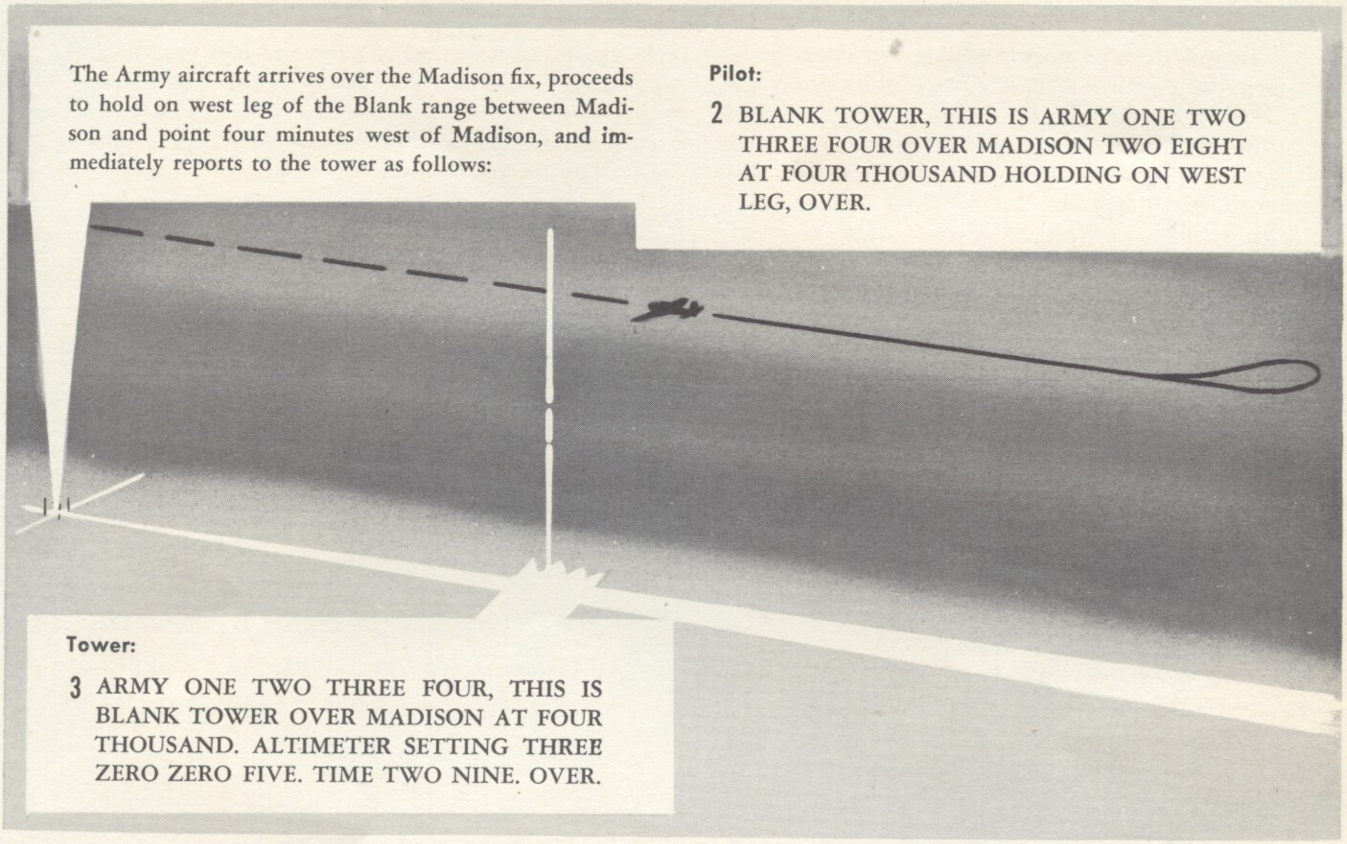
8 AMERICAN THREE LEAVING MADISON, LEAVING TWO THOUSAND AT FOUR SIX.



The Army aircraft arrives over the Madison fix, proceeds to hold on west leg of the Blank range between Madison and point four minutes west of Madison, and immediately reports to the tower as follows:

Pilot:

2 BLANK TOWER, THIS IS ARMY ONE TWO THREE FOUR OVER MADISON TWO EIGHT AT FOUR THOUSAND HOLDING ON WEST LEG, OVER.



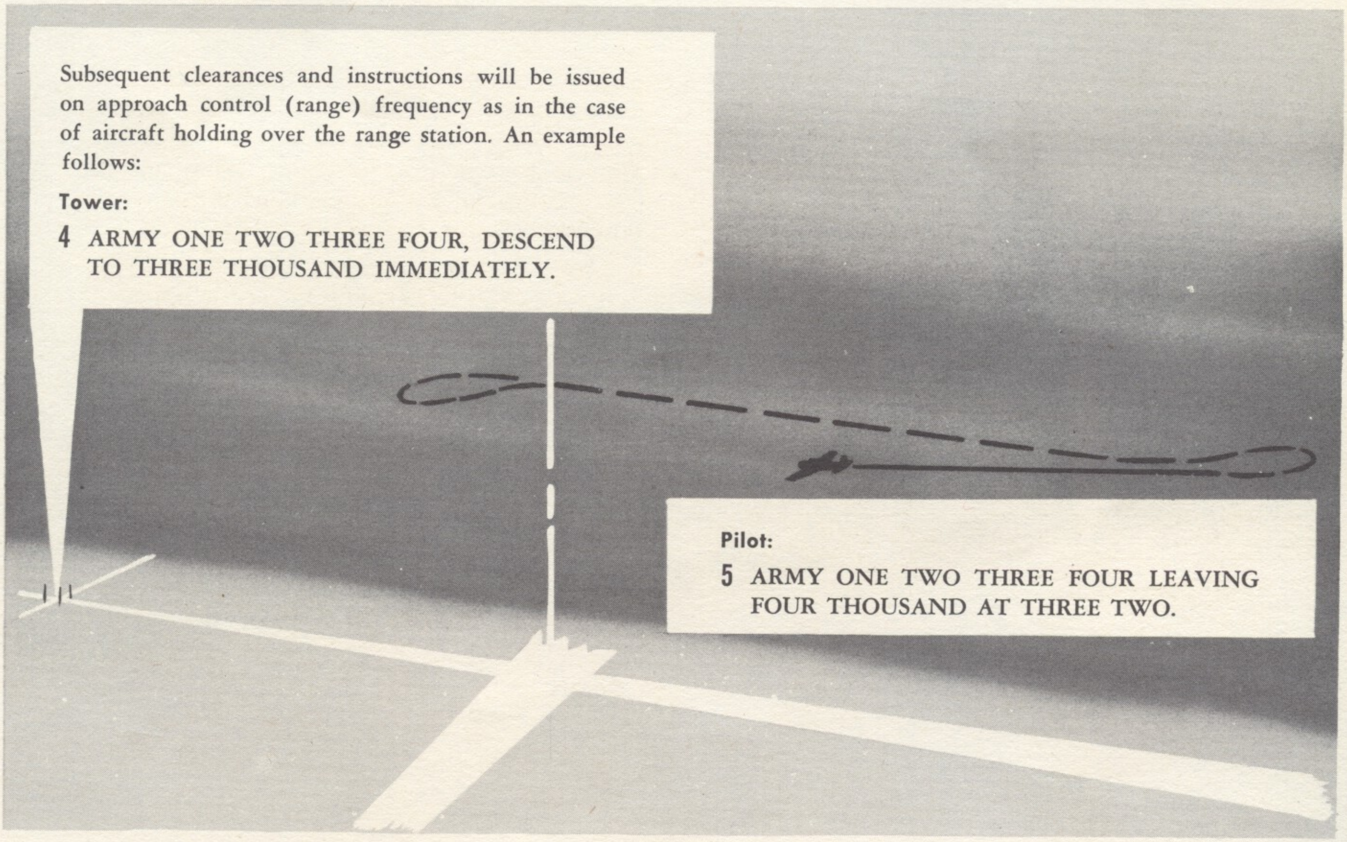
Tower:

3 ARMY ONE TWO THREE FOUR, THIS IS BLANK TOWER OVER MADISON AT FOUR THOUSAND. ALTIMETER SETTING THREE ZERO ZERO FIVE. TIME TWO NINE. OVER.

Subsequent clearances and instructions will be issued on approach control (range) frequency as in the case of aircraft holding over the range station. An example follows:

Tower:

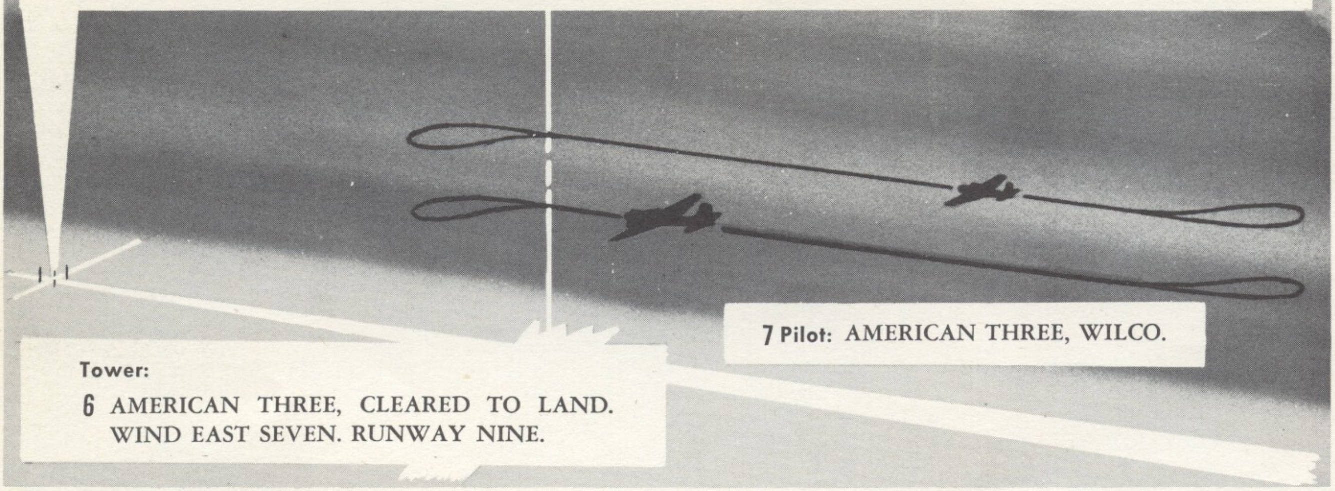
4 ARMY ONE TWO THREE FOUR, DESCEND TO THREE THOUSAND IMMEDIATELY.



Pilot:

5 ARMY ONE TWO THREE FOUR LEAVING FOUR THOUSAND AT THREE TWO.

As in the case of aircraft holding over the range station, the aircraft is stepped down in this manner until clearance to enter the traffic pattern, or to land, is issued. However, in the case of aircraft holding at a fix on the approach leg the succeeding aircraft is cleared down to the initial approach altitude on the *holding* side of the holding fix *after* the preceding aircraft has reported *leaving* the holding fix on final approach. This procedure eliminates that portion of the time delay in descending from an assigned altitude above the initial approach altitude to the initial approach altitude after receipt of clearance authorizing an approach. To illustrate, assume that an air carrier aircraft, American Airlines Flight Three is preceding Army 1234 in the approach sequence and is holding at two thousand feet (Initial approach altitude in this case) west of Madison and that Army 1234 is now holding at three thousand feet. The following clearance is issued to American Three:



Tower:

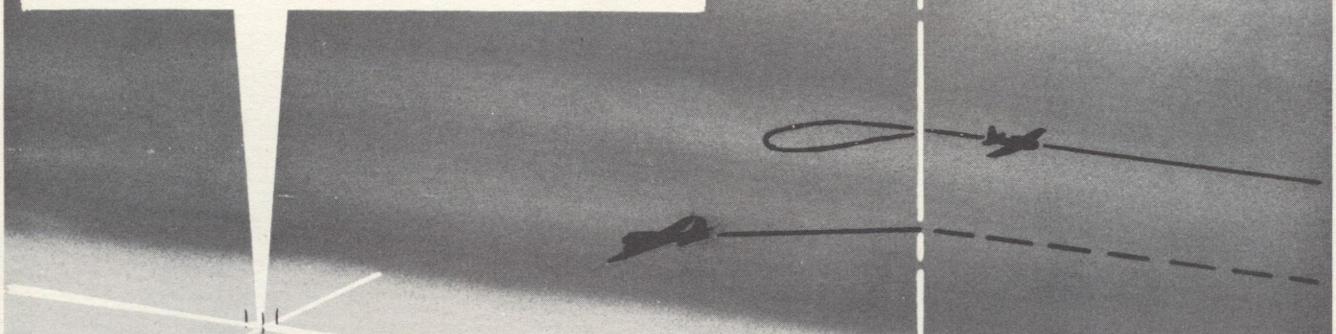
6 AMERICAN THREE, CLEARED TO LAND. WIND EAST SEVEN. RUNWAY NINE.

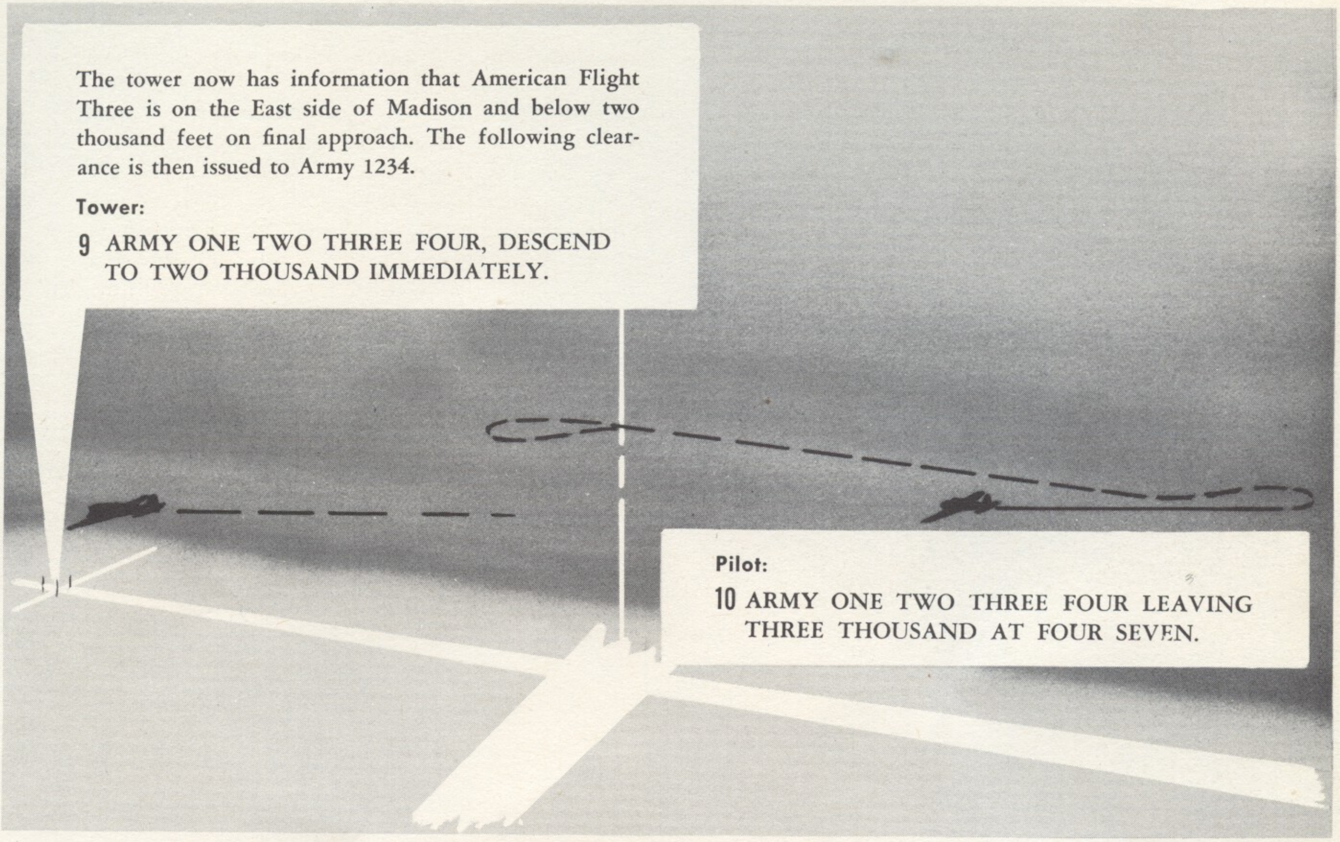
7 Pilot: AMERICAN THREE, WILCO.

American Flight Three then starts his final approach, crosses the Madison fix, descending from two thousand to final approach altitude (altitude crossing the range station) and reports:

Pilot:

8 AMERICAN THREE LEAVING MADISON, LEAVING TWO THOUSAND AT FOUR SIX.





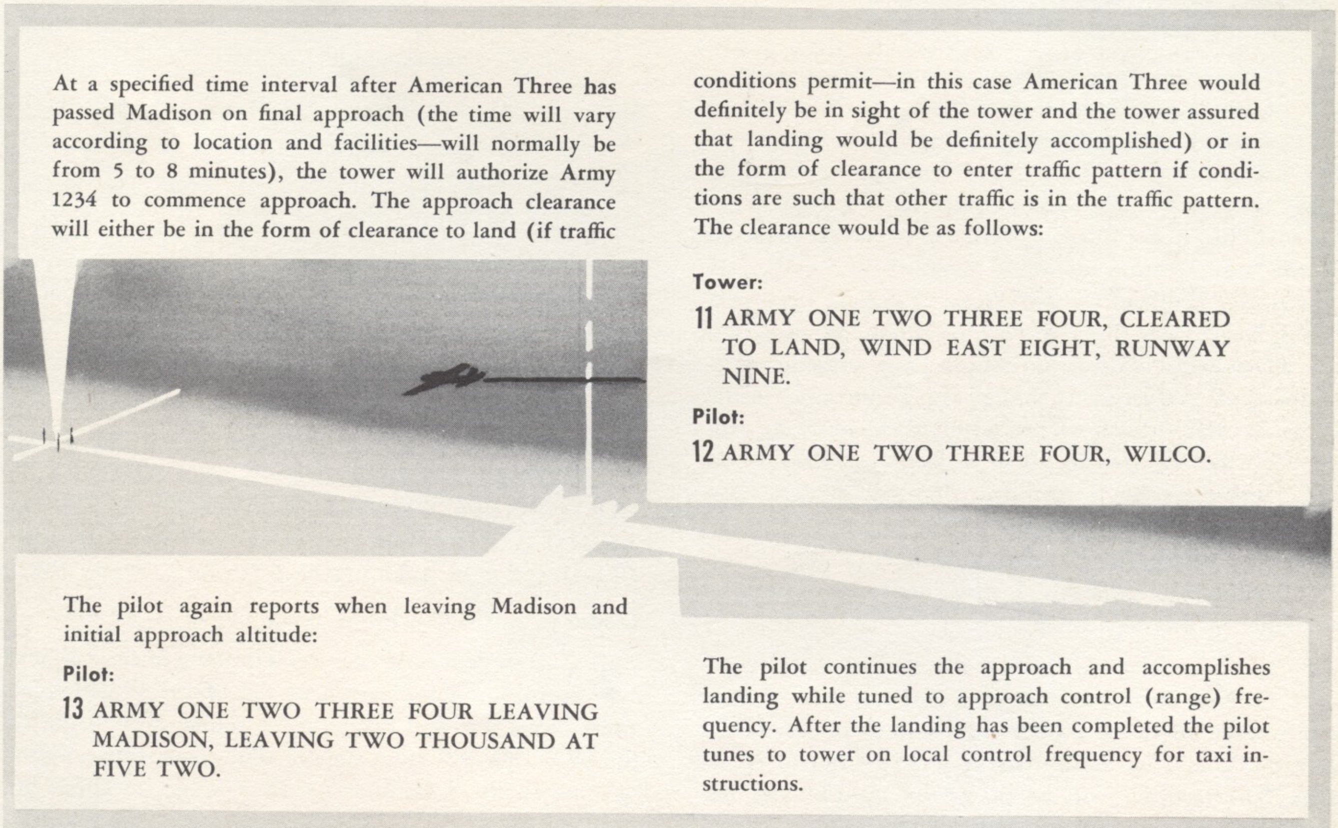
The tower now has information that American Flight Three is on the East side of Madison and below two thousand feet on final approach. The following clearance is then issued to Army 1234.

Tower:

9 ARMY ONE TWO THREE FOUR, DESCEND TO TWO THOUSAND IMMEDIATELY.

Pilot:

10 ARMY ONE TWO THREE FOUR LEAVING THREE THOUSAND AT FOUR SEVEN.



At a specified time interval after American Three has passed Madison on final approach (the time will vary according to location and facilities—will normally be from 5 to 8 minutes), the tower will authorize Army 1234 to commence approach. The approach clearance will either be in the form of clearance to land (if traffic conditions permit—in this case American Three would definitely be in sight of the tower and the tower assured that landing would be definitely accomplished) or in the form of clearance to enter traffic pattern if conditions are such that other traffic is in the traffic pattern. The clearance would be as follows:

Tower:

11 ARMY ONE TWO THREE FOUR, CLEARED TO LAND, WIND EAST EIGHT, RUNWAY NINE.

Pilot:

12 ARMY ONE TWO THREE FOUR, WILCO.

The pilot again reports when leaving Madison and initial approach altitude:

Pilot:

13 ARMY ONE TWO THREE FOUR LEAVING MADISON, LEAVING TWO THOUSAND AT FIVE TWO.

The pilot continues the approach and accomplishes landing while tuned to approach control (range) frequency. After the landing has been completed the pilot tunes to tower on local control frequency for taxi instructions.

6. TRAINER EXERCISES.

a. A suitable cross-country Instrument Trainer Chart should be selected for the problem. For illustrative purposes, it is assumed that the New York Area chart has been selected. The student will be required to study the weather sequence for an intended flight from Philadelphia to La Guardia Field. With the cooperation of the local weather station a hypothetical weather sequence covering the route of flight will have been prepared. Instrument flight conditions should be indicated on the sequence. A weather report for a suitable alternate airport (Allentown) should also be included in the sequence. After study of the weather sequence the student will be required to fill in a clearance (AAF Form #23) including his instrument flight plan. The use of this form will be explained to the instructors by the Officer in Charge of the department. AAF Regulation 15-23 contains applicable instructions and should be available in the department.

b. The instructor will furnish the student with a copy of T. O. Nos. 08-15-1 and 08-15-3, and will then instruct him to take off in the trainer and climb to 10 feet (field elevation), and hold for Airway Traffic Control clearance. The recorder will be placed on the Philadelphia Municipal Airport and aligned with the trainer.

1 The student will now initiate a call to the Philadelphia Tower:

Student: "HELLO, PHILADELPHIA TOWER, THIS IS ARMY 1234, OVER."

Instructor: "HELLO, ARMY 1234, THIS IS PHILADELPHIA TOWER, OVER."

Student: "ARMY 1234, READY FOR TAKE-OFF ON CROSS-COUNTRY TO LA GUARDIA FIELD, REQUEST AIRWAYS CLEARANCE, OVER."

Instructor: "ARMY 1234, HERE IS YOUR ATC CLEARANCE; YOU ARE CLEARED TO FREEHOLD INTERSECTION, TO MAINTAIN 3000 FEET, CONTACT LA GUARDIA RADIO WHEN OVER FREEHOLD INTERSECTION FOR FURTHER INSTRUCTIONS. ALTIMETER SETTING 29.96. YOU ARE CLEARED FOR IMMEDIATE TAKE-OFF, OVER."

Student: "ARMY 1234. WILCO, OUT."

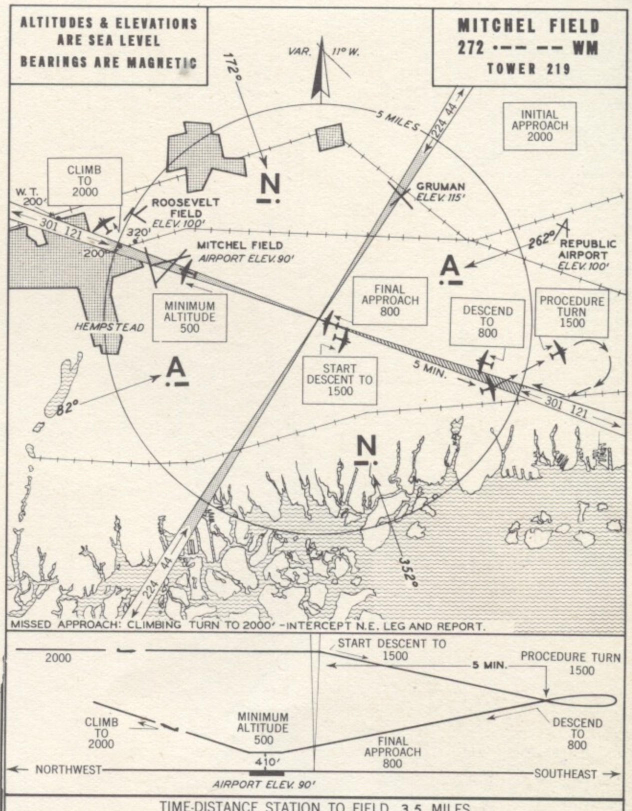
2 The student now takes off, climbing to the assigned altitude on the northeast leg of the Philadelphia radio range. He will maintain his course to the right of the beam. He will from time to time request his co-pilot to tune to the Lakehurst localizer range, to check his progress along the route. The instructor will play the part of the "co-pilot" talking to the pilot on the aircraft interphone, and using any suitable phrases, inform the pilot that the Lakehurst localizer range is being received. While the desk controls are on VOICE, the instructor will set the A and N mixture control and volume to correspond to the position of the recorder.

3 When the Freehold Intersection is reached, the instructor will turn the marker selector switch to number 3 position, and will transmit the visual signal only. The student now requests his "co-pilot" to tune in New York radio range and will initiate a call to New York Radio as follows:

Student: "HELLO, NEW YORK RADIO, THIS IS ARMY 1234, OVER."

The instructor will reply:

Instructor: "HELLO, ARMY 1234, THIS IS NEW YORK RADIO, OVER."



TIME-DISTANCE STATION TO FIELD 3.5 MILES					
110 M.P.H.	120 M.P.H.	130 M.P.H.	140 M.P.H.	150 M.P.H.	160 M.P.H.
1 MIN. 55 SEC.	1 MIN. 45 SEC.	1 MIN. 37 SEC.	1 MIN. 30 SEC.	1 MIN. 24 SEC.	1 MIN. 19 SEC.

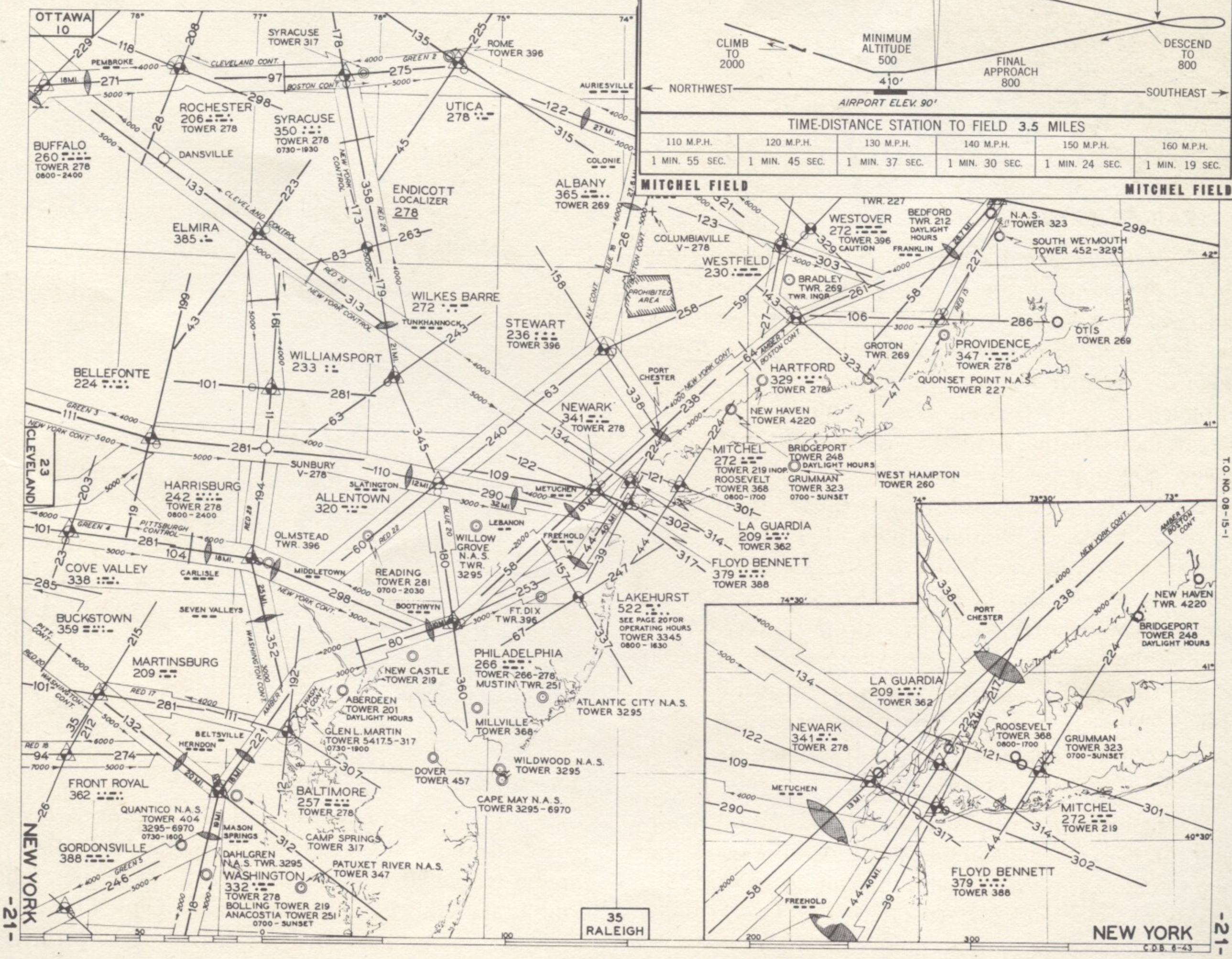


Figure 64—Student's Cockpit Charts

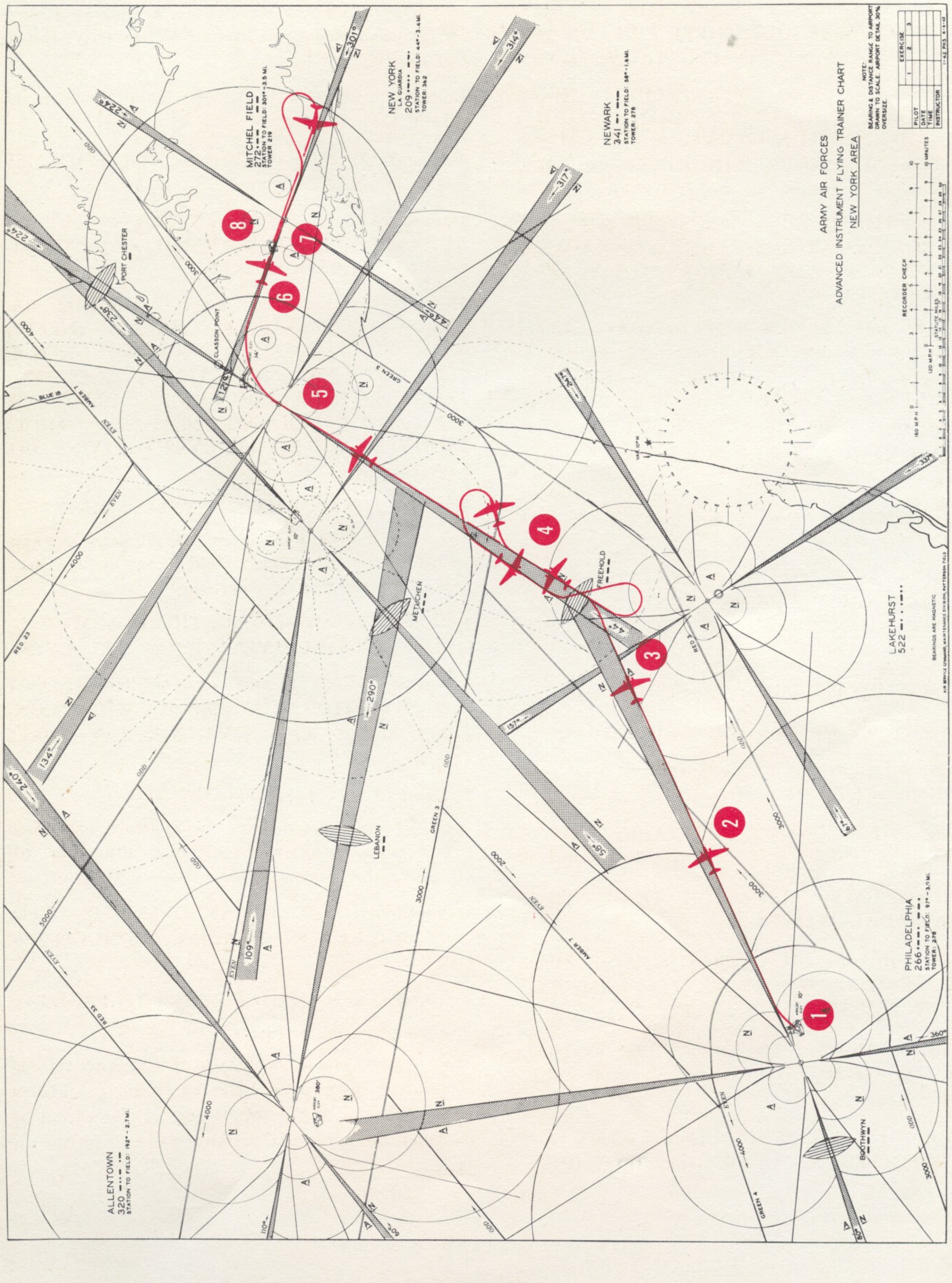


Fig. 65—New York Area Chart

Student: "NEW YORK RADIO, THIS IS ARMY 1234, OVER FREEHOLD THREE FIVE AT 3000 FEET, REQUEST ATC INSTRUCTIONS, OVER."

Instructor: "ARMY 1234, OVER FREEHOLD, THREE FIVE AT 3000 FEET, HOLD BETWEEN FREEHOLD AND A POINT 4 MINUTES NE ON THE SW LEG OF THE NEW YORK RANGE AT 3000 FEET, OVER."

Student: "THIS IS ARMY 1234, HOLD BETWEEN FREEHOLD AND POINT 4 MINUTES NE ON SW LEG OF NEW YORK RANGE AT 3000 FEET, WILCO, OUT."

4 The student will now make a procedure turn from four minutes beyond the Freehold Intersection, return to the fix and complete another procedure turn. When he is again flying NE bound on the New York Range, the instructor will call:

"HELLO, ARMY 1234, THIS IS NEW YORK RADIO, OVER."

Student: "HELLO, NEW YORK RADIO, THIS IS ARMY 1234, OVER."

Instructor: "ARMY 1234. YOU ARE CLEARED TO THE NEW YORK CONE, MAINTAIN 3000 FEET. REPORT WHEN OVER CONE FOR LET-DOWN CLEARANCE, OVER."

Student: "THIS IS ARMY 1234, WILCO, OUT."

The student will now proceed to the New York cone.

5 After identifying the cone he will call New York Radio as follows:

Student: "HELLO, NEW YORK RADIO, THIS IS ARMY 1234, OVER."

Instructor: "HELLO, ARMY 1234, THIS IS NEW YORK RADIO, OVER."

Student: "ARMY 1234, OVER THE CONE ZERO FIVE AT THREE THOUSAND FEET, REQUEST LANDING INSTRUCTIONS, OVER."

Instructor: "ARMY 1234, NEW YORK CLOSED, PROCEED TO MITCHEL FIELD AT 2500 FEET, OVER."

Student: NEW YORK RADIO, THIS IS ARMY 1234, I AM PROCEEDING TO MITCHEL FIELD, OUT."

6 The student now requests the "co-pilot" to tune to Mitchel Radio and then he will initiate a call to that station:

Student: "HELLO, MITCHEL RADIO, THIS IS ARMY 1234, OVER."

Instructor: "HELLO, ARMY 1234, THIS IS MITCHEL RADIO, OVER."

Student: "ARMY 1234, OVER STATION ONE ZERO AT 2500 FEET, ON INSTRUMENTS, REQUEST LET-DOWN CLEARANCE, OVER."

Instructor: "ARMY 1234, THIS IS MITCHEL RADIO, YOU ARE CLEARED TO MAKE AN INSTRUMENT APPROACH. CEILING FIVE HUNDRED FEET, VISIBILITY 2 MILES, ALTIMETER SETTING ZERO ZERO FIVE, YOU ARE THE ONLY SHIP USING THE RANGE, DESCEND TO TWO THOUSAND FEET AND REPORT OVER THE CONE ONE TWO, OVER."

Student: "THS IS ARMY 1234, WILCO, OUT."

7 The student now resets his altimeter and approaches the Mitchel Field Range at 2000 feet. When over the cone, he reports:

Student: "MITCHEL RADIO, THIS IS ARMY 1234, OVER CONE ONE SEVEN AT 2000 FEET, OVER."

Instructor: "ARMY 1234, FINAL APPROACH ON E LEG MITCHEL RANGE, REPORT WHEN CONTACT. WIND WEST FIVE, RUNWAY THREE ZERO, OVER."

Student: "ARMY 1234, WILCO."

8 The student completes the approach and when over the airport at the minimum altitude he will call the Mitchel Tower:

Student: "ARMY 1234, I AM OVER THE FIELD, CONTACT, REQUEST LANDING INSTRUCTIONS. OVER."

Instructor: "ARMY 1234, CLEARED TO LAND."

This completes the problem.

The foregoing exercise is included as a suggested method of utilizing the various Advanced Instrument Trainer Area Charts. Similar problems may be worked out by the chief instructors, and scenarios prepared for the use as needed.


CULMINATION
HE MADE IT!