 FM 1-20

WAR DEPARTMENT

ARMY AIR FORCE FIELD MANUAL

*

TACTICS AND TECHNIQUE OF AIR RECONNAISSANCE AND OBSERVATION

April 20, 1942

Lt. Arneberg

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TACTICS AND TECHNIQUE OF AIR RECONNAISSANCE AND OBSERVATION

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ARMY AIR FORCE FIELD MANUAL

TACTICS AND TECHNIQUE

OF

AIR RECONNAISSANCE AND OBSERVATION

(This manual supersedes FM 1-20, February 10, 1941, including Training Circular No. 20, War Department, 1942.)

CHAPTER 1

GENERAL

SECTION I

SCOPE AND DEFINITIONS

■ 1. SCOPE.—This manual contains instructions relative to the tactics and technique involved in air reconnaissance and observation and in the various types of air reconnaissance and observation missions executed in support of air and ground forces.

■ 2. DEFINITIONS.—*a. Air observation and reconnaissance.*—The gaining of information through visual and photographic means carried in aircraft.

b. Reconnaissance mission.—A flight for the purpose of obtaining information by visual or photographic means. Reconnaissance missions are classified as distant, close, and battle.

c. Artillery mission.—A flight for the purpose of locating artillery targets, adjusting artillery fire, reporting the effect of fire, or for the surveillance of scheduled artillery fire and enemy activity.

d. Liaison mission.—A flight to transmit information or instructions or otherwise to maintain contact between a commander and other commanders or organizations.

e. Air area.—The area within which a commander is charged with responsibility for air reconnaissance and observation.

SECTION II

TACTICAL FUNCTIONS

■ 3. GENERAL.—Air reconnaissance and observation operations are characterized by wide range and great depth, by the provision for taking air photographs, and by the rapidity with which information is obtained and transmitted. They are limited by poor visibility, bad weather, antiaircraft fire, and the opposition of hostile combat aviation.

■ 4. MISSIONS.—Reconnaissance and observation aviation units are organized, equipped, and trained to conduct air reconnaissance, observe fire, gain military information by visual and photographic means, transmit instructions and reports in accordance with the orders of the units to which assigned or attached, and to furnish aerial photographs for use as photomaps.

■ 5. FUNCTIONS.—Air reconnaissance and observation missions include operations involving search, patrol, tracking, contact, and adjustment of artillery fire, as well as liaison and courier tasks.

■ 6. CHARACTERISTICS OF RECONNAISSANCE AND OBSERVATION AIRCRAFT.—*a.* Air force reconnaissance aviation is equipped with airplanes capable of conducting the long-range strategic and striking force reconnaissance over land and sea. The airplanes may be specially equipped bombardment types which are also capable of use for air attack.

b. Observation aviation is characterized by equipment designed for wide angle vision, and to meet the needs of ground units for gaining military information from the air by visual and photographic means. Its speed and performance are suitable to the purpose for which it is intended and are such as to permit reconnaissance of an extensive area in a short period of time; its communication facilities permit the rapid transmission of reports to the using agencies. Observation aviation is equipped with—

(1) High performance airplanes of high speed and sufficient range to penetrate hostile territory, and equipped for photographic or visual reconnaissance.

(2) Light, low performance airplanes designed for artillery observation missions and liaison missions in rear of friendly front lines.

■ 7. RECONNAISSANCE BY COMBAT AVIATION.—The gaining of information by units of combat aviation is usually incident to the accomplishment of their principal mission of air combat. Aircraft engaged on air attack missions may be routed over specified areas for the purpose of gaining information concerning a particular activity or installation within such area. When air reconnaissance and air attack are combined in one operation, the primary task is air attack unless otherwise indicated.

SECTION III

FACTORS AFFECTING AIR RECONNAISSANCE AND OBSERVATION

■ 8. GENERAL.—*a.* (1) Ability to see is essential to the performance of air reconnaissance and observation. Unless the radius of visibility is sufficient to enable the observation crew to locate the object, activity, or area to be observed and to see it with sufficient distinctness to secure the desired information, air reconnaissance and observation is impracticable.

(2) Air reconnaissance and observation missions will be unproductive if the enemy counterreconnaissance measures deny access to the area or objective to be observed, or cause the incapacitation of the observation crew or the destruction of the airplane prior to the time that information secured is transmitted.

b. Among the factors affecting the ability to see are the type and amount of illumination, the clarity of the atmosphere, the size or mass of the objective, the terrain characteristics and ground covering, the angle of view, and the altitude from which the observations are made.

c. Security is affected by the type and strength of the hostile antiaircraft defenses; the performance characteristics and defensibility of our equipment; the skill of the combat crew in employing their defensive weapons, if intercepted, and in avoiding detection and interception under the prevailing weather and visibility conditions. Darkness, clouds, and poor visibility conditions increase the difficulty of detection and interception by the enemy and thus contribute in greater or lesser degree to security.

■ 9. ILLUMINATION.—The illumination provided by the sun, the moon, and the stars is termed "natural illumination." That provided by flares, photographic flashlight bombs, and similar means is termed "artificial illumination." Objectives are said to be self-illuminated when they are illuminated by fires or lights within them or nearby.

a. Sunlight.—(1) Sunlight affords the most satisfactory illumination for air reconnaissance and observation. The capabilities of daylight reconnaissance and observation are limited by adverse weather conditions. The extent to which adverse weather conditions interfere with reconnaissance and observation during daylight depends on the characteristics of the flying equipment, the familiarity of the flying personnel with the terrain to be traversed, the flying and air observation experience of the crew, the nature of the information required, and the location and character of the objective.

(2) Daylight with favorable visibility conditions permits the rapid reconnoitering of large areas, facilitates aerial photography, and provides the most favorable conditions for a detailed examination of the ground. For that reason it may be expected that troop and supply movements will be made at night whenever practicable and that if daylight movements are necessary the enemy will take all possible steps to prevent their discovery.

(3) Daylight favors the detection, interception, and attack of reconnaissance and observation airplanes. Daylight reconnaissance and observation of defended areas may be impossible, especially if deep penetration of enemy territory is required.

b. Night.—(1) Darkness imposes a considerable handicap on air reconnaissance and observation. Adverse weather and visibility conditions, such as low clouds, snow, rain, dust and smoke, that merely reduce the effectiveness or ease of daylight operations may completely bar night operations. Night sea search is unreliable. Night reconnaissance is most productive in the examination of previously located fixed objectives, routes of communication, and small areas that can be located with sufficient accuracy at night to permit the use of artificial illumination.

(2) While general area reconnaissance is impracticable at night, bright moonlight affords sufficient illumination for

the observer to detect larger objects and, under certain conditions, small bodies of troops and single vehicles in the open or on light-colored roads. The general characteristics of the terrain (whether wooded or open), prominent coastal indentations, lakes, rivers, highways, and railroads ordinarily can be distinguished by moonlight with clear visibility. However, artificial illumination is necessary for the detailed examination of the ground.

(3) Night aerial photography with artificial illumination produces excellent results under good visibility conditions. The area covered by a single photograph, however, is limited, hence great accuracy is necessary in the location of the objective. Technical improvements are expected to increase the altitude from which night photographs can be taken successfully, with a corresponding increase in the area covered by a single photograph.

■ 10. WEATHER.—*a.* Weather is a factor primarily because of its effect on visibility and on flight. Severe atmospheric disturbances, such as thunderstorms and line squalls, constitute a practical bar to air reconnaissance and observation operations within the area they cover.

b. Rain and falling snow affect air reconnaissance and observation to the extent that they restrict visibility. Frequently, however, surface activity will be disclosed by the trampling, soiling, or melting of snow. Rain and falling snow adversely affect radio reception in aircraft; if sufficiently heavy they render reception impossible.

c. Areas covered by fog are completely screened from the eye or the camera of the air observer. At night open lights and fires may be seen through thin fog.

d. Air observation of surface objectives and activity through more than thinly scattered clouds is impossible. Clouds effectively block vision. It is therefore generally necessary to observe from beneath the lowest layer of clouds. When the nature of the mission permits the use of clouds for concealment, the detection and interception problem of the enemy is rendered more difficult.

e. Haze, dust, and smoke restrict the radius of visibility. If present to any great extent, either singly or in combination, they may render air reconnaissance and observation unpro-

ductive. Haze, dust, and smoke are far more serious at night than by day, and may completely bar night reconnaissance and observation when present in quantities that during the daytime would be classified as moderate.

■ 11. VISIBILITY OF OBJECTIVES.—Prominent terrain features, such as mountains, lakes, and rivers; and large man-made works, such as power dams, isolated large buildings, and cities and towns, generally constitute the most distinguishable objectives. Within cities and towns, water front and railroad installations, parks, and monumental type buildings stand out prominently. Smoke and the dust raised by moving columns can be seen for long distances in the daytime; lights and fires are visible for great distances at night. The distance from which troops, vehicle columns, and small supply establishments or installations can be seen is dependent, among other things, on the degree of concentration or dispersion, the terrain, the ground cover, the efforts made to secure concealment, and the angle of view. The air observer may miss many important details, however, because of his rapid movements and the necessity for watching the upper air to guard against surprise by hostile pursuit aviation. The observation team cannot function as an all-seeing eye that minutely examines and reports on every detail in the sector over which it flies. Visual reconnaissance of a specific area or objective should be supplemented by photographs when practicable. A well-camouflaged gun, not visible to the observer, may be visible in a photograph or may cast a shadow which, recorded by the camera, discloses the position of the gun to an intelligence officer studying the photograph. Stereoscopic photographs are especially valuable in the discovery of details which are not visible to an observer.

■ 12. TERRAIN CHARACTERISTICS AND GROUND COVER.—Terrain characteristics and ground cover are of importance to the extent to which they conceal or defilade objectives and activities on the surface. Terrain features are of importance because of the manner in which they facilitate flight orientation, both day and night. Prominent coastal indentations, large lakes, and wide rivers are of material assistance in night orientation. (The distance and altitude from which they can be seen at night are dependent upon the amount of natural

illumination and general visibility conditions.) Ground cover is of importance because of the opportunity it presents for concealment and for the employment of camouflage. Vehicles, troops, and small supply facilities and installations dispersed in woods are difficult to see and, with proper camouflage discipline, may remain undetected for an appreciable period of time. The presence of troops may be disclosed by the cutting of new paths, trails, or roads, by fire or smoke, and by a general lightening of the appearance of the area. The presence of vehicles may be disclosed by the disturbance of the road shoulder at the point at which they left the road and the crushing of the vegetation incident to their movement to their concealed position. The crushing of vegetation incident to the movement of personnel and matériel shows very plainly in night as well as day photographs.

■ 13. ANGLE OF VIEW.—In general, air reconnaissance and observation is more effective when the line of sight is vertical or nearly vertical, and becomes less effective as the line of sight approaches the horizontal. Terrain features and ground cover may defilade objects when the angle of view is oblique, whereas they may be no bar to detection if the angle of view is vertical or nearly so. For this reason the examination of broken or wooded areas to locate troops, vehicles, and objects of low visibility generally must be accomplished at low altitudes and will, therefore, take longer or require more airplanes than would be the case in a flat area with no ground cover. However, in wooded areas it is frequently possible to secure good observation by an oblique view, and oblique photographs taken under such conditions are often more effective than vertical photographs.

■ 14. ALTITUDE.—*a*. The altitude from which details on the ground can be seen depends on the visibility and ground cover. Under good visibility conditions during daylight, motor convoys, railway trains, and long marching columns can be seen and their direction of movement ascertained from an altitude of 10,000 feet. Small bodies of troops, not concealed in trenches or fox holes, can be observed from 2,500 feet. At 1,500 feet the observer can follow the progress of an infantry attack. At 1,000 feet he can determine whether trenches, fox holes, or shell holes are occupied. To identify troops by

their uniform and equipment it is necessary to descend to within 500 feet of the ground. When operating at extremely low altitudes it will often be necessary for the observer to make a number of trips over the same terrain to assure himself that he has not missed some important details.

b. Sea search is facilitated by the lack of defilade. With normal visibility, smoke can be seen from 18 to 25 miles. Ten thousand feet is the most suitable altitude from which to search for surface vessels, which, with clear atmosphere, can be seen from 11 to 15 miles, depending on their size. Five thousand feet is the best altitude when searching for submarines on the surface. From this altitude they can be seen, with clear atmosphere, from 5 to 8 miles depending on the smoothness of the sea. One thousand feet is the best altitude for sea search at night. From that altitude, with favorable visibility, smoke can be seen about 3 miles and surface vessels from 2 to 3 miles, depending on their size.

c. The altitude above the terrain covered at which aerial photographs are taken will influence the scale of the photographs. The camera used for photographic reconnaissance should have a focal length that will give the desired scale at the altitude at which it is planned to operate.

■ 15. SECURITY.—*a.* Airplanes employed in the performance of air reconnaissance and observation have the greatest freedom of action when operating singly. Airplanes operating singly are particularly vulnerable to attack by hostile aircraft and must resort to every reasonable means of avoiding discovery and attack by hostile aviation.

b. Reconnaissance and observation aircraft operating in formation have their maneuverability restricted. The requirements of formation-keeping may seriously interfere with the performance of the reconnaissance or observation mission. Small formations of reconnaissance or observation airplanes do not have sufficient defensive strength to cope with enemy fighters in force. When the securing of vital information requires the penetration of areas wherein enemy fighter aviation is known to be operating, two or more airplanes may be assigned to the same task in order to increase the likelihood of at least one returning. When so assigned they operate independently. The presence of friendly fighter patrols may

afford adequate protection against hostile aircraft in shallow penetrations of enemy territory. Special support by escort fighters may be required to carry out air reconnaissance or observation missions in the presence of hostile fighter forces.

c. Darkness in itself affords a great measure of security because of the difficulty of locating airplanes at night and of making interception after location has been accomplished. When an objective in a defended area can be located at night with sufficient accuracy to permit the use of flares, and when such flares will provide adequate illumination, night reconnaissance or observation is indicated.

d. Whenever practicable, reconnaissance and observation aviation takes advantage of concurrent air operations in other areas, which may serve to occupy or draw off hostile defensive air elements.

SECTION IV

OPERATIONS

■ 16. GENERAL.—Air reconnaissance and observation operations are important to gain information or to facilitate combat operations of other forces.

■ 17. AIR OBSERVATION TEAMS.—Insofar as practicable each air observation team (pilot and air observer) should remain intact throughout any operations. Teamwork, which is an essential factor in the conduct of war, is thus promoted. Moreover, it is desirable that air observation teams should be assigned the same type of mission throughout any operations, if possible. By so doing the combat team idea is more nearly carried out between the supporting and the supported units.

■ 18. FAMILIARITY WITH PLANS.—To insure the most intelligent cooperation between the air observer and the supported unit, the air observation team should be familiar with the general scheme of maneuver of the supported forces and with the details of every operation in which they may be called upon to take part. The plan of employment of other reconnaissance and observation units and of all air force operations in the vicinity should be known to planning personnel to insure coordination and to allow the observation units to take advantage of the fact that hostile fighters will be attracted to the routes taken by friendly air forces.

■ 19. FAMILIARITY WITH TERRAIN.—Pilots and observers engaged in air reconnaissance and observation should be sufficiently familiar with the terrain over which they operate to maintain their orientation without too frequent diversion of their attention to the study of a map while in flight. It is especially important that they be familiar with the terrain during the conduct of night reconnaissance missions, as many of the landmarks that assist orientation in the daytime will be indistinguishable at night. Accurate orientation is essential for the employment of artificial illumination and night photography.

■ 20. ALTITUDE.—*a.* No definite rule can be stated regarding the altitude at which air reconnaissance and observation missions are performed. The most suitable altitude depends upon such factors as the mission, the character of hostile fighter activities, the amount and effectiveness of hostile antiaircraft fire, the performance characteristics of the aircraft employed; the ceiling; visibility conditions, clouds, or other weather conditions; the degree to which the aircraft is camouflaged and its motor muffled; as well as the type and details of the information to be obtained. During the conduct of a single mission it may be necessary to operate at various altitudes, that is, to cross the lines at the maximum altitude, and to descend to within a few hundred feet at the objective in order to obtain essential details. Photographic missions usually are flown at greater altitudes than visual observation missions. In general, the greater the detail required the lower the altitude at which the objective must be examined. Except for some photographic missions, including mapping photographic missions, the choice of altitude should be left entirely to the pilot and observer performing the mission. They will fly at the altitude that will be most favorable for obtaining the desired information and at the same time expose them as little as possible to the chance of being shot down.

b. Distant reconnaissance missions ordinarily are flown at the maximum altitude permitted by atmospheric conditions and the service ceiling of the airplanes employed.

c. Close reconnaissance missions ordinarily are flown at that altitude which will provide the necessary detail without a too serious compromise of security. When practicable, the

maximum altitude is utilized for the approach and withdrawal, the airplane descending to the altitude most suitable for examining the objective when at or in the vicinity of the objective.

d. (1) In the absence of effective fighter opposition, battle reconnaissance missions are flown at low or intermediate altitudes. So long as the airplane remains over friendly territory, the observation team is free to select the altitude most favorable for air observation. When over enemy territory the airplane must be kept above the effective range of small-arms fire, about 2,500 to 3,000 feet. It will then be within the effective altitude band of small-caliber antiaircraft artillery. Decision as to whether to operate in that band or go higher into the band of larger-caliber antiaircraft artillery (above 4,500 feet) will be governed by the nature of the information sought and the relative amount and effectiveness of the two types of antiaircraft artillery.

(2) In the presence of effective hostile fighter aviation, daylight battle reconnaissance missions are flown at extreme altitude, observation being conducted from as deep within friendly territory as possible.

■ 21. NIGHT OPERATIONS.—Despite the difficulties of night reconnaissance, an experienced air observer usually can obtain valuable information. His success is based on his knowledge of the appearance of things at night, what to look for, and where to look for it. It is very difficult for the enemy to carry on much activity at night without indications of it showing in some form, for example:

a. Columns.—On light-colored roads, columns are visible in the form of dark irregular masses. Men walking in single file on each side of the road are practically invisible on an average night, but their presence may be disclosed by accidental light or reflection from metallic equipment.

b. Bivouacs.—The location of bivouacs may be disclosed by light, fire, or by visible smoke, especially during the early part of the night. The ground in the vicinity of a bivouac or encampment becomes lighter in appearance, and paths may appear in a few days because of the trampling of the vegetation.

c. Trains.—On clear nights, trains can be seen against a contrasting background. Horse-drawn and motorized

trains may be distinguished by the difference in their rates of movement. The presence of a considerable number of vehicles in a limited area may indicate the location of a supply depot or dump.

d. Rail transportation.—Railroad trains ordinarily can be seen from low altitudes on clear nights. On dark nights the location of a railroad train may be indicated by the lights on the rear of the train, by the glow in the cab of the engine or the reflection on the smoke when the fire door is opened, or by a shower of sparks from the smokestack. Railroad stations may be located by platforms, the convergence of roads, or by lights, particularly the red and green signal lights.

e. Airdromes.—The discovery of airdromes at night ordinarily is difficult, unless hostile flying activity discloses their location. On clear moonlight nights, airplanes taxying, taking-off, or landing may be seen, and the presence of aircraft on the ground may be noted. On dark nights activity may be indicated by signal, boundary, range, or flood lights. If the location of the airdrome is known, activity or preparations for activity may be discovered by the use of flares or night photography.

f. Antiaircraft defenses.—Antiaircraft defenses, being easily concealed or camouflaged, are difficult to discover at night, when not in action. Antiaircraft artillery in action is disclosed by the searchlight beams, and by the flashes of the guns and machine guns, but it may be difficult to plot their position accurately unless recognizable terrain features can be seen.

g. Artillery.—Field artillery batteries may be hidden in woods and ravines, and usually can be discovered at night only when they are in action. The exact location of a single gun may be difficult to determine, as the flash is of short duration, but it often is possible to estimate very closely the zone of batteries in action. The caliber of the guns frequently may be determined by their rate of fire.

h. Front lines.—The opposing front lines usually are indicated by rockets sent up at various intervals. An observer who is thoroughly familiar with his sector can, by flying low, identify the bursts of shells and the fire of rifles or machine guns. A careful observer should, except under conditions of

poor visibility, be able to detect heavy reinforcements moving into a given area. Information of such movements is very important because they usually indicate an impending attack.

■ 22. ACCURACY OF REPORTS.—It is essential that observers exercise care in the preparation of their reports, in order that the information gained may be accurately and completely stated. An observer should report exactly what he saw, where he saw it, and the time at which that particular observation was made. Without all three factors, *what, where,* and *when,* with regard to each item of information reported upon, the missions may have been a waste of time. Special care must be exercised in avoiding errors when reporting negative information. An observer may correctly state, for example, that no troops were observed at a particular place at a specific time. Because of the possibility of concealing troops from the view of the air observer, a report that no troops were at that place at the time of observation might be erroneous. When enemy forces are seen, however, the report should include as accurate an estimate as can be made of their strength, composition, disposition, and direction and rate of movement.

■ 23. NATURE OF INFORMATION.—The nature of the information desired will affect both the time and the manner in which air reconnaissance and observation is executed. Orders for air reconnaissance and observation of defended areas should, whenever practicable, call for information in the simplest form which will meet the requirements of the situation and which at the same time will require the least exposure of the airplane to enemy fire.

■ 24. COMMUNICATION.—*a.* On close and distant reconnaissance missions, radio communication is necessary if the time factor is important. However, the use of radio should be kept to a minimum by reconnaissance airplanes deep in enemy territory to reduce the probability of location and tracking by means of radio goniometry. Long messages should be dispatched in a series of short transmissions, with sufficient interval between transmissions to enable the airplane appreciably to alter its position.

b. Radio is the most satisfactory method of communication for artillery missions conducted by airplanes, but in the

event that radio cannot be used, acceptable results can be secured from other means of air-ground communication, such as wing signals, pyrotechnics, etc.

c. Two-way radio, and dropped messages, pick-up messages, and panels provide the most satisfactory methods of communication. Pyrotechnics, signal lamps, and other means of communication are employed, if necessary, in accordance with prearranged plans.

■ 25. SECURITY.—*a.* (1) When the task of a reconnaissance mission involves deep penetration of hostile territory, the hours of darkness should be utilized to the maximum extent. If the nature of the mission or other conditions preclude night reconnaissance, the hours of darkness should be utilized either for the approach or the withdrawal.

(2) Unfavorable weather conditions which do not definitely preclude air reconnaissance may contribute to security if they can be utilized. The opportunities afforded for concealment by clouds during the approach and withdrawal, and while at the objective, should be exploited to the utmost. Airplanes on contact missions or engaged in tracking enemy surface forces should withdraw into the clouds whenever practicable upon completion of each examination of the objective, and should utilize the clouds to cover their successive approaches to the objective. In the case of solid overcast conditions of such a nature as to preclude over-the-clouds flight, a certain amount of concealment can be obtained by flying just in the clouds, emerging periodically if necessary to check position or observe. Aircraft approaching an objective from the sun are difficult to see, hence the up-sun approach should be utilized whenever practicable.

b. (1) Observation airplanes cannot execute daylight battle reconnaissance missions in areas dominated by hostile fighter aviation without serious losses. If they must be employed for such reconnaissance regardless of the probability of loss, they operate at maximum altitude and restrict to the minimum the depth of penetration and time of exposure. If attacked, they seek the protection of friendly antiaircraft fire, losing altitude rapidly by irregular maneuver to gain speed and eliminate attacks from below.

(2) When the hostile air situation is such as to permit the execution of daylight battle reconnaissance missions at low or intermediate altitudes, the speed, course, and altitude of the airplane are changed continuously while over enemy territory to avoid effectively aimed antiaircraft fire. Pilots avoid circling objectives or remaining in restricted areas for more than 1 minute at a time. If the required information cannot be obtained in 1 minute, the pilot withdraws some distance and reapproaches the objective from a different direction at a different altitude.

■ 26. AIRDROMES.—*a.* Because of the profitable targets they present for enemy air attack, the use of group airdromes for reconnaissance and observation aviation supporting ground forces should be avoided whenever practicable.

b. The airdromes of units of reconnaissance and observation aviation should be located in the vicinity of the supported unit and included in its communication net whenever it is practicable.

(1) Units of reconnaissance aviation supporting combat aviation should be based within the base area of the supported force and should be included in its ground and air communication net.

(2) Units of reconnaissance and observation aviation operating in support of ground forces should establish advance landing fields in the immediate vicinity of the command post of the unit which they support.

c. Airplanes should be concealed if cover is available on or accessible to the airdrome. If cover is not available, the airplanes should be dispersed.

■ 27. CAMOUFLAGE.—*a.* Reconnaissance and observation airplanes should be camouflaged whenever possible to reduce their distinguishability by enemy ground and air forces. Flight camouflage is generally ineffective early in the morning or late in the afternoon and when the airplane is silhouetted against a cloud background. It is of limited value against air observation when the angle of view is horizontal or nearly so.

b. Proper camouflage of airdromes, airdrome installations, landing fields, and airplanes on the ground will materially reduce their distinguishability. Simulated airdromes with salvaged and dummy airplanes present a means of misleading

the enemy. The amount of camouflage required at advance landing fields depends on the number of airplanes located there and the attitude of the enemy. One or two airplanes on an advance landing field normally would not be a profitable target for enemy air attack, but if it is enemy practice to attack such targets then the airplanes should be concealed when present. (See FM 5–20.)

■ 28. OPERATING INFORMATION FOR AIR COMMANDERS.—In actual operations there will rarely be an occasion when all the missions desired can be performed. Air commanders should maintain an adequate reserve for pending developments and always guard against exhausting their units prior to the arrival of the final or critical phase of the battle. Accomplishment of this objective may be facilitated by the following procedure:

a. Anticipate the developing situation by keeping in close touch with the plans of the superior commander by—

(1) Frequent conferences with the staff of the supported unit.

(2) An adequate exchange of liaison officers.

b. Detail only a reasonable number of air observation teams to be on the alert.

c. Advise all personnel when they are not subject to call in order that they may take advantage of a designated period for needed rest.

d. Combine missions whenever possible.

e. Advise the commander of the supported unit when the remaining number of air observation teams available to conduct missions begins to encroach upon a reasonable reserve.

CHAPTER 2

AIR RECONNAISSANCE FOR AIR FORCE AVIATION

SECTION I

GENERAL

■ 29. PURPOSE.—Air reconnaissance is performed in support of air force aviation for the purpose of developing objectives and of obtaining information essential to the accomplishment of combat missions. In some situations combat units may themselves be required to obtain much of the information they need; however, reconnaissance aviation normally provides air reconnaissance as a service of information for combat aviation.

■ 30. MISSION.—Offensive air operations may be conducted over either land or sea areas, therefore units performing air reconnaissance for combat aviation forces must be trained and equipped to operate effectively over land or sea. It is essential that the area covered by reconnaissance aviation in gaining information for air force aviation extend far beyond the sphere of action of ground forces and that it include all probable objectives for the application of air power.

SECTION II

SECURING INFORMATION

■ 31. GENERAL.—The air offensive relies on air reconnaissance for current information of known objectives and for the development of new objectives.

■ 32. SEARCH OF SEA AREAS.—*a.* Reconnaissance aircraft may be employed in search operations over sea areas in one or more of the following ways:

(1) In cooperation with, or in lieu of, surface vessels engaged in search operations.

(2) In cooperation with ship or shore based naval reconnaissance aircraft.

(3) In independent reconnaissance missions in support of GHQ aviation forces.

b. Reconnaissance missions over sea areas will, in general, have one or both of the following purposes:

(1) To prevent the undetected approach of a hostile naval force. In the normal case, the desirable limit of this operation will be sufficiently in advance of the territory to be protected to prevent a surprise attack being launched by surface or air against the protected locality.

(2) Search for specific objectives in defended areas. In this type of search operation, the profitable limit of search is normally the radius of action of the friendly air striking forces.

■ 33. SEARCH TERMINOLOGY.—The following terminology is employed in the discussion of methods of search. (See fig. 1.)

Search.—Reconnaissance for the purpose of locating objectives in sea areas within which little or no information is available concerning enemy activity.

Scout.—An airplane engaged in search.

Scouting line (*AB*).—A straight, broken, or curved line on which scouts are located in a formation suitable to conduct a scouting operation in accordance with a definite plan.

Scouting distance (*FN*).—The distance in miles between adjacent aircraft on a scouting line. Under ordinary conditions a distance equal to seven-tenths of the radius of visibility is considered sufficient leeway for air navigational errors and changes in weather conditions, since for the parallel part of the search the scouting distance will be 1.3 times the radius of visibility (twice the radius of visibility less allowance for error).

Scouting front (*OP*).—The distance in miles measured along the scouting line from the extremity of visibility on one end of the scouting line to the extremity of visibility at the opposite end of that line.

Scouting interval (*QRTSC*).—The distance in miles measured between two scouts which are patrolling the same line, measured along this line. (This definition is used only in certain methods of search.)

Position circle (*IJK*).—A locus of position points of a force which has proceeded a known or assumed distance from a known or assumed point of departure. The circle is drawn with the point of departure as a center and a radius equal to the distance covered by the force. Point *H* represents the last reported position of enemy surface craft.

Scouting course (*AD*).—The course made good by scouts when searching toward the enemy or across his probable routes. Scouting course, line *AD*, is 90°.

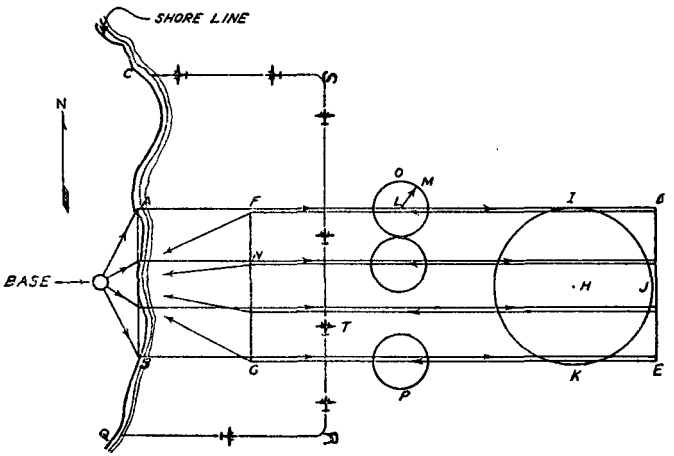

FIGURE 1.—Terminology chart.

Line of departure (*AB*).—The initial position of a scouting line, from which scouts proceed on their prescribed courses for search.

Line of retirement (*DE*).—The position of the scouting line at which a search to the rear is initiated.

Line of return (*FG*).—The position of the scouting line where scouts leave their stations on the scouting line and return to their bases.

Maintenance of scouting line (*OP*).—The scouting line is said to be maintained when scouting distance and scouting front are kept constant.

Line of bearing (*AB*).—Line of bearing of a scouting line is the direction of a straight scouting line *from* a reference

point, expressed as a true bearing from that point. Since *A* is the reference point, the line of bearing of the scouting line is 180°.

Point of origin (A–B).—The point of origin of a scouting line is the geographical position of one end of the initial position of the scouting line.

Radius of visibility (LM).—The radius of a circle from the center of which the object to be observed can be seen in any direction.

■ 34. FACTORS AFFECTING SEARCH.—The methods to be used in search operations can be determined only after careful consideration of the factors which may influence the search. Some of the more important factors are—

a. Characteristics of searching aircraft as to range and speed.—These characteristics affect the size of the area that can be searched, the time required for search, and the frequency with which the search can be repeated.

b. Number of aircraft available for search.—This factor primarily affects the size of the area that can be searched.

c. Availability of convenient base or bases from which search operations may be conducted.—This becomes a major factor if the operating base or bases are located in areas considerably removed from the coastal frontier, as such location necessitates the operation of aircraft over unprofitable land areas prior to taking up the search.

d. Size and shape of area to be searched.—These factors have a direct bearing on the number of airplanes required, the hours of daylight essential for the operation, and the method of search employed. The search of a long narrow area extending seaward to the limit of the radius of action of the scouts presents problems materially different from those that arise in the search of a long coastal area of limited depth seaward.

e. Time available for search.—Sea search at night is relatively unprofitable; hence, the amount of daylight available for the conduct of the search will influence the selection of the search method.

f. Weather conditions.—Weather is a factor primarily because of its effect on visibility and the safety of flight. Weather conditions, if sufficiently unfavorable, may preclude flight operations entirely.

g. Flight navigational errors.—The scouting distance normally is based upon the estimated radius of visibility in the search area for the type of objective sought, less the allowance for air navigational errors; hence these errors influence the number of scouts required for the search of a given area.

h. Location, direction, and rate of movement of objective.—The location, direction, and rate of movement of the objective directly influence the extent of the area that must be covered. The rate of movement and the time elapsed since the objective was last sighted will determine the size of the position circle.

■ 35. METHODS OF SEARCH.—*a.* Search operations may be conducted in a wide variety of methods. No one plan is adaptable to all situations. The methods selected for employment in any particular situation should be well suited to the conditions existing at the initiation of the search and those likely to be encountered during the operation.

b. Search plans should be as simple as possible. The problems of navigation, particularly when operating over sea areas out of sight of land, are tremendously increased if the plan requires that a multiplicity of courses be flown during the mission.

c. Aircraft engaged upon search missions usually operate singly within assigned subareas or along designated courses, the whole operation being so coordinated as to insure complete coverage of the entire area to be searched. When the number of aircraft available is insufficient to examine effectively all of an area desired to be searched, it is far better to search the entire area as thoroughly as possible than to search completely a portion believed to be critical. Search operations may be performed by aircraft in tactical formation whenever the situation is such as to require either offensive or defensive action beyond the capabilities of individual aircraft.

d. When the immediate attack of objectives discovered during search operations is required, the scouts are equipped with the required offensive armament, and the search is conducted in a manner most favorable to the success of the attack. The tactics and technique of air attack are covered in FM 1–10

■ 36. PARALLEL SEARCH.—*a.* Parallel search is a form of search in which the scouts take position on a scouting line which is advanced by the movement of all scouts along parallel courses.

b. As a method, parallel search has the following advantages:

(1) It is applicable for use by long range scouts.

(2) It provides the same coverage for the whole area searched by distributing the scouts uniformly along the scouting line during the advance. Normally, the scouts are spaced at a distance equal to twice the radius of visibility or less, depending on the degree of concentration desired to offset possible errors in navigation or changes in visibility.

(3) It is applicable for use by airplanes based on airdromes dispersed generally in rear of the initial position of the scouting line.

(4) It is fairly flexible. However, the orders for the search pattern, assumed visibility, etc., should be issued well in advance of the time search is to be initiated. Last minute changes in orders should be avoided. If a scout drops out shortly before the mission is to be flown it usually is preferable to continue with the search as originally planned rather than attempt readjustment of the scouting line at that time.

c. (1) In parallel search, the aircraft proceed from their operating bases to initial positions on a line of departure, which may lie along the edge of the area to be searched, along the shore line, or in any other convenient position. The line of departure should be so located, if practicable, that the participating scouts can accurately locate their respective initial search positions. The several scouts normally leave the line of departure simultaneously and proceed along parallel courses to a designated line of retirement.

(2) The scouting distance is normally based upon the estimated radius of visibility in the search area for the type of objective sought, less the allowance for air navigational error. In the absence of definite information of the width of the disposition of the forces sought, no allowance should be made for disposition width, the search being conducted on the basis of discovering a single vessel.

(3) The maximum distance at which the line of retirement can be located is determined by the operating radius of the scouts. The minimum distance at which the line of re-

tirement should be located is determined by the requirements of the mission, based upon the capabilities of the enemy forces and time and space factors.

(4) Airplanes on reaching the line of retirement normally retrace their outward flight paths.

(5) Parallel search patterns incorporating lateral movement of the scouts at the line of retirement, to permit the use of more than double the radius of visibility (less the allowance for navigational error) between adjacent flight courses, should be avoided if possible. Because of the "holes" in such search patterns, single vessels and even small forces may escape detection, even though they remain continuously in the searched area. However, if the objective sought is a large naval disposition of known width or diameter, and if the scouts available for the search are insufficient in number to permit covering the area otherwise, they may displace laterally at the line of retirement a distance not to exceed the known least dimension of the enemy disposition, returning on courses parallel to, but one side of, their outward courses. All airplanes should displace in the same direction.

d. A method of parallel search from a single base to prevent the unobserved arrival of a hostile aircraft carrier within an

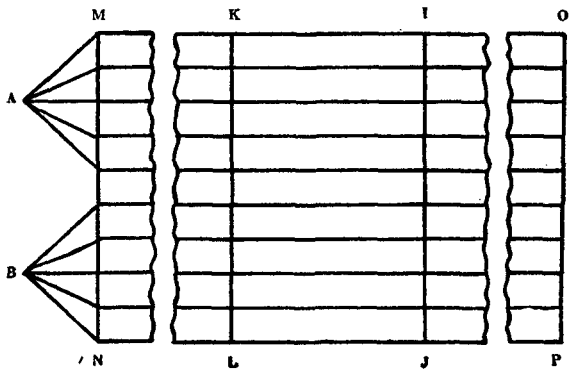

FIGURE 2.—Parallel search.

area from which objectives on or near the coast could be attacked is outlined in figure 2. The area to be searched is determined by the extent of the coast line which is to be

defended against surprise attack. The extent of the area which can be searched simultaneously is limited by the number of aircraft available. The coverage of only a narrow front is shown in figure 2; the method is the same for any practicable width of front.

e. (1) The search plan outlined in figure 2 is based upon the following assumptions:

(*a*) Weather, clear; radius of visibility, 15 miles; daylight 6:00 a. m., darkness 6:00 p. m.

(*b*) Range of hostile aircraft, 1,000 miles.

(*c*) Speed of hostile aircraft, 180 m. p. h.

(*d*) Speed of hostile carrier, 25 m. p. h.

(*e*) Range of scouts, 3,000 miles.

(*f*) Operating speed, 180 m. p. h.

(*g*) Information of enemy force—None.

(*h*) Time available for search—Daylight examination of critical areas.

(*i*) Scouting distance, 20 miles (twice the radius of visibility less 10 miles for navigational error).

(2) *A* and *B* represent two airdromes located about 100 miles apart and well in from the coast line. The line of departure *MN* is on the coast line. The line of retirement *OP* is approximately 1,095 miles from the coast line. The location of the line of retirement is determined in this case by the performance of the enemy equipment and by the fact that only one search is to be made every 24 hours. The determination is as follows:

Let a=maximum distance from coast line that carrier can release its aircraft, steam in, and recover them.
b=operating radius of carrier-based aircraft.
c=endurance of carrier-based aircraft.
d=speed of carrier.

Then:

$$a=b+\frac{c\times d}{2}$$
$$=500+\frac{5.55 \text{ hours}\times 25}{2}$$
$$=569 \text{ miles.}$$

The maximum distance at which the hostile aircraft can be launched, reach the coast line, and return to the carrier is 569 miles, represented by the line *IJ*. If aircraft are re-

leased on the line *IJ*, the carrier must steam toward the coast and pick up the aircraft at 1,000 less 569 or 431 miles out, represented by the line *KL*. If the carrier could reach the line *KL* to discharge the aircraft, it could steam outward and pick them up on the line *IJ*. The problem then is to prevent the carrier reaching the line *IJ* (569 miles out) unobserved. The line of retirement must be out far enough to prevent the carrier from arriving on the line *IJ* between searches. Leaving the line of departure at daylight, the searching aircraft can reach the line *IJ* (569 miles out) at 9:10 a. m., and the carrier must be within 600 miles of that line to reach it by 9:10 a. m. the next day, steaming toward the coast at 25 miles per hour. The scouts must, therefore, search beyond the line *IJ* to a distance equal to 24 hours' steaming of the carrier, divided by the rate of approach of the carrier and scouts, times the speed of the scouts, or:

$$\text{Distance}=\frac{600}{180+25}\times 180=527 \text{ miles.}$$

569 miles+527 miles=1,096 miles, thus fixing the position of the line of retirement *OP* at that distance from the coast line. Aircraft with an operating range of 3,000 miles can go 1,096 miles to sea and return to the line of departure with ample allowance for operation from airdromes located well back from the coast. The above computations do not make any time allowance for the effect of wind, for hostile aircraft to launch an attack after reaching the coast line, or for the launching and recovery of the carrier-based aircraft. An application of appropriate factors for these effects tends to reduce the distance to the line of retirement.

■ 37. RADIAL SEARCH.—*a.* Radial search, as its name implies, is a method of search wherein the scouts leave a common point and fan out radially. Even when some other form of search is employed, the beginning and end of the search may take the form of a radial search, since oftentimes the scouts are based at one airdrome.

b. As a method, radial search has the following advantages:

(1) It is best suited for use by a number of scouts of short or medium endurance operating from a single base.

(2) All scouts leave their point of origin at the same time.

(3) An equal coverage is obtained in all directions to which the search is projected in, roughly, the same elapsed time.

(4) During the period when the scouts are near the point of origin, they are relatively close together. This results in a better coverage of that part of the area nearest the point of origin, and also permits early concentration of scouts at any objective found near the origin.

(5) Unless sectors are omitted, the flanks of the area are constantly covered against enemy approach.

c. Disadvantages of radial search are as follows:

(1) It is not adapted to search of very long radius. As the scouts fan out, a distance is reached beyond which the scouting interval would become excessive. This can be overcome by using a large number of scouts in a limited sector, but would not result in economy of forces.

(2) Except near its outer limit, the scouting front is not as great as in other standard methods.

(3) The coverage over the area is not equally efficient.

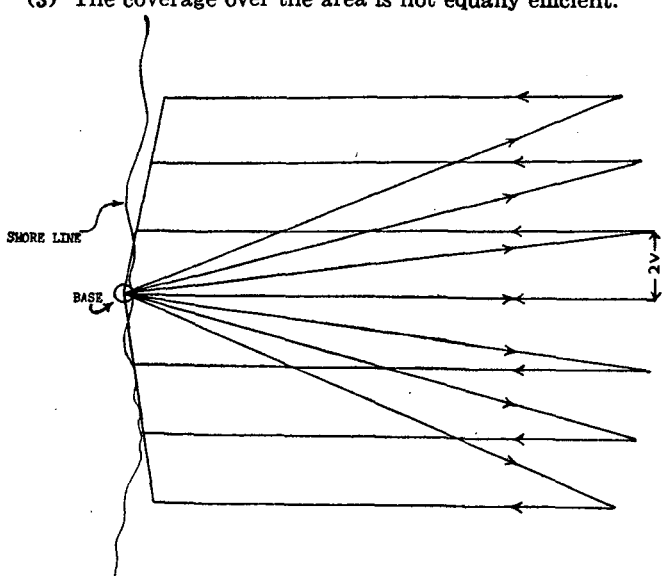

FIGURE 3.—Radial search followed by parallel track search—2V = 2 × visibility.

(4) Because of the wind, all the scouts usually do not reach the limits of the sector at the same time.

d. There are a number of forms of radial search, each of which has its own particular advantages and disadvantages.

(1) When a return search is desired, the airplanes on reaching the line of retirement return along parallel tracks. This method is feasible when the maximum distance between scouts at the line of retirement equals twice the visibility. Figure 3 illustrates this search pattern.

(2) If the search has been flown so that the distance between scouts is three times the visibility, at the line of retirement, complete search can be obtained by each scout moving laterally the radius of visibility at the line of retirement and then returning to his base. This is illustrated in figure 4.

(3) If a complete return search is not required, the scouts on reaching the line of retirement move laterally one-half the radius of visibility and then return to their base. The number of scouts required is thus less than if each scout retraced its outward course. This form of search provides practically complete coverage at the outer limit of the search area and also insures double coverage of the inner part of the area on the return search, due to the convergence of the scouting courses.

(4) If the area to be searched has considerable depth and it is desirable that the search be completed as quickly as possible, the double bank method of radial search is indicated. In this method of search, the search area is divided into inner and outer sectors. One group of scouts searches the inner sector, while a second group concurrently searches the outer sector. This method of search is particularly valuable when the search must be completed as shortly after daylight as possible. In such a case, the outer bank of scouts takes off at such time as will permit them to arrive on the line of retirement of the inner bank at daylight; the inner bank takes off at such time as will permit them to initiate their search at daylight also. The search of the two sectors thus proceeds concurrently and, if the sectors are approximately equal in depth, the search is completed in half the time that would be required if one group of scouts covered the entire area. This method of search lends itself to the combined

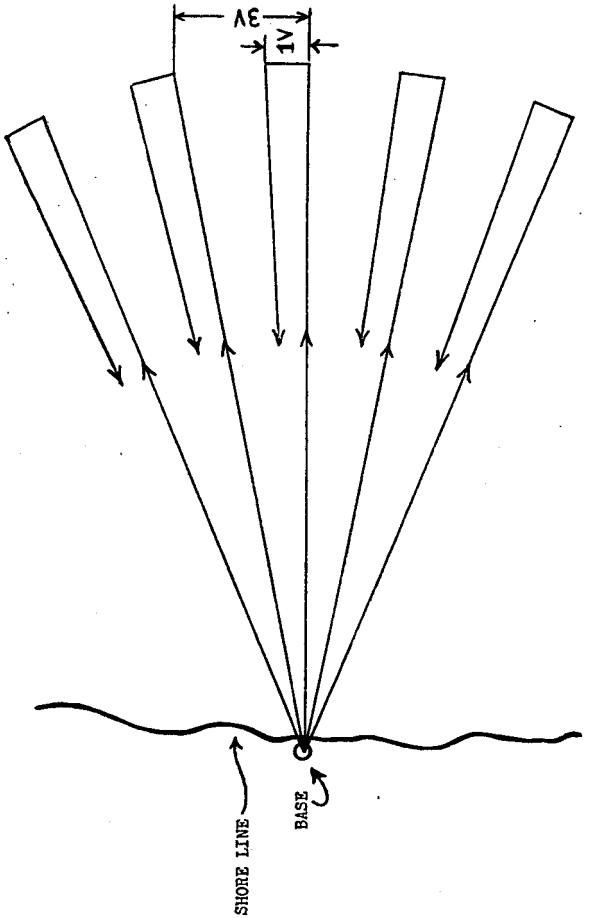

FIGURE 4.—3V radial search—3V = 3 × visibility.

use of long and short range scouts. Figure 5 illustrates a double bank radial search.

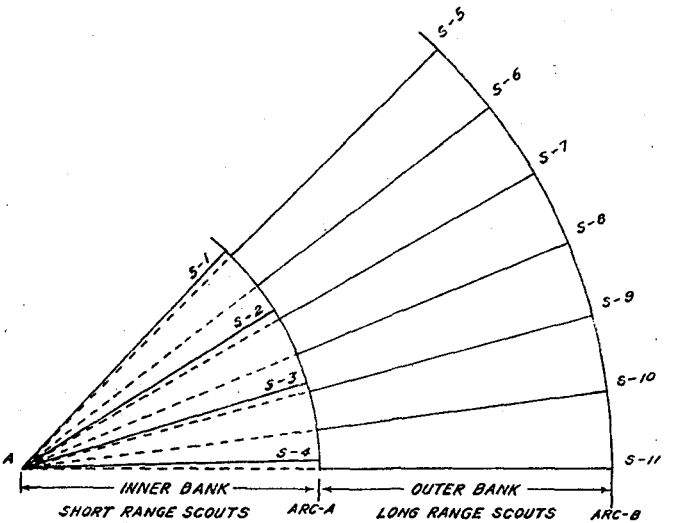

FIGURE 5.—Radial search, double bank method.

■ 38. RADIAL-PARALLEL SEARCH.—*a.* A combination of radial and parallel search methods may be employed in searching for an objective reported to have been in a specific position at a previous time, with location, time, and space factors such as to preclude the possibility of the objective being in the immediate vicinity of the base at the time the search is started.

b. In this method of search the scouts fan out radially on leaving the base. On reaching a predetermined line (which may be either straight or curved and which may be reached individually or concurrently), the scouts change from diverging to parallel courses. On reaching the line of retirement the scouts may either return along their outward flight courses or directly to the base. If the critical area is far offshore, the scouts should be kept in formation while proceeding to the point from which the critical part of the search will begin. This should insure a more thorough search of

the critical area since the line of departure is more accurately established thereby.

c. In the planning of this form of search, the essential requirement is that the spread of the search fan and the depth of the search be sufficient to include all possible positions of the objective under the existing conditions of elapsed time, relative speed, wind force and direction, and other influencing factors. The required fan spread and depth of search can be accurately determined graphically by plotting a large number (twenty or more) possible objective courses (evenly spaced through the area of possible movement), and plotting for each such course the point at which the objective can be intercepted under the conditions of time of take-off that can be made good by the scouting force, the estimated wind in the search area, and the assumed maximum speed of the objective. If the points of interception are connected by smooth, curved lines, they will outline the area that must be searched and thus show the required search fan spread and the depth of search necessary.

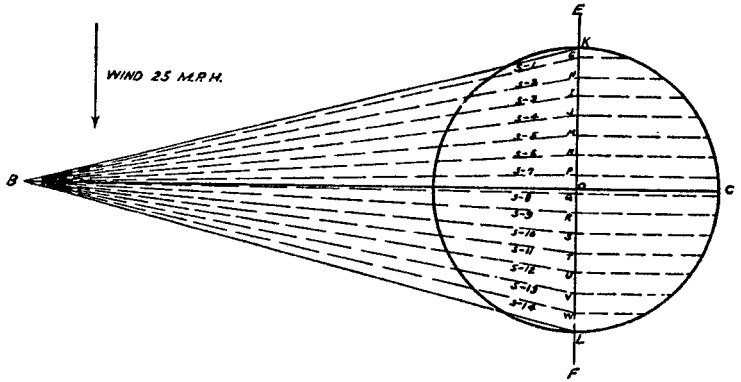

FIGURE 6.—Radial-parallel search.

d. In the event that time does not permit such accurate determination of the objective's position area and hence of the required fan spread and search depth, that area can be determined approximately in such a manner as to insure that the

objective cannot be outside the search pattern. To be on the safe side, such approximations will always include more area than the objective can possibly reach and hence will require more airplanes than would be necessary with the more exact determination, but nevertheless these methods are of value when time is a vital element.

e. A radial-parallel search plan based on one method of approximating the area to be searched is shown in figure 6.

f. (1) This search plan is based on the following assumptions and command decisions—

(*a*) The objective was located under such conditions that it could not be trailed. Its subsequent movements are not known. It is estimated that the location report is accurate to within 20 miles.

(*b*) Receipt of the location report was delayed 2 hours due to communication conditions.

(*c*) Time and space factors necessitate minimum time for plotting search pattern.

(*d*) Scouts will take off individually at such time as to arrive on the line *KL* where scouts change from diverging to parallel courses simultaneously. The scouting line will advance from the line *KL* as a straight line.

(2) The search pattern is plotted as follows—

(*a*) The base *B* and the reported position of the objective *O* are plotted, using a convenient scale.

(*b*) The point *C* at which interception would be made under the prevailing wind conditions, assuming the objective moved continuously directly away from the base on a course in prolongation of the line *BO* at maximum speed, and that the probable error in the reported position would not exceed 20 miles, is plotted.

NOTE.—In computing interception, use the time of take-off that can be made good and the air speed at which it is planned to operate.

(*c*) With a distance equal to *OC* as a radius and with point *O* as a center, a circle is struck off.

(*d*) The line *EF* is drawn through point *O* perpendicular to the line *BC*. Points *K* and *L* mark the intersection of that line with the circle. Line *EF* is the line at which the airplanes will change from diverging to parallel courses.

(*e*) Lines *BK* and *BL*, forming the triangle *BKL*, are drawn. Under the assumed conditions, if the objective lies on the line *EF*, or anywhere on the base side of that line, it must lie within the triangle *BKL*. Hence the area *BKL* represents the area to be covered by radial search.

(*f*) Points *G*, *H*, *I*, *J*, *M*, etc., mark the positions of the individual airplanes on the line *KL*. They are spaced 1.3 times the radius of visibility under the existing visibility conditions, point *G* being seven-tenths the radius of visibility inside point *K*. When the scouts arrive on the line *KL* they change their course so as to fly parallel to the line *BC*.

(*g*) Since the distance *OC* represents the maximum distance the objective can travel prior to interception, the objective must lie within the semicircle *KCLO*, if it is not in the triangle *BKL*. Hence the arc *KCL* is the line of retirement. On reaching the line of retirement, all scouts discontinue the search unless otherwise instructed, and return individually to the base by the most direct route.

(*h*) Lines *S–1*, *S–2*, *S–3*, etc., represent the outward courses of the scouts. The return courses are not shown.

■ 39. SQUARE SEARCH.—*a*. This method of search is of great use in locating a target, whether stationary or moving.

b. It has its most frequent application in a striking force when, on flights to a target, arrival at the dead reckoning position fails to disclose the target. At that time the search is begun.

c. In order successfully to prosecute the search, an assumed visibility must be used and courses and distances to be flown on the different legs must have been calculated before take-off or at least prior to arrival in the target area. Figure 7 shows the pattern of the search.

d. The length of the search is dependent upon the amount of fuel available for search, opposition encountered over the target, the assumed visibility, and the errors in the dead reckoning position of the target as obtained by the navigator.

■ 40. CROSS-OVER PATROL.—*a*. This type of patrol is highly satisfactory when patrolling a channel but can be used under other circumstances.

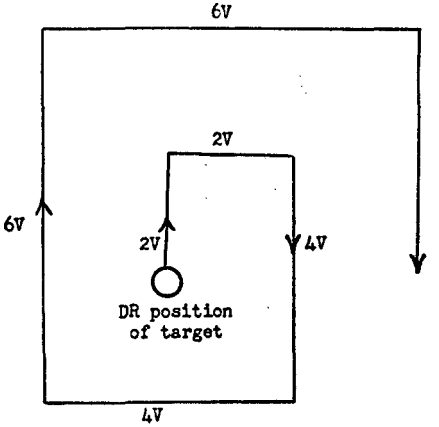

FIGURE 7.—Square search—V = visibility.

b. A cross-over patrol for covering a channel between two land areas is shown in figure 8.

Let: A=aircraft speed.
E=enemy speed.
V=radius of visibility.
XY=length of patrol.
D=effective length of patrol.

Then: $XY=\frac{2VA}{E}=2V$

However, the effective length of area patrolled (D) equals $\frac{2VA}{E}$ since visibility takes care of outer limits. Aircraft pass over point Z at intervals equal to $\frac{2V}{E}$ and over points X and Y at intervals equal to $\frac{4V}{E}$.

■ 41. ENDLESS CHAIN PATROL.—*a.* This type of patrol may be used when it is necessary to establish a patrol between two points in such a manner that no moving craft can pass without being detected.

b. Although the cross-over patrol accomplishes this more economically, it may be necessary, due to the distance between the two points, to use the endless chain method.

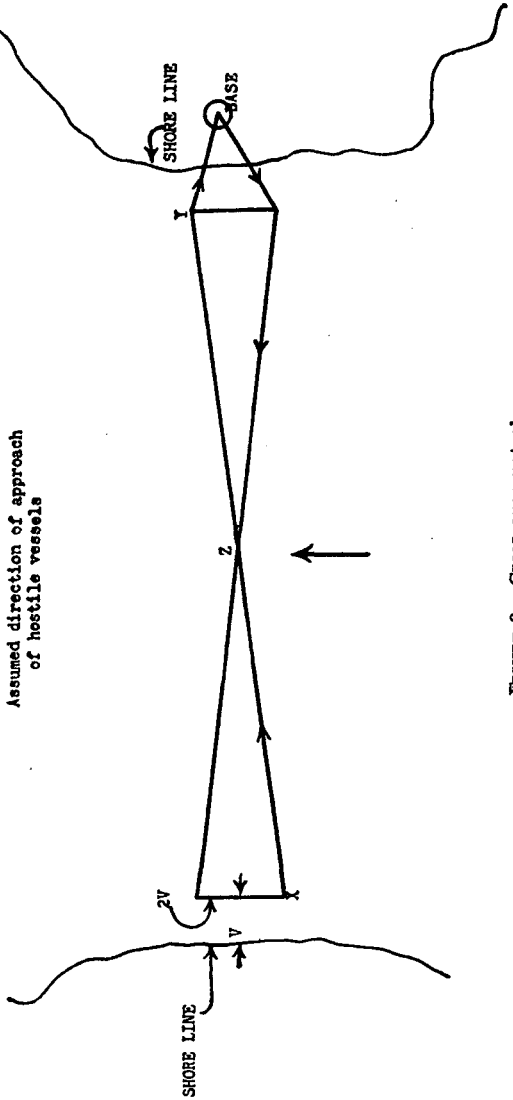

FIGURE 8.—Cross-over patrol.

c. An endless chain patrol is shown in figure 9.
Let V=radius of visibility.
E=enemy speed.

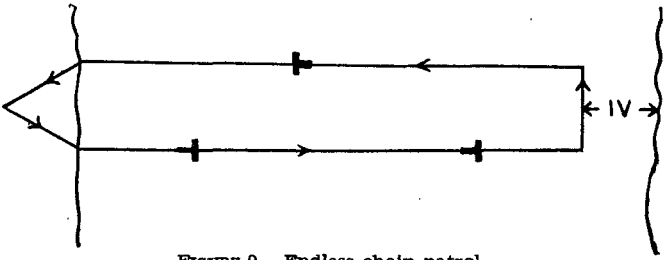

FIGURE 9.—Endless chain patrol.

Aircraft must pass any given point at a definite time interval so that moving craft will not be able to enter or leave the visibility distance without being detected.

The time interval will be:

$$\frac{2V}{E}$$

d. The efficiency of this patrol is unaffected by the distance between the outward and inward tracks. In practice this has been found to be about $1V$ or 10 miles apart.

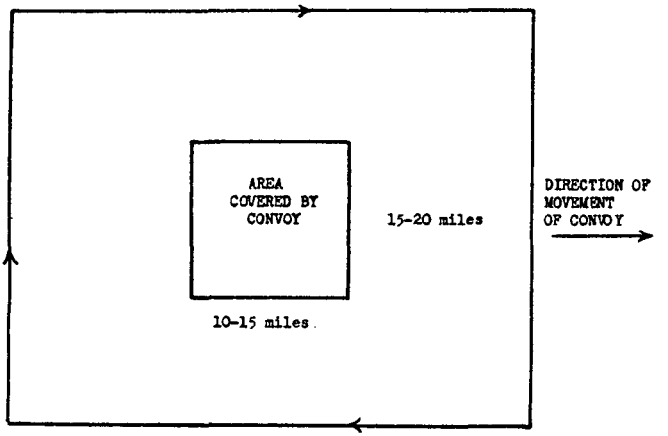

FIGURE 10.—Convoy patrol.

■ 42. CONVOY PATROL.—The name of this patrol describes its function. To avoid enemy countermeasures, the pattern to be used should vary. An effective one is the rectangular type illustrated in figure 10.

■ 43. CREEPING LINE AHEAD SEARCH.—This type of search may be used in conditions of poor visibility to locate a convoy or single ship which is to be escorted. Aircraft is flown to a point several miles ahead or astern of convoy's reported position depending upon the cirmumstances. Aircraft commences the creeping line ahead search up or down the convoy's course as shown in figure 11.

NOTE.—The distance of 15 miles again depends on circumstances, for example, accuracy of own DR and probable accuracy of convoy's reported position.

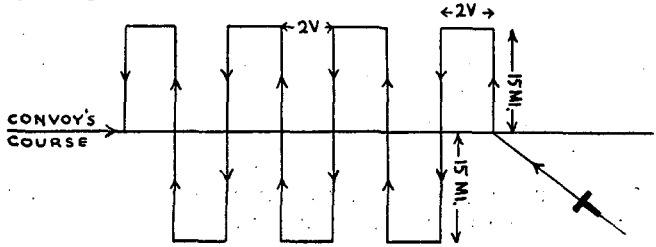

FIGURE 11.—Creeping line ahead search.

■ 44. RECONNAISSANCE MISSIONS.—*a.* Reconnaissance missions in support of aviation forces usually precede the operations of striking units in order to secure any information required in planning for the most effective employment of the striking unit. The requirements of reconnaissance missions frequently may be met by visual observation alone; however, photographic equipment will always be carried on all reconnaissance missions. Photographs frequently can be used to advantage in supplementing information obtained by visual means. When photographs are taken they should be taken in pairs with 60 percent overlap to facilitate stereoscopic study of the included area. Air reconnaissance missions executed for aviation forces are affected by the factors which govern the conduct of air reconnaissance as a whole, and the most suitable method for employment in any situation depends upon the nature of the information sought, the area to be covered, and the existing weather conditions.

b. Enemy opposition is to be expected during the conduct of reconnaissance missions, particularly those involving deep penetration of hostile territory or the examination of important enemy installations which are vulnerable to air attack. Single airplanes operating at high altitude and utilizing the existing clouds as the means of concealment will frequently escape detection by the enemy. Reconnaissance missions should be so planned that the exposure to active antiaircraft defense agencies will be as brief as possible consistent with the accomplishment of the mission.

■ 45. SURVEILLANCE.—Surveillance is executed for the purpose of keeping an activity, area, or objective under continuous observation. It is employed in support of aviation forces only when the desired results cannot be obtained in any other way and usually is carried out by airplanes operating singly. When a fleeting objective has been located for the purpose of launching an air attack against it, surveillance may be necessary in order to facilitate interception by the attacking force. Contact, development, and tracking of an enemy force may form a progressive phase in search operations and, in such situations, relatively protracted surveillance may be necessary. The security of aircraft engaged in the performance of surveillance is of paramount importance. Surveillance may be impossible in the presence of hostile fighter airplanes which are not otherwise engaged.

■ 46. CONTACT.—Reconnaissance may consist of periodically contacting air activity, area, or objective when continuous observation, though desirable, is impracticable. Personnel engaged in contact missions should avoid regularity, both in the interval between successive examinations and in the direction of approach and retirement, to guard against detection and surprise after several visits to the vicinity of the objective, particularly if the objective lies within the zone of action of hostile fighter aviation.

■ 47. TRACKING.—*a.* It may be necessary to track highly mobile hostile air, ground, or sea forces to determine the location of newly occupied enemy airdromes or air bases or the course and disposition of enemy surface or air forces or to secure other similar types of information. Tracking missions may be executed either by reconnaissance forces

or by aircraft detached from a tactical command in flight for that purpose, as when hostile aircraft are encountered during the conduct of a combat mission.

b. (1) Airplanes may be alerted on the ground for the specific purpose of tracking hostile airplanes reported to be in the vicinity. This action is of particular importance when the location of enemy air bases has not been determined. Carrier-based aircraft raiding a shore objective may be tracked to the carrier by reconnaissance airplanes which maintain contact with the carrier to facilitate an attack by bombardment aviation.

(2) Tracking aircraft at night is difficult at best and may be impossible under many conditions. However, if the area from which enemy air forces are operating is unknown and it is desired to locate that area, night tracking of hostile aircraft should be attempted.

c. The presence of tracking aircraft should be concealed from the force being tracked. In the case of aircraft the tracking airplane should follow behind at the maximum limit of visibility and at a somewhat lower altitude, maintaining, when advantageous, an up-sun position. In tracking naval surface forces defended by aircraft, the tracking mission should be flown in the manner prescribed for contact missions.

SECTION III

SUPPORT OF AIR ATTACK

■ 48. GENERAL.—Reconnaissance aviation supports the striking aviation in air attack by—

a. Developing objectives.

b. Guiding air striking forces to the objective.

c. Providing weather data over the route to and at the objective.

d. Illuminating targets for night attack.

e. Determining the results of attack.

■ 49. DEVELOPING OBJECTIVES.—For methods of developing objectives for air attack see section II.

■ 50. GUIDANCE.—*a.* When attacking units must operate over terrain with which they are not familiar they may have difficulty in locating objectives under conditions of low visi-

bility, especially when adequate flight maps are not available, or at night. Reconnaissance units may be of great assistance by providing information of the best route to and from the objective and also data as to landmarks en route that may be of value as check points. A single airplane free to search can locate a particular terrain feature more readily than can an attacking formation which may be operating on a carefully timed and coordinated schedule. Reconnaissance personnel familiar with the route may be utilized as navigators in the attacking units when desirable.

b. Reconnaissance aviation may be of great assistance to attacking units during night operations by dropping flares to serve as beacons to guide the attacking units to their objectives. The distance at which flares can be seen at night varies with weather conditions, and under favorable circumstances may be as great as 75 miles. The guiding aircraft precede the attacking unit by a suitable interval, depending upon conditions of visibility, and drop flares at predetermined intervals along the route without reference to particular terrain features to provide directional guidance, or at previously determined positions along the route to provide positional guidance. The plan of operation should provide for dropping flares at such intervals or in such localities as will facilitate the attack without indicating to the enemy the objective. Guiding aircraft must avoid flying in the vicinity of the objective until the attacking unit is ready to launch the attack. Guiding flares are dropped from high altitudes if it is contemplated that they will be visible for great distances; at other times they may be dropped in the same manner as are flares intended for illumination of the ground area over which they are dropped.

■ 51. WEATHER DATA.—*a.* Weather is a factor in determining the manner in which an air attack is delivered. When the objective is located deep in enemy territory it may be necessary to obtain special weather information for the objective area. This is a task for reconnaissance aviation supporting aviation forces.

b. The technique of executing a weather reconnaissance mission is similar to that for other types of distant reconnaissance. The orders for the mission will prescribe the information desired.

■ 52. ILLUMINATION OF TARGETS.—*a.* (1) The reconnaissance airplanes responsible for illuminating the targets may accompany the striking force to its initial point or may proceed there independently, arriving at a designated time.

(2) The number of illuminating airplanes required will depend upon the nature of the target and the ease or difficulty with which it may be located at night. Fewer airplanes are required to locate and illuminate a target disposed in length, such as a road or railroad, than are required for the location and illumination of a target which is more or less a point, such as a bridge, building, or airdrome. The amount of natural illumination and the proximity of the objective to easily recognizable landmarks will also be factors. Because of control difficulties, more than nine airplanes should not be assigned to a single illumination task.

(3) The navigators of the leading element of the illuminating force should be provided with aerial photographs of the target and its immediate vicinity to enable them to orient themselves by the light of the first flares dropped. Such orientation will reduce the possibility of an illumination failure on the first trip over the target.

b. The initial task of the illuminating force is the location of the target. The airplanes charged with this portion of the task fan out on leaving the initial point, taking positions abreast on a line at approximately 1-mile intervals. When about 5 miles from the estimated target center, these airplanes begin dropping illumination flares at 15-second intervals. Flares are dropped until the airplanes have passed 5 miles beyond the estimated target center, unless "target located" is signaled sooner. On receiving the target located signal, the initial illuminating airplanes withdraw. If the target has not been located, the search is repeated in accordance with the mission plan.

c. The next part of the illuminating task is to illuminate the target sufficiently to permit the bombardiers of the attacking force to lay their bomb sights on it, or to provide an illuminated aiming point. The airplanes charged with this part of the task fly to the rear and above the first group of illuminating airplanes. The observer first sighting the target signals by radio or pyrotechnics "target located"; he will then mark the target by flying low over it and releasing illuminating

flares, or by dropping a row of white phosphorus bombs through the target center. The remaining airplanes of the second part of the illuminating force then drop additional flares on the line of bombing approach, beyond the target (keeping the target within the flare area of illumination), or place intersecting rows of white phosphorus bombs through the target at such an angle that the attacking force is given a definite aiming point. They then withdraw.

d. On withdrawing, the illuminating force returns to its base. The difficulties of rallying at night, as well as the ineffectiveness of supporting night gun fire, render it inadvisable for the illuminating force to attempt to rejoin the bombardment formation for the return flight.

■ 53. DETERMINATION OF RESULTS OF ATTACK.—Determination of the results of air attack is a function of bombardment aviation. When, however, it is impracticable for bombardment aviation to accomplish this, reconnaissance aviation may be employed for the purpose. The reconnaissance airplane may accompany the attacking force or may examine the target later. Aerial photographs provide the most satisfactory record of the results of air attack.

CHAPTER 3

AIR RECONNAISSANCE AND OBSERVATION FOR GROUND FORCES

SECTION I

GENERAL

■ 54. GENERAL.—Observation aviation operating in support of ground forces does not replace any of the other intelligence agencies available to the commander of those forces but supplements them and can provide the commander with information which he cannot secure by any other means.

■ 55. TASKS.—*a.* Observation aviation is employed in the reconnaissance of areas in and beyond the zone of reconnaissance of ground troops. Its purpose is to obtain for the supported commander original and/or supplementary information on which he will base his tactical decisions. The reconnaissance of movements of hostile troops in rear and on the flanks of battle and of hostile detrucking points and detraining stations is of especial importance.

b. Observation aircraft are also employed for the execution of artillery and liaison missions. Whenever practicable, airplanes are reserved for missions involving the observation of objectives which are beyond the effective view of ground troops.

c. Normally, one or two airplanes are maintained on the alert at the squadron airdrome or at an advanced landing field near the division, corps, or army command post, prepared to execute liaison or emergency missions on order of the division, corps, or army commander.

SECTION II

DISTANT AND CLOSE RECONNAISSANCE MISSIONS

■ 56. ENEMY COUNTERRECONNAISSANCE.—The enemy will attempt to limit our air reconnaissance and observation by all

means at his disposal. If he elects to effect suitable concentrations of fighter aviation in a ground battle area, he may compel the use of combat type airplanes for or in support of observation missions involving flight over his territory.

■ 57. ARMY RECONNAISSANCE.—Reconnaissance missions for the purpose of securing information essential to the army commander are performed by the observation aviation attached to or supporting the army.

a. When the army starts its movement toward the enemy, the army aviation performs air reconnaissance missions in the area in which the army commander is vitally and immediately interested. These missions are executed well within enemy territory and cover the rear areas, flanks, and front of the hostile forces. The scope of army air reconnaissance includes such items of information as the location, strength, composition, route, and directions of movements of hostile forces; hostile defensive organization, lines of communication, and traffic thereon; construction; the location of enemy supply establishments, bivouacs, and airdromes; route reconnaissance; and the outstanding features of the terrain.

b. When the army operates on an independent mission in a separate theater, the army aviation performs both the normal GHQ and army reconnaissance functions. When on such a mission, the army may have combat aviation units attached. The army reconnaissance aviation performs the reconnaissance functions necessary to the practical employment of such support forces in the event the latter are not prepared to perform their own reconnaissance.

■ 58. CORPS AND DIVISION RECONNAISSANCE.—*a.* Corps air reconnaissance missions properly commence when the corps zone of operation is initially designated, and continue throughout the period during which the corps is in contact with the enemy. They are executed to secure detailed information of tactical importance to the corps commander within the area for which he is responsible. Corps reconnaissance is of a much more intensive and detailed nature than is the more distant army reconnaissance upon which the general plan for the employment of the corps is based. Corps reconnaissance missions usually involve continuous day and night observation within the corps zone of operation, for obtaining detailed in-

formation relative to the location of hostile advance forces, their strength, composition, movements, defensive organization, supply arrangements, and detraining points.

b. When contact between the two main hostile forces is imminent and the division air area has been defined, the division aviation takes over the intensive aerial reconnaissance of that area. Throughout the period that the division is on the front, continuous up-to-date information of the enemy and of the terrain, especially in the hostile divisional areas, is necessary to the division commander for the planning and execution of his operations. Particular attention is given to indications of enemy withdrawal, traffic, movements of reserves and reinforcements, defensive works, bivouacs of troops and of trains, artillery positions, ammunition distributing points, and command posts. Night air reconnaissance will be especially valuable in detecting rail traffic and troop and vehicle movements on highways; early morning and late evening flights often will pick up the ending or the beginning of such movements. Observation of the flashes of the guns during darkness affords an excellent opportunity for locating active artillery position. Ground observation, within the limits of visibility, can furnish much information of activity in the forward areas. The burden of air reconnaissance normally must be borne by the heavier-than-air units working with the division. Reconnaissance in the division air area requires close attention to minor details and usually involves the frequent photographing of enemy works, including trench systems, wire entanglements, machine-gun emplacements, artillery positions, supply dumps, command posts, and communication systems.

SECTION III

BATTLE RECONNAISSANCE MISSIONS

■ 59. GENERAL.—*a.* Battle reconnaissance missions include the location of the opposing front lines, observation of the progress of combat, location of hostile resistance holding up an advance or of enemy penetrations into our positions, and assembly of hostile troops for attack or counterattack.

b. During an attack the division commander and commanders of subordinate and adjacent units are particularly

concerned with points along the front where the attack has progressed; points where the attack has been stopped; points where units have been separated, leaving a gap in the line; and points where hostile forces are forming for counterattack.

c. When the enemy is launching an attack, these commanders are particularly concerned with points where penetrations have been effected and with the location and movement of hostile reserves.

d. The task of maintaining contact with our own front line units and locating and reporting enemy installations and activities near the front is primarily a responsibility of the ground troops. When these agencies prove inadequate, airplanes may be used to assist in the accomplishment of these tasks. Before directing missions of this type, commanders should take into consideration the high casualty rate to be expected and should balance this factor against the value of the information desired.

■ 60. AERIAL PHOTOGRAPHS.—Much of the information of friendly and enemy locations and activities in the forward areas can frequently be obtained by proper and systematic use of high altitude vertical and oblique aerial photographs. A large scale reconnaissance strip can be made of the general front line areas of a division front in a very short time. Overlapping verticals are the most suitable type of photographs for such study. The information obtained from photographs is frequently more complete and accurate than can be obtained by visual means in this area. Photographic reconnaissance is also much less hazardous to flight personnel and matériel than a low altitude visual observation mission. For these reasons, aerial photography supplemented by terrestrial observation should be fully exploited, visual observation from an airplane being employed only when all other means prove inadequate or too slow.

■ 61. LOCATION OF FRIENDLY FRONT LINES.—*a.* The location of the friendly front line may be obtained by signaling assault battalions "Display marking panels." Front line companies then display marking panels without delay. The observers may signal each assault battalion in turn "Display identification panels" and "Report your front line by pick-up message." If the battalion commander is in doubt as to the

location of his assault companies, he notifies the observer of this fact by signal or pick-up message.

b. These methods of locating the friendly front line require a complete understanding between the ground troops and the air observer. Proper teamwork can be obtained only after thorough training. Each rifle squad carries six marking panels—three black marking panels for use on snow or other light-colored background, and three white marking panels for use on normal background. When panels are to be used, the pilot flies toward the front until friendly troops are no longer exposed; the observer then identifies himself by means of a prearranged signal. He then fires a prearranged pyrotechnic signal calling on the infantry to "Mark front lines" by displaying marking panels. The observer marks the line of panels on his map or sketch for dropping.

(1) The use of panels to mark the front line requires that the infantrymen recognize friendly airplanes. The infantry should be warned, if practicable, of the approach of a friendly airplane which should have distinctive markings on the wings or fuselage and may also carry streamers for purposes of identification. It is essential that prearranged signals be employed as a means of identification to minimize the possibility of the display of marking panels to a hostile airplane and the danger of friendly airplanes being shot down by friendly troops.

(2) Panels facilitate the accurate location of the front line, but their use cannot be depended upon in all situations for the following reasons:

(*a*) Infantry engaged in an attack may be too much occupied to display panels.

(*b*) It is dangerous to display panels when they may be seen by enemy air observers.

(*c*) In rolling or wooded areas, panels displayed in sheltered localities may not be seen from an airplane.

(*d*) The infantryman may lose his panel or throw it away to lighten his load.

(*e*) Panels that have become dirty may not be seen by the observer, even when properly exposed.

c. If the Infantry fails to display panels or if they are not seen, the observer then seeks to effect location by flying at

a low altitude to a point well defined by landmarks, located near where friendly troops were last seen or reported. If the front line has advanced appreciably, the troops seen in this vicinity may be exposed and small units of transport may be seen. The observer then continues toward the front until troops are observed taking cover from hostile fire in shell holes, fox holes, behind trees, walls, or crests of slopes; or moving forward by infiltration. When any of these conditions exist, the pilot turns and flies generally along the front, the observer marking its location on his map. While over the front the pilot must fly an irregular course, using all of his maneuverability and speed to minimize the danger of being shot down by ground fire. This method of front line location is used only when all other visual methods fail and the time element completely precludes the use of aerial photography.

d. The location of the friendly front line is reported by dropped message to the division command post and when desirable also to subordinate command posts.

■ 62. INFORMATION TO BE FURNISHED OBSERVER BY INFANTRY COMMANDER.—When applicable, the following information should be furnished the observer (and pilot) by the infantry commander prior to the execution of any battle reconnaissance—

a. Definite and limited mission.

b. Specific information desired.

c. Pertinent information of our own and hostile forces necessary to the intelligent accomplishment of his mission, including scheme of maneuver.

d. Method, time, and place of reporting information obtained.

e. Information concerning location of command posts, current signal operation instructions, especially pyrotechnic signals and identification panel code.

■ 63. INFORMATION REQUIRED BY INFANTRY COMMANDER.—*a.* The air observer on a battle reconnaissance to observe *enemy* activities especially seeks information of—

(1) Location, strength, composition, and direction and rate of movement of possible reserves and tanks.

(2) Location of hostile strong points or centers of resistance.

(3) Location or movement of hostile artillery.

(4) The organization or strengthening of hostile positions.

(5) Obstructions that interfere with the advance of friendly infantry.

b. The air observers on a battle reconnaissance to observe *friendly* activities seek information of—

(1) Location of front line.

(2) Points along the front where our attack has penetrated and progressed.

(3) Points along the front where our attack has stopped.

(4) Gaps in our lines.

(5) Movements of our troops.

c. Information obtained is transmitted to the appropriate infantry command posts and to the artillery.

d. Penetrations of enemy territory to secure information are made as brief as possible. Circling to permit continuous observation and regularity in method and direction of approach and retirement will be avoided. (See pars. 20*d* and 25*b*.)

■ 64. INFORMATION OF ARTILLERY FIRE.—The observer notes all areas in which artillery shells are seen to be falling. This information is of great value to division headquarters and to the observer himself in carrying out his mission. Hostile shells falling on a portion of the line previously occupied by enemy troops indicate a retirement which probably will be followed by advance of friendly troops. Hostile shells falling wide of friendly operations indicate that the enemy lacks knowledge or observation of such operations. In observing enemy shell bursts, the locality, frequency, quantity, and damage done should be noted and reported as accurately as possible, because this information will assist division headquarters in estimating the enemy's most likely line of action and hostile artillery strength and caliber, and in deciding the counter-battery measures necessary.

■ 65. PYROTECHNIC SIGNALS.—Prearranged pyrotechnic signals may be used by front line units to communicate with the airplane or with friendly artillery. Particular attention is paid to reporting and relaying these signals. Important pyrotechnic signals are immediately transmitted by radio to di-

vision headquarters; when there is any doubt as to the message getting through, it is confirmed by a dropped message. Infantry signals to the artillery are transmitted by the airplane to the artillery command post concerned.

■ 66. PANEL AND PICK-UP MESSAGES.—Messages may be transmitted to the airplane by means of panels displayed at panel stations of battalion, regimental, brigade, and division headquarters. Such signals are employed in accordance with an air-ground liaison code of signals. Written messages may be delivered direct to the airplane by means of the pick-up method, from a station near the command post of the headquarters at which the message originates. The technique of picking up messages is described in FM 24–5.

■ 67. PREPARATION OF MESSAGES.—Messages should be accurate, legible, and in appropriate detail. Messages should be dropped as soon as possible after important information has been secured, thereby affording the ground commander the maximum opportunity to use the information and preventing its loss in case the airplane is shot down. Messages are prepared in duplicate; the original is dropped, and the duplicate is attached to the observer's written report which is turned over to the unit operations officer immediately upon completion of the mission.

SECTION IV

LIAISON MISSIONS

■ 68. PURPOSE.—Liaison missions are performed to assist a commander in locating and maintaining contact with elements of his own, adjacent, or higher units, or to transmit information or orders when such transmission can be more effectively accomplished by air messengers than by other means of communication.

■ 69. PROCEDURE.—When a liaison mission is executed for the purpose of having a staff officer observe the terrain in an area wherein hostile pursuit is active, the staff officer should be a qualified aerial gunner in order that he may man the gun of the station he occupies, which may be the only gun that can be brought to bear within its field of fire. The loss of effective fire from one gun station on a reconnaissance type

airplane seriously reduces its defensibility, thus increasing the possibility of the loss of the airplane and all personnel aboard in the event of an attack by hostile aircraft.

■ 70. PERFORMANCE.—The factors affecting air reconnaissance and observation as a whole exercise an equal influence on command and liaison missions.

SECTION V

ADJUSTMENT OF FIRE FOR MOBILE ARTILLERY

■ 71. ARTILLERY MISSIONS.—*a.* Cooperation with artillery calls for the furnishing of information to the artillery as to the nature and location of its targets, and for assisting the artillery by aerial adjustment of its fire. To accomplish its mission with effectiveness and speed under conditions of modern warfare, the field artillery, especially long range artillery, must be furnished with air observation. Air observation permits reports on fire in areas defiladed from ground observers and, under favorable observing conditions, permits rapid and accurate conduct of fire because the amount of error, as well as its direction, can be sensed.

b. In general, artillery missions for air observers include—

(1) *Registration,* the adjustment of fire on a point or locality to facilitate obtaining data for subsequent fires. Registration is very rapid when the observer can locate on a map or photo the corresponding location on the ground of the center of impact of a group of shots.

(2) *Surveillance* of fires by reporting the amount of error of initial fires for which accurate data have been prepared by the artillery. With maps and photos, surveillance of fires should be the rule when map or photo locations of both pieces and target are accurately known to both observer and the artillery.

(3) *Adjustment* of fire on targets previously assigned by the artillery or located by the observer when map or photo locations of both pieces and target are accurately known to both observer and the artillery.

■ 72. ASSIGNMENT OF MISSIONS.—*a.* Artillery missions are executed by observation aviation units with divisions, corps, and armies. Upon request of the artillery commander, the

division, corps, or army commander designates the type and amount of observation aviation to be used to conduct artillery missions.

b. The number of observation aircraft assigned to the artillery may vary from one per division or artillery groupment to one per artillery battalion. If a single plane is available to a division or groupment, it is usually assigned to division artillery headquarters or groupment headquarters for control; then, with all battalions listening in on the established radio frequency, any one of them can take up any mission assigned to it.

c. In general, missions assigned to an air observer should be those which cannot be executed conveniently or accurately from the ground. When targets are reported by the observer, the decision to deliver fire rests with the artillery commander. Because of possible hostile activity and the probable need for the aircraft on other missions, aircraft must be used on artillery missions at maximum possible efficiency.

■ 73. AIR OBSERVER.—*a.* Successful cooperation between artillery and supporting aviation requires very close liaison and thorough understanding between the units concerned.

b. The air observer should be detailed from the field artillery organization receiving air support. He acts under the orders of the field artillery commander and is responsible for the proper procedure and technique, except for the actual operation of the airplane. He must be qualified to operate the signal communications to the field artillery unit.

c. The maneuvering of the airplane is the responsibility of the pilot, who, however, will be guided as far as conditions permit by the expressed desires of the observer.

d. The use of single-seater observation airplanes for artillery missions is limited. Pilots are not ordinarily trained in the principles of adjustment of artillery fire. Moreover, the pilot's concern with the handling of the airplane will interfere with an alternate role as observer.

e. The artillery must be on the alert to assist in detecting the approach of enemy planes and to warn the observing airplane of such activities.

■ 74. TYPES OF COMMUNICATION.—The most effective means of communication between airplane and ground is two-way

radiotelegraph or radiotelephone. Radiotelegraph produces the stronger signals, has the greater range, and is less subject to interference; radiotelephone is the faster. Communication by air-ground radio and ground-air panels is also effective. With careful prearrangement, communication by two-way radio or by radio and panels may be reduced and sometimes eliminated. Dropped or picked-up messages are often practicable, especially if they are marked photos or maps. Visual signals, in general, are slow and impracticable; with prearrangement they may have limited use.

■ 75. LOCATION OF TARGETS.—Under stabilized conditions, photography is the most satisfactory means of locating artillery targets which have been camouflaged to prevent their discovery. In open warfare many targets are of such a fleeting nature that prompt action on the part of the air-observer and the artillery with which he is working is necessary if artillery fire is to be put down on these targets before they disappear or move out of range. Enemy combat groups holding up the advance and enemy reserves moving up to reinforce the front must be taken under fire as soon as they can be located. Hostile artillery positions must be discovered and counterbattery fires laid down without delay.

■ 76. PROCEDURE AND TECHNIQUE.—For details of designation of targets, communication procedure, methods of registration, adjustment, and surveillance of fires see TM 6–210.

SECTION VI

COOPERATION WITH CAVALRY

■ 77. GENERAL.—*a.* Reconnaissance and observation aviation does not replace or supplant Cavalry as a reconnaissance agency but is of particular value to and increases the effectiveness of that arm by extending its radius of action and directing attention to known or suspected hostile forces, thereby obviating useless marching and conserving men, horses, and matériel. Air observers working in cooperation with Cavalry can furnish timely information to the commander pertaining to—

(1) Disposition, strength, and composition of the hostile main force.

(2) Location and strength of hostile security and reconnaissance detachments.

(3) Rates and direction of movement and routes followed by hostile forces in the observed area.

(4) Condition of routes and bridges suitable for use by the supported friendly units.

(5) Terrain features which may be utilized to advantage by either hostile or friendly forces.

(6) Liaison between friendly units or parts of the cavalry command.

b. Reconnaissance aviation is of particular value to a cavalry commander during the initial phases of a strategic or tactical movement. Information as to the location of the hostile main forces, their security and reconnaissance detachments, and their routes and rates of movement will enable the cavalry commander to conserve his forces and to advance more rapidly and accurately on his objective.

c. During combat, observation aviation cooperates with Cavalry in essentially the same manner as with Infantry.

■ 78. CAVALRY REQUIREMENTS FOR AIR RECONNAISSANCE AND OBSERVATION.—*a.* The requirements of Calvary differ somewhat from those of the Infantry because of the differences in the capabilities and limitations of the two arms. Air reconnaissance for Cavalry usually requires the coverage of relatively large areas because of—

(1) The greater mobility of Cavalry, particularly of mechanized units, as compared with Infantry.

(2) The relative freedom of action, particularly by horse Cavalry, with respect to roads.

(3) The wide dispersion of cavalry formation and of detachments engaged in reconnaissance.

b. It is essential that personnel operating with Cavalry have a thorough knowledge of cavalry tactics and objectives, and that they be familiar with the plans of the cavalry commander, pertinent to the immediate operation.

■ 79. ARMY, CORPS, OR DIVISION CAVALRY.—Air reconnaissance and observation for Cavalry which is operating as an integral part of an army, corps, or division is furnished by the parent ground unit. Cavalry commanders initiate requests for such air missions as are necessary, in cooperation with their units,

and these missions are executed by order of the appropriate ground force commander through his chief of aviation or air officer. Air observers normally communicate to the Cavalry, by radio or dropped messages, all information of value to the latter in the performance of its assigned missions. Observation aviation may be attached to a cavalry unit functioning as part of an army, corps, or division.

■ 80. CAVALRY IN INDEPENDENT ACTION.—Whenever a cavalry corps or division operates as an independent command, the requisite reconnaissance and observation aviation normally is attached and functions under direct control of the cavalry commander. The aviation attached to an independent cavalry command must be highly mobile and capable of moving forward, as the situation requires, to new airdromes along the line of communication. The location of airdromes along the line of communication of the cavalry command facilitates their supply and also their defense from attacks by hostile ground raiding parties. The types of missions to be carried out are similar to those performed in cooperation with the Infantry, but the reconnaissance airplane on a cavalry mission penetrates to greater distances and covers far more territory than would be the case with an infantry force of comparable size.

■ 81. MECHANIZED CAVALRY.—*a.* Continuous air reconnaissance and observation is necessary when operating in cooperation with mechanized cavalry during rapid movements. The air observer keeps the cavalry commander informed of the location, strength, composition, and movements of all hostile forces within the area under observation.

b. The air reconnaissance should extend far enough to the front and flanks of the advance elements of the supported mechanized force to give timely warning of the presence, composition, strength, and movements of hostile forces. Special objectives of the mechanized force may be located and kept under surveillance. Air observers cooperating with mechanized cavalry reconnoiter routes to be traversed and report obstructions or other conditions which might affect the conduct of the cavalry mission.

c. The air observer communicates directly with the mechanized units by dropped and pick-up messages, by visual

signals, or by radio. An advance landing field will be seized or prepared if cooperation will be improved thereby.

SECTION VII

COOPERATION WITH SEACOAST ARTILLERY

■ 82. GENERAL.—*a.* The Army Air Forces cooperate with seacoast artillery by providing information with respect to the location, composition, strength, speed, and direction of approach of naval targets and by reporting the deviations of the fall of shots from the target. (See FM 4–15.)

b. During night operations, airplane flares may be used for the illumination of targets. This is particularly important in the case of targets which are beyond the range of shore searchlights. It may be desirable to utilize flares for the illumination of targets which are within range of the searchlights, when the use of searchlights might assist the enemy in determining the location of essential elements of the seacoast defense installation. The most effective illumination is obtained by placing the flare within 2° of the ground observer-target line, about 2,000 yards beyond the target as viewed by the ground observer, and at an altitude of approximately 1,800 feet. For tracking where more than one observing station is being employed, a flare is required for the observer-target line of each observer. This requirement will normally restrict the employment of airplane flares to distant searching missions. (See par. 251, FM 4–5.)

■ 83. PRELIMINARY ARRANGEMENTS.—Prior to the execution of a reconnaissance or artillery adjustment mission, the observer, whenever possible, should confer with the artillery commander with whom he is to cooperate. It is important that the method to be employed and the procedure to be followed be understood by all concerned.

■ 84. COMMUNICATION.—The methods of communication between the observing aircraft and the firing battery employed upon missions in cooperation with mobile artillery may be used in conjunction with the firing of seacoast batteries.

■ 85. METHODS OF TARGET LOCATION.—*a. Maps and charts.*—When accurate and suitable maps and marine charts are available, the observer may estimate the location of the target

with reference to grid lines, buoys, channel markers, or lighthouses and determine its speed and direction of movement. The direction is reported by the magnetic bearing of the course of the target, and its speed is estimated to the nearest 5 knots.

b. Sound ranging.—If available, long range subaqueous sound ranging apparatus can be used for determining the target location with sufficient accuracy to get the initial shot close enough to the target to enable the air observer to report the deviation satisfactorily.

c. Radio goniometry.—If radio direction finding equipment is available, radio signals sent out while the airplane is flying in prolongation of the course of the target can be picked up by two or more shore stations and the course of the target plotted. The airplane then flies along the battery-target line which, when plotted, provides a "fix" from which initial firing data may be computed. The airplane may, while flying in prolongation of the course, report the position of the target with reference to that of the airplane. The observing airplane must avoid flying directly over the target or within range of hostile antiaircraft guns.

■ 86. OBSERVATION OF FIRE.—Airplanes provide the best means of observation when firing at extreme ranges, or at shorter ranges when fog banks or smoke screens obscure the target from shore observation stations. Coast artillery weapons usually fire at moving targets on water areas with very few reference points, so the methods used for adjustment of mobile artillery firing at terrestrial objectives are not altogether applicable. The principal problems of cooperation with the Coast Artillery Corps are those of communication, target location, and reporting deviations of the fall of all shots.

■ 87. REPORTING FALL OF SHOTS.—*a. Methods employed.*—Deviations of the fall of shots may be reported with reference to the battery-target line; with reference to a north-south or east-west line through the target; or by means of the so-called "clock system."

b. Battery-target line method.—The battery-target line method normally is used at short ranges in connection with terrestrial position finding and subaqueous sound ranging.

This method is not suitable for use in connection with airplane observation of fire at extreme ranges except under conditions of good visibility. When reporting the fall of shots by means of this method, the magnitudes of deviations are reported both over or short and right or left with reference to the battery-target line.

c. Directional line method.—The reporting of deviations with reference to a north-south or east-west line is difficult unless fixed landmarks, visible to the observer, are available for purposes of orientation. The magnetic compass in the airplane is unstable during maneuvers which may be required at the time of the fall of shots and cannot be relied upon as the sole means of orientation when turns have to be made at frequent intervals. A gyro turn indicator is therefore required. It must be checked against the magnetic compass at every opportunity to insure prompt correction of precession.

d. Clock system.—When using the clock system the observer superimposes an imaginary clock face over the target. The line 12 o'clock–6 o'clock passes through the vessel longitudinally with the bow at 12 o'clock. This method is suitable for either short or long range firing and does not require reference to any orientation point or line outside of the

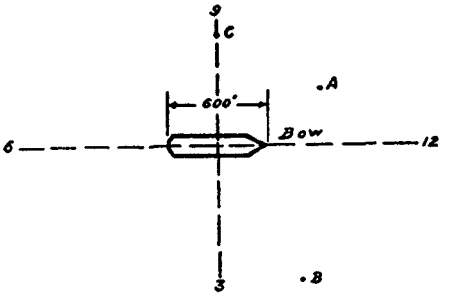

FIGURE 12.—Clock system.

target vessel itself. Knowing the approximate over-all length of various types of vessels, the observer can use the length of the target as a reference scale by means of which the magnitude of the errors may be estimated. Deviations are reported in yards and with reference to clock directions.

Example: Shots falling at locations *A*, *B*, and *C* in figure 12 are reported as follows:

Shot *A*, 200 yards at 11 o'clock.
Shot *B*, 300 yards at 2 o'clock.
Shot *C*, 200 yards at 9 o'clock.

The location of the fall of each shot is reported with reference to its deviation from the center of the target.

■ 88. CLASSIFICATION OF FIRE.—The fire of seacoast batteries at naval targets may be divided into two classes—

a. Trial fire.—Trial fire is employed until the center of impact is properly adjusted to secure effective fire against the target.

b. Fire for effect.—Fire for effect is conducted for the purpose of destroying the target.

■ 89. ADJUSTMENT.—The observer reports the deviation of each shot or of the center of impact of each salvo observed to the plotting room of the battery, from which point the fire is controlled. The observer continues to report until the target is destroyed or until another mission is assigned.

SECTION VIII

COOPERATION WITH ARMORED AND MOTORIZED FORCES

■ 90. ORGANIZATION.—*a. Aviation requirements.*—Armored forces operating either offensively or defensively require extensive reconnaissance and observation from supporting aviation. For the efficient conduct of these forces this service must be rapid and timely.

b. Mobility.—The aviation units supporting armored forces must be capable of shifting airdromes at rates up to 200 miles per day while maintaining the requisite capacity for or promptness in executing missions. Special equipment is rerequired to facilitate and expedite this movement and the establishment of successive operating airdromes. To increase the mobility of the aviation units, the equipment provided should be kept at the minimum required for self-sustaining operations.

■ 91. MISSIONS.—*a.* The types of missions performed are in general the same as for Infantry and Cavalry. However,

they are more frequent, employ a different technique, cover larger areas, and require greater speed in execution. The situation moves so rapidly over such a wide area that more than one airplane executing the same type of mission simultaneously is sometimes necessary. When speed of execution is demanded by the situation, the air commander often makes and transmits immediate decisions as to the disposition of airplanes when he is in the air without reference to his ground headquarters. It is imperative that information gathered on missions, with the possible exception of distant reconnaissance, be transmitted to the armored force commanders prior to landing. Written reports of the results of route reconnaissances, artillery, and liaison missions are seldom formally prepared and furnished to the armored forces. Continuous contact must be maintained with armored force advance elements on the ground. This necessitates prompt mutual identification and suitable methods of rapid communication, air-ground and ground-air.

b. The rapidity of armored force operations may frequently require that combat aircraft perform the dual role of reconnaissance and attack during a single flight in order to insure timely support in fast moving situations.

■ 92. TYPES OF MISSIONS.—*a. Route reconnaissance.*—Commanders of armored forces require information as to conditions of roads, bridges, defiles, and general terrain many miles away in order to guide their fast moving columns. Unexpected "turn-arounds" are at best costly in time and effort and tend to spread confusion and lower morale. Ground reconnaissance elements cannot always obtain this type of information sufficiently in advance. Moreover, general information from the air will greatly help the armored force commander in directing his ground reconnaissance elements in the right directions, avoiding unnecessary detailed reconnaissances of impassable routes. The information desired by the armored force commander must be timely and frequent, otherwise a bridge may be destroyed or a defile blocked between the time the reconnaissance is made and prior to the arrival of the advance guard of the armored force.

b. Distant reconnaissance.—This mission is executed for the purpose of informing the armored force commander and keeping him informed of the presence, absence, movements,

and activity of hostile forces, particularly mobile forces, in certain areas and localities. When operating in enemy territory or when enemy mobile forces can reach the friendly territory within which the armored force is operating, this type of mission is practically mandatory for successful operations. It will be found, however, that this type of mission may at certain times and in some situations be combined with route reconnaissance missions, thereby conserving the aviation reconnaissance forces. Contact with enemy mobile ground forces may be maintained by tracking them to determine their movements, bivouacs, and concealment areas. In the absence of orders to the contrary, endeavor should be made to conceal the presence of tracking aircraft from the ground forces being tracked by remaining behind at the maximum limit of visibility, by taking advantage of the up-sun position, and by leaving the vicinity of the force being tracked for limited periods.

c. Liaison.—Although all ground commanders are concerned with the position and location of their commands when they are on the march, the problem of the armored force commander in establishing and maintaining this liaison is a serious one. Routes of march and movement of the armored force, combined with the fact that much of its maneuvering will be in the presence of enemy mobile forces or within territory controlled by the enemy, make aviation practically the only means available for this purpose. The armored force commander may frequently find it advantageous personally to direct the movements of his forces from the air.

d. Artillery missions.—In cooperating with the armored force artillery, definite preliminary arrangements are seldom possible, and such missions are frequently assigned to airplanes already in the air. Otherwise, these missions are similar to those executed in cooperation with artillery, infantry, and cavalry divisions.

■ 93. COMMUNICATION.—*a.* Armored forces use very little wire communication even in the artillery. Due to the rapidity of movement, main reliance must be placed on radio and supplementary means. Their observation aviation units must depend more on radio than similar units supporting infantry and cavalry organizations in spite of the greater distances

involved. Transmission of important messages by either voice radio or by radiotelegraph in the clear may be authorized by the armored force commander in a fast moving situation. Efficient communication not only between air and ground but also between airplanes is absolutely essential to the conduct of successful operations.

b. The radio station of the aviation unit intercepts and records all messages between the air and the ground. If required on account of the distances involved, a radio relay station is established. The intelligence section of the unit utilizes these intercepted messages to keep the situation map up to the minute.

■ 94. MOTORIZED FORCES.—The above-stated procedures regarding cooperation with armored forces are applicable also to cooperation with motorized forces, when they are maneuvering in motors, although in a somewhat lesser degree. When motorized infantry and cavalry detruck and fight on foot or mounted, the procedures for cooperation with Infantry and Cavalry apply.

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