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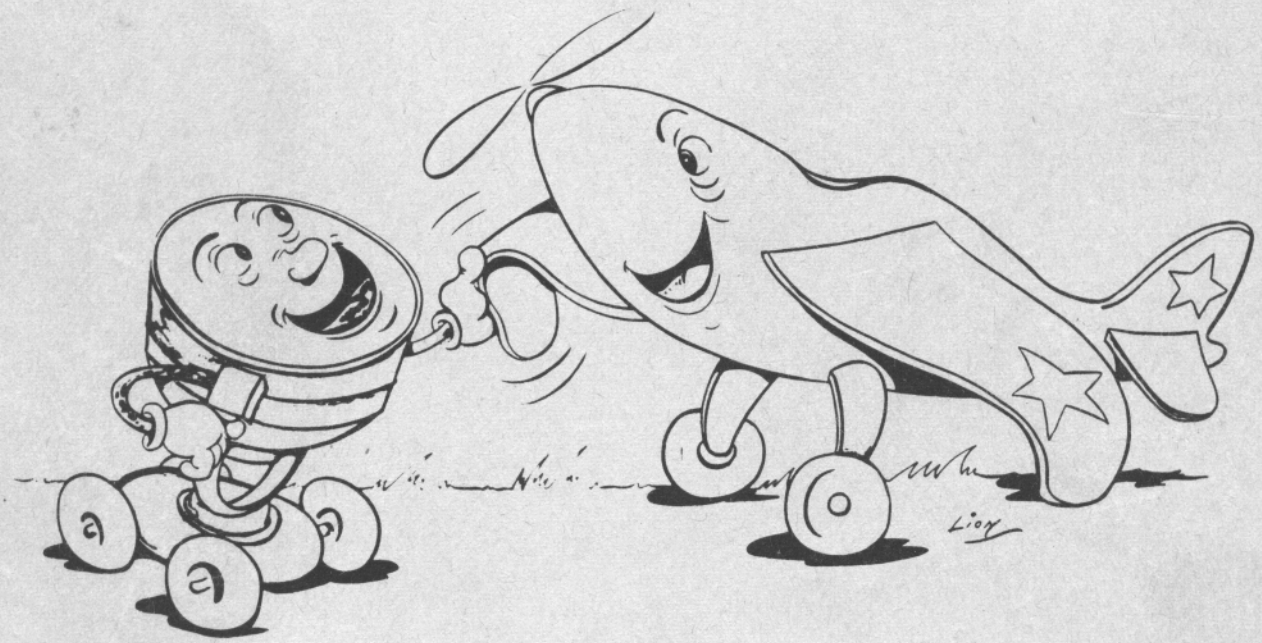
ARMY AIR FORCES SCHOOL OF APPLIED TACTICS

INSTRUCTION TEXT

THE FIGHTER-SEARCHLIGHT TEAM



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ESTABLISHMENT OF A FIGHTER-SEARCHLIGHT DEFENSE INCLUDING THE AAAIS

EMPLOYMENT AND TRAINING OF FIGHTER AVIATION AND ANTIAIRCRAFT SEARCHLIGHT UNITS IN COMBINED OPERATIONS

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Army Air Forces School of Applied Tactics
Orlando, Florida
December 20, 1942

FOREWORD

The intent of this text is to describe a system of searchlight defense in which the searchlight training and tactics are designed to facilitate the employment of fighter aviation as a means of defense against night bombing attacks, while retaining completely their ability to furnish adequate illumination for antiaircraft guns.

The system welds together the fire power and tactical mobility of fighter aviation, and its ability to concentrate force, with the capability of modern 60-inch antiaircraft searchlights, under conditions of normally good visibility as known in this country, to illuminate aircraft at any altitude present airplanes have attained.

Two considerations are basic:

(1) That there is no essential difference between the illumination of targets for antiaircraft gun fire or for attack by fighters; that a searchlight defense, once organized with the requirements of both antiaircraft guns and fighters in view, and the personnel trained in the few, simple, special requirements of illumination for fighter cooperation, can furnish fully adequate illumination for either, and,

(2) That in any area defense comprising several defended objectives within a few miles of each other, all searchlights in the area should be integrated into a single, coordinated blanket defense, under a single searchlight group commander, to the great advantage of overall effectiveness.

The system of Fighter-Searchlight Team operation and control described herein is not, in general, experimental in nature. Except for certain minor modifications, it was given thorough trial, and its general effectiveness proved, in 1941, and is actively in operation in certain theatres at the present time.

HUME PEABODY,
Brig. General, U.S. Army,
Commanding.

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PART ONE

ESTABLISHMENT OF THE SEARCHLIGHT DEFENSE FOR FIGHTER COOPERATION

CHAPTER ONE

BASIC

Section I

FEATURES AND ADVANTAGES OF THE EMPLOYMENT OF AA SEARCHLIGHTS FOR FIGHTER COOPERATION

1. ADVANTAGES.--Three principal advantages accrue from the employment of AA searchlights for illumination of enemy targets for fighter attack, where practicable, as opposed to their use with AA guns alone:

a. It enables the defense to take advantage, at night, of the great fire power of fighters, where otherwise they would be idle at night, with the exception of those equipped with air-borne interception devices, and their fire power of no value.

b. It makes it possible for the defense to make use, at night, of the outstanding advantage which fighter aviation enjoys over other means of air defense, i.e., its tactical mobility, which allows it to be concentrated against an enemy attack, rather than being forced to remain idle until and unless an enemy approaches its position.

c. It makes it possible, with radio-directed lights, capable of maintaining continuous illumination of an enemy target flying above a haze,

broken clouds, or a thin overcast, to operate fighters above such haze or cloud conditions and to permit them to attack effectively.

2. WARNING REQUIRED.--It does not eliminate the requirement of fighters for a considerable degree of advance warning of an enemy attack in order for them to leave the ground, climb to the enemy's altitude, and close to an interception and an attack. Under conditions where little warning is available guns can still operate at their full effectiveness.

3. COMBINED DEFENSES.--In combined defenses, where fighters must operate close to gun defended areas, or actually over them, as in the case of coastal objectives, great advantages accrue from the setting up of a combined searchlight defense, available either for the needs of fighters or of AA guns. Dispositions and employment of lights and the training of crews, in a manner suitable for fighter cooperation, are equally suitable for the use of AA guns. Such a searchlight defense, spread over an area which includes gun defended objectives, can give a much higher degree of effectiveness of defense than one designed for either alone.

Section II

THE PROBLEM

4. ELEMENTS OF THE PROBLEM.--In the establishment of a system for effective fighter-searchlight defense against enemy night raids, the following are basic elements of the problem:

a. Illumination.--(1) Illumination of the enemy targets must be adequate to allow the fighter pilot to:

(a) See the illuminated target, or at least initially, to see its location by the intersection of accurately directed searchlight beams.

(b) Proceed to the point of interception.

(c) Press home an attack.

(2) Illumination of at least a major proportion of all targets of multiple, wave or formation attacks must be produced.

(3) Illumination of the target must be such as will facilitate attack by the friendly fighter. It must not hinder such attack by blinding the fighter pilot, nor necessitate his entering the illuminated zone about the target in order to close in to effective range.

(4) Illumination of the friendly fighter through error must be insured against.

b. Economy of Force.--The system must be such as will make full use of the ability of modern searchlights, properly directed, to illuminate targets adequately for fighter attack. All available searchlights must be employed to their full effectiveness.

c. Full Advantage Must be Taken of All Illumination Produced.--The system of plotting the enemy's course and of control of the fighters in the air must be such as will allow them to take fullest advantage of the illumination of enemy targets, once it is produced.

d. Concentration of Force.--The system must allow of the concentration against an enemy attack, in the immediate area of illumination, of a sufficient force of fighters to meet it with all practicable effectiveness.

5. SUBSIDIARY REQUIREMENTS.--a. Requirement 4 a (1) (a), the production of illumination adequate to render the target visible to the fighter pilot, necessitates the employment of high-intensity, high-efficiency searchlights of the most modern type, accurately directed by modern position finding devices, all operated by well trained crews. The 60-inch high intensity AA searchlight is such a searchlight. The modern radio locator fills the requirement of the position-finding device. When sufficient radio locators are not available, a reasonably effective substitute, for conditions of good visibility, can be provided in the sound locator for target altitudes up to 15,000 feet, with proper training of crews. For the carrying of targets through haze, or above partial cloud ceilings, or of targets very effectively camouflaged, each light must be equipped with a radio locator. For continuous illumination under conditions of good visibility it is necessary only that the outer 2 rows of searchlights be equipped with radio locators, the inner lights to function only as carry lights. Where only a small proportion of radio locators is available, they should be concentrated in the outer rows of lights.

b. Requirements 4 a (1) (b) and (c), the production of illumination adequate to allow the fighter to proceed to a point of interception and to press home an attack, necessitate:

(1) Continuity of illumination, after its initial establishment.

(2) Depth of searchlight area sufficient to give the fighter pilot the time required.

c. Requirement 4 a (2), illumination of the maximum possible proportion of all targets of multiple attacks, demands thorough training of searchlight personnel in basic searchlight technique, thorough indoctrination and training of non-commissioned officers designated as detector and searchlight commanders in the tactical handling of their equipment, and decentralization of tactical control almost wholly to detector and light commanders. In no case can tactical control be exercised by any commander higher than the platoon commander in charge of 6 searchlight sections, and by him only in exceptional circumstances. Attempt to exercise tactical control of individual searchlights by any higher commander can result only in serious reduction of effectiveness.

d. Requirement 4 a (3), the handling of illumination so as to facilitate, not hinder, attack by the friendly fighter pilot, necessitates thorough training and indoctrination of individual searchlight commanders in the tactical control of beams.

e. Requirement 4 a (4), the insuring of non-illumination of the friendly fighters, requires that they remain always inside the boundaries of the searchlight area. The employment of IFF or similar identification equipment by friendly fighters serves to distinguish them from the enemy in cases where only one plane approaches a given part of the area at one time. Even with its use, however, no means is known of distinguishing friendly from enemy planes when they become intermingled with each other, while approaching the searchlight area. Avoidance of illumination requires that the friendly fighters remain always inside the boundaries of the searchlight area until after an intersection of searchlight beams has been formed on or near the target. This imposes the subsidiary requirement of positive identification of his position to the fighter pilot, preferably by a dim searchlight beam, sufficiently dim as not to be visible to a distant enemy, or by a highly directional radio beacon, with axis vertical. If the dim searchlight beam is used, a different color of beam, as red, blue, yellow and green, should be assigned each control point.

f. Requirement 4 b, economy of available searchlight equipment, dictates that all tactically effective searchlights be employed for actual illumination of targets, in order not to waste their capabilities on lesser tasks that can be performed by other means.

g. Requirement 4 c, the taking of the fullest possible advantage of all illumination produced, dictates that the fighter be placed, prior to initial illumination of the incoming enemy,

(1) As close as practicable to such point of initial illumination.

(2) At proper altitude.

h. Requirement 4 d, concentration of force, necessitates sufficient advance information of the approximate size of the enemy raid to allow concentration of the force required in the immediate vicinity of initial illumination.

CHAPTER TWO

DESIGN OF SEARCHLIGHT DEFENSES FOR FIGHTER COOPERATION

Section I

BASIC

6. CHARACTERISTICS OF SEARCHLIGHT DISPOSITION.—a. It is basically imperative that a searchlight disposition, intended for illumination of an enemy for friendly fighter attack, be absolutely homogeneous, closely knit, and as regular as possible in shape. For example, a group of relatively small, separate searchlight areas, with holes of blackness between, will be of practically no value for fighter work. Even with the best of information and control systems, it is not to be expected that it will be possible to place fighters closer than a few miles to the anticipated point of initial illumination. This being the case, bombardment speeds being what they are, it is imperative that the illumination, once begun, be maintained continuously, without interruption, for at least several consecutive minutes, if fighters are to be given a reasonable opportunity to reach the illuminated enemy and at least press home an initial attack.

b. The setting up of a relatively extended defense, with holes scattered therein, is almost certain to result, in the general case, in the bombers running through the illumination and into darkness before fighters will reach them. An irregular outline of illumination, with "peninsulas" of searchlights extended beyond the main inner boundaries, can be expected to produce the same result. This requirement of homogeneous, comparatively regular shape is so imperative that it transcends that of size of the searchlight defended area.

c. Most critical of all, however, is the requirement that the friendly fighters remain always <u>inside</u> of the outer boundaries of the searchlight area until after an intersection of searchlight beams has been formed on or near the target. This fact makes it critically necessary that all parts of the searchlight area be of regular, even shape, and sufficiently large in all dimensions as to allow circling friendly fighters a high degree of probability of being able to remain inside its boundaries at all

times. Such reasonable minimum dimension is believed to be about ten miles for this purpose alone. Greater depth will be required for effective interception and combat.

7. AAAIS DETECTION AND PLOTTING SYSTEM.--In order to supply fighters in the air with the information they require in order for them to be in the near vicinity of initial illumination of an incoming raid before the illumination begins, certain dispositions of the available radio locators, and a communication and plotting system so set up as to make their information available in the most effective form, are required. This plotting system constitutes, in addition, a most effective aid to a gun defense of an area as well. Since it constitutes a close-in, relatively precise information service, it is hereafter referred to as the Antiaircraft Artillery Intelligence Service. While serving both gun and fighter elements of the defense, where both are present, it is to be emphasized that it is the requirements of the fighters which most stringently dictate its nature. Any such system adequate for fighter aviation, can easily fill the relatively simple requirements of a gun defense. The system is covered in detail in Chapter 4 of Part One.

8. TACTICAL CONSIDERATIONS.--a. A system of defense should be so designed as to be capable of operating effectively against the most difficult type of attack which an enemy can direct against it. The most difficult type of air attack for an air defense to handle is one which concentrates a large number of planes over a small part of the defense for a short period of time. Such an attack constitutes an attempt at overwhelming a small part of the defense by presenting more targets during the brief period of the attack than can possibly be handled by a system oriented with a view to operating against only one target at a time. Since such a type of attack constitutes the most difficult type for a defense to handle, it offers the expectation of the smallest percentage of losses to the attacker. An alert enemy can be expected to take advantage of this.

b. The only effective answer to a concentration of force by the attacker at a given point of the defense, is a similar concentration of force at the point of attack, by the defender, to meet it. The ability to concentrate force through its tactical mobility constitutes the outstanding advantage of fighter aviation over the other means of air defense. A proper system of air defense employing fighter aviation must envisage both this need for concentration of force, and the capacity of fighter aviation to accomplish it. The system of fighter-searchlight defense described herein is accordingly designed so as to be capable, when necessary, of employing multiple fighters with maximum effectiveness against concentrated attacks by multiple enemy raiders.

Section II

DESIGN OF THE SEARCHLIGHT INTERCEPT UNIT WITH A VIEW TO PLACEMENT AND CONTROL OF FIGHTERS WITHIN IT

9. DEFINITION OF THE SEARCHLIGHT INTERCEPT UNIT AND THE CONTROL POINTS.--a. The Searchlight Intercept Unit is the largest portion of the searchlight area within which a given fighter, or group of fighters, may be directed to an interception from a single principal control point. Based upon the data furnished him from the AAAIS Detection and Plotting System, covered in Chapter 4 of Part One, concerning the course, altitude, and number of planes of the enemy target, or targets, the Intercept Officer directs the movement of the proper number of fighters from the principal control point to the proper sub-control point, or points, at the proper altitude, prior to initial illumination of the enemy targets.

b. The principal control point is a fixed marker visible at night, such as a distinctive terrain feature (as a prominent body of water), a vertical searchlight beam, or a radio beam, and is the center of a fighter orbiting circle of 2½ miles radius. It is the basic control point of the searchlight intercept unit. It is, in addition, the point at which a reservoir of reserve fighters may be built up, if required, to meet continuous enemy wave attacks, and from which they may be fed out to the appropriate sub-control points as needed. Under such conditions, the fighters may be "stacked-up" at successive altitudes, with flights of 3 or 6 fighters orbiting the principal control point at each level, each flight being separated from its adjacent flights by 2000 feet of altitude.

c. The sub-control point is a fixed marker visible at night, such as a distinctive terrain feature (as a prominent body of water), a vertical searchlight beam, or a radio beam, and is the center of a fighter orbiting circle of 2½ miles radius. It is from this sub-control point, that is, from the orbiting circle centered thereon, that the fighters proceed, by visual perception of the intersection of beams directed on the incoming target, to the actual interception and attack. Only a general direction, such as "Intersection West", is given to the fighters when they are notified of the formation of an intersection.

10. DEPTH.--a. The question of depth of the defense, that is, the minimum dimension of the searchlight area through which enemy targets must pass, in order to reach their targets, can be reduced to a single factor--minimum time required by the fighters to allow them to accomplish an interception and effectively press home an attack before the target passes out of the searchlight area. The total time required depends upon a number of factors:

(1) The time required by the fighter to reach the enemy, i.e., accomplish an interception, after illumination begins, which is dependent directly upon:

(a) The proper placement of fighters, prior to illumination, at a sub-control point as close as practicable to the point at which initial illumination will occur. This placement, in turn depends upon the precision and speed of the system of plotting the courses of enemy targets.

(b) Upon the speed of the enemy planes. Present bombardment aircraft, particularly at the higher altitudes, can attain speeds as high as 300 miles per hour.

(c) Upon the command of speed of the fighter over the enemy target. It is considered that such a command of speed of 20% is the maximum that can safely be counted upon. A proper control system, and proper placement of fighters prior to illumination, reduces the importance of this factor, but it must be given major weight in any case.

(2) (a) The time required to press home an effective attack, after interception occurs, which is dependent upon the type of enemy attacks, whether

1. by scattered single planes,

2. by planes in column at intervals, or

3. by formation.

(b) The first two types are essentially the same insofar as this factor is concerned, that is, each individual enemy target requires attack by an individual fighter. The third, flying by the enemy in loose formation constitutes the most effective type of concentrated attack, since it combines more completely and effectively than any other type, the factors of presenting many targets, to a small part of the defense, for a short period of time. Such a concentrated attack requires:

1. the highest efficiency on the part of the searchlights,

2. a system of control of fighters which will allow of concentrating them against such an attack, and

3. during its passage through the searchlight area,

requires continuous attacks on the rear of the formation by a number of fighters if any effective fraction of the enemy is to be destroyed before

the whole passes out of the illumination. Such a continuous series of attacks on the rear of the enemy formation by friendly fighters require time, causing this type of enemy flying to constitute the critical factor in the determination of illumination time required.

b. A consideration of all such factors leads to the conclusion that 5 minutes of continuous illumination of enemy targets is required for reasonably effective operation by fighters. A minimum of such a period of illumination can be produced by a searchlight defense 25 miles in depth. Data of a recent exercise showed a grand average of illumination time of 5 minutes and 28 seconds produced by a 25 mile deep band of lights, with target speeds up to 300 miles per hour. These data represented an overall average of times of illumination produced on all targets, under all weather conditions, over all altitude bands, the average including targets only briefly illuminated or missed altogether in concentrated attacks, or because of overcast ceilings, as well as including targets picked up in advance of the forward line of lights, and carried beyond the rearward line.

11. THE CONTROL POINT SYSTEM.--a. Avoidance of Illumination of Friendly Fighters.-- In order to enable the fighters to take most effective advantage of all illumination produced, they must have been located, prior to initial illumination, as close as practicable to the point at which it will occur. Further, in order to insure against inadvertent illumination of friendly fighters it is necessary that they be so controlled that they remain always definitely <u>inside</u> the outer line of lights until an intersection of searchlight beams has been formed on or near the target. The best means of accomplishing this is by the establishment of definite sub-control points located on a line approximately 7½ miles inside the outer line of lights, and spaced about 5 miles apart. Fighters are able to maintain a circle of 2½ miles radius without difficulty. Fighters orbiting such a sub-control point on a circle of 2½ miles radius would never approach closer than 5 miles to the outer boundary of the area, before illumination of the incoming target, and would never need be illuminated themselves. The orbit circle, 5 miles in diameter, of a given fighter or formation of fighters at a sub-control point, constitutes the basic element of breadth of the searchlight intercept unit. However, in the case of a local defense of a coastal objective, it will usually be necessary to move the control points closer than 7½ miles from the coastline in order to make interceptions as early as possible.

b. Capacity of the AAAIS Detection and Plotting System.-- (1) The effective range of the AAAIS Detection and Plotting System covered in chapter 4 of Part One is in excess of 20 miles, which, with target speeds

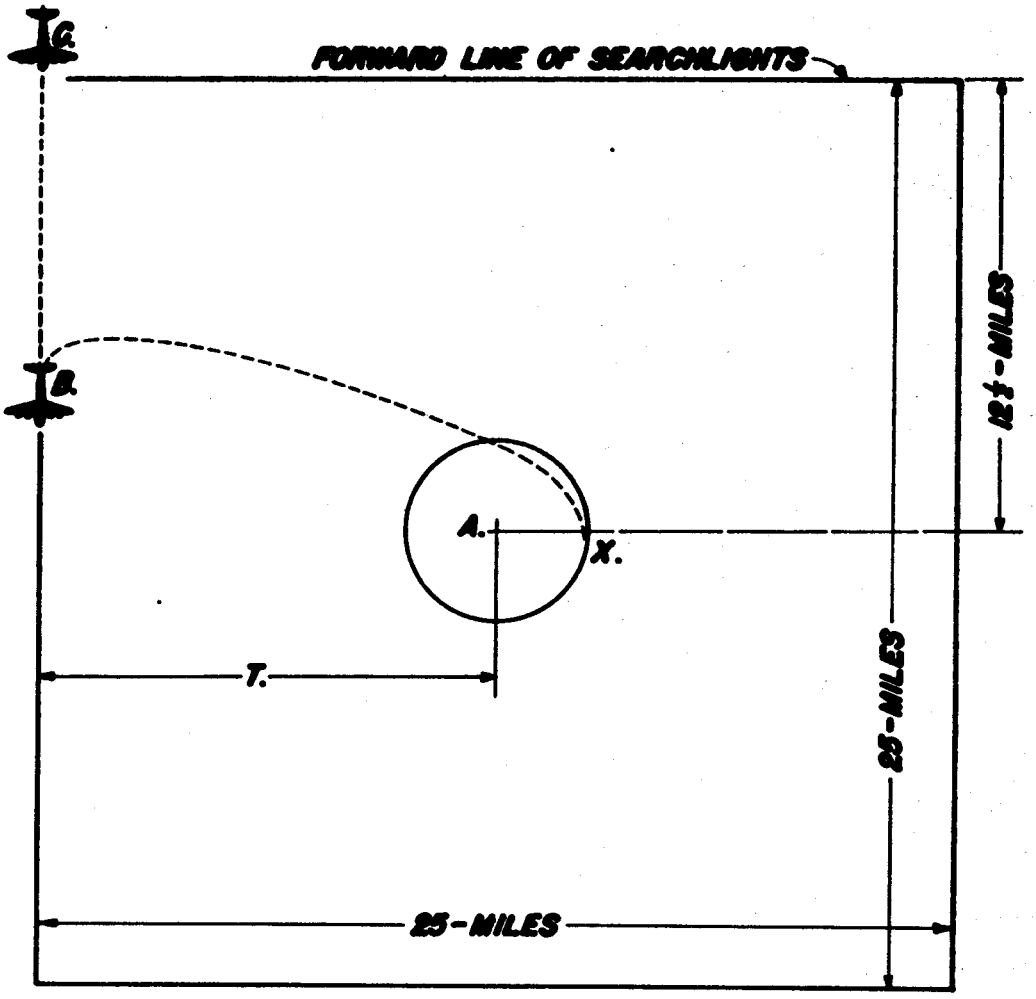


FIGURE-1.

LOSS OF COMBAT TIME RESULTING FROM USE OF SINGLE CONTROL POINT ONLY

(Under the worst condition of Initial Illumination - on the forward line of lights, see Figure 4.)

A — Central Control Point.
B — Point of Interception.
C — Point of Initial Illumination.
T — Lateral Travel of Fighter.
X — Position of fighter at time of Initial illumination.

(Assumed speed of enemy - 300 MPH)

Illumination of target initially produced at C -- Interception not accomplished until target reaches B.

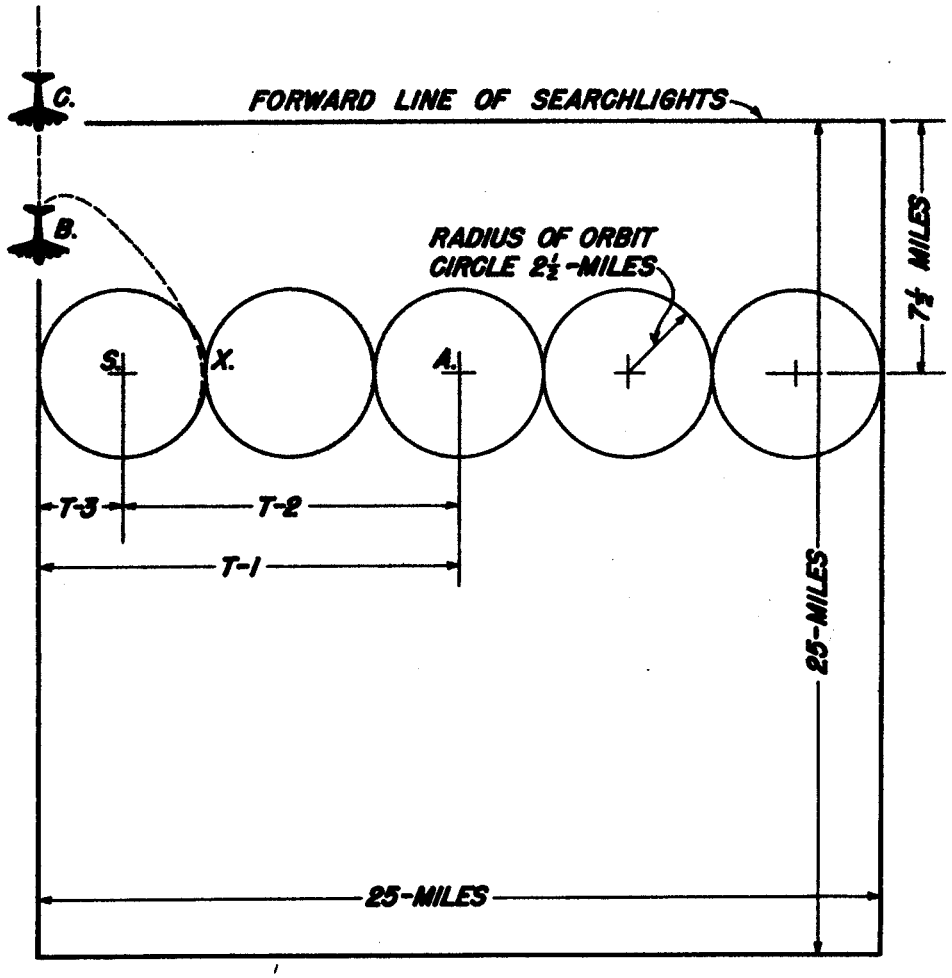


FIGURE-2.

SAVING OF COMBAT TIME RESULTING FROM MOVING FIGHTER FROM A TO S PRIOR TO INITIAL ILLUMINATION

(Under the worst condition of initial illumination on forward line of lights. See Figure 4.)

A — Principal Control Point.
B — Point of Interception.
C — Point of Initial Illumination.
S — Sub-Control Point.
T1 - Total Lateral Travel of Fighter.
T2 - Mean Lateral Travel prior to Initial Illumination.
T3 - Mean Lateral Travel after Initial Illumination.
X — Position of Fighter at Time of Initial Illumination.

(Assumed speed of enemy plane — 300 MPH)

of 300 miles per hour, affords a warning period of 4 minutes before the target can reach the forward boundary of the area. Initial illumination is produced at a maximum slant range of 15,000 yards, and at a minimum angular elevation on an approaching target of 150 to 250 mils above the angle of mask. Under these conditions, the horizontal range of initial illumination varies with altitude from a maximum of approximately 8½ miles in advance of the forward line of lights for a target altitude of approximately 7800 feet, down to a minimum of about one-half mile for a target altitude of 500 feet. (See Figure 3.) The minimum distance of one-half mile for a low altitude approach bears upon the capacity of the fighter to intercept effectively after he has been placed at the sub-control point, covered in sub-paragraph c, below. The maximum distance of 8½ miles bears upon the time available for the placing of the fighter at the sub-control point before initial illumination.

(2) At 300 miles per hour, the incoming target, under conditions of most distant initial illumination, at 8½ miles range, will have been illuminated for approximately 1 3/4 minutes before it crosses the outer line of lights. The difference between the time of initial detection and the time of initial illumination, 4 - 1 3/4 minutes, or 2 1/4 minutes is the time available for the movement of the fighter before initial illumination, under the worst condition. With ½ minute of dead time allowed for initial plotting and dispatch of the fighter, a net time of about 1 3/4 minutes is left.

c. Advantage of the Sub-Control Point System.-- The object of the detection and plotting system and of the movement of the fighter to the appropriate sub-control point prior to initial illumination is one -- to prevent wastage of illumination. By the placing of the principal control point deep within the searchlight intercept unit instead of on the line of sub-control points, interception could be made direct from the principal control point, and sub-control points could be eliminated. This, however, would permit interception to be made only after the target had proceeded deep into the searchlight intercept unit, and would result in wastage of the combat time which could have been made available to the fighter during the early part of the illumination had interception been accomplished earlier. A reference to Figures 1 and 2 indicates the saving in combat time. In each case the worst condition of initial illumination for interception is assumed, i.e., initial illumination occuring at the forward line of lights, rather than in advance of it, as would normally be the case. (See Fig. 4.) In Figure 2, the lateral travel, T_2, was accomplished prior to initial illumination, resulting in an interception at "B" near the forward line of lights. In Figure 1, the total lateral travel, T_1, must be accomplished after initial illumination, resulting in much deeper penetration by the target into the area prior to interception. The difference between the length of the

lines "BC" in the two diagrams represents the saving in combat time resulting from the use of the detection, plotting and sub-control point system. The direct result of this saving of combat time is the lessening of the required depth of the searchlight defense, with resultant economy of searchlight equipment. The equipment thus saved is then available for use elsewhere, with resultant increase in the overall effectiveness of the defense.

d. Interception from the Sub-Control Point.--(1) Once the fighter has been placed at the sub-control point, i.e., orbiting it on a circle of 2½ miles radius, interception is accomplished by visual means thereafter. When two searchlights go into action and produce an intersection of 2 beams, the information "Intersection" is reported direct to the plotting room from the detector section which is sending in data. The intercept officer repeats it by radio to the fighter orbiting the sub-control point. The fighter pilot thereupon turns, if necessary, toward the forward boundary of the area, and looks for the intersection of the two searchlight beams. Having seen them, he at once proceeds visually to make the interception. No further directions are given him after the information "Intersection".

(2) The line of sub-control points is placed 7½ miles behind the forward line of lights basically for the purpose of insuring that the orbiting fighters definitely stay inside the searchlight area, and thus avoid being inadvertently illuminated themselves. It is now necessary to determine whether this placing of the fighters is suitable in all respects, by analyzing the problem of interception from a given sub-control point, i.e., to determine whether, under the worst condition of enemy course, and of location of the fighter on his orbit circle at the time of initial illumination, interception is still possible before the enemy crosses the line of sub-control points, and a stern chase by the fighter results. Because of the small assumed margin of speed of the fighter over the enemy, of only 20%, a stern chase is, at all reasonable costs, to be avoided.

(3) An examination of Figures 3 to 6 discloses that the worst condition of initial illumination, insofar as interception by the fighter is concerned, is that of the extreme low altitude approach shown in Figure 4. Accordingly, for purposes of this analysis, initial illumination is assumed to occur at the line of forward lights, although it will occur, in the majority of cases, several miles in advance of that line. The worst course which can be adopted by the enemy, once initial illumination has occurred, is one which proceeds directly inward from the point of initial illumination on a line perpendicular to the line of forward lights, and consequently to the line of sub-control points, and tangent to one side of the fighter's orbit circle, that is, passing midway be-

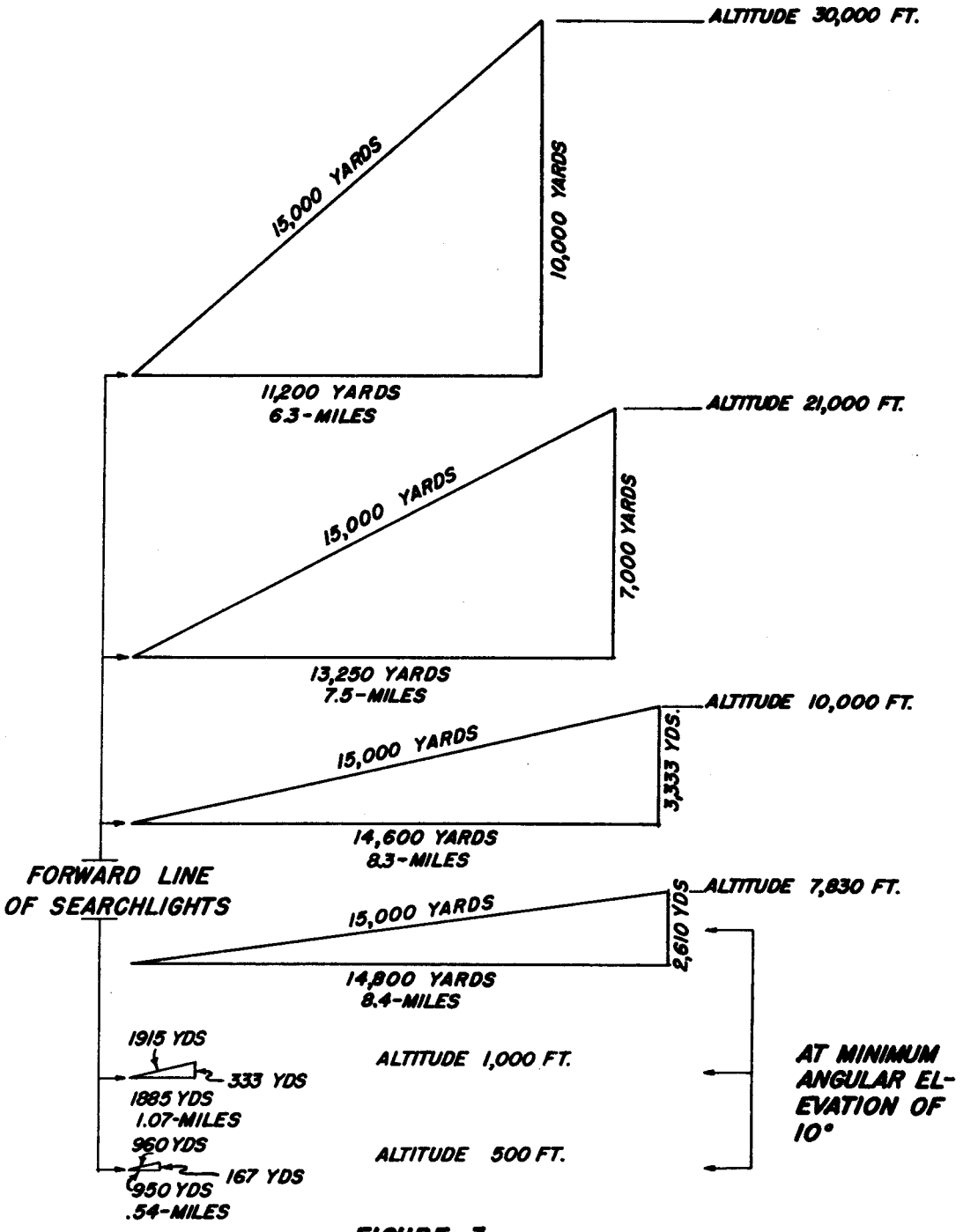


FIGURE-3.

VARIATIONS OF HORIZONTAL RANGE OF INITIAL ILLUMINATION WITH ALTITUDE FOR A SLANT RANGE OF 15,000 YARDS

tween two adjacent sub-control points. For this to represent the worst condition for the fighter, it is necessary also that he be located at the moment of initial illumination, on the opposite limb of the orbiting circle, at the point most distant from the point of initial illumination. (Point "X" of Figure 7.) It is by following such a course that the enemy can most quickly cross the line of sub-control points, and turn the attempted interception into a stern chase. Any movement on his part toward a diagonal course, such as I-C, Figure 7, will increase the time during which he is illuminated before he can cross the line of sub-control points. The fighters can move laterally faster than the enemy can.

(4) For this to represent the worst condition presupposes also that the fighter has been placed at the proper sub-control point prior to initial illumination. As covered in par. 11b, a full 4 minutes of plotting is available under conditions of the extreme low altitude approach. (See Figure 4.) Ample time is available to detect possible changes in the course of the target, and to readjust the fighter's position to another sub-control point.

(5) The worst condition, insofar as time available for plotting and for movement of the fighter prior to initial illumination is concerned, is that of initial illumination at maximum range, i.e., at an altitude of 7800 feet. (See Figure 6.) Under this condition, initial illumination occurs approximately 8½ miles in advance of the forward line of lights, 16 miles in advance of the line of sub-control points. During the time required by the target to traverse that 16 miles, the fighter can move laterally 1.2 x 16 = 19.2, miles from X to D of Figure 8, or beyond the far side of the orbiting circle of the 2nd sub-control point away. An error of more than 2 sub-control points in the placing of the fighter is not within reasonable expectations. Any movement of the enemy toward a diagonal course, such as from I to Y, Figure 8, can result only in his earlier interception, since the fighter can move laterally faster than can the enemy.

(6) All intermediate conditions of initial illumination between that at maximum and that at minimum range in advance of the forward line of lights, result either in more plotting time than in the one case, or in more time for interception after initial illumination, than in the other case. It is thus seen that all other conditions of initial illumination than those analyzed result in conditions more favorable to the fighter. It must always be kept in mind that the fighter can move laterally faster than can the enemy, whether before initial illumination, because of changes in the enemy's plotted course, or after initial illumination, because of the direction of his visible course.

12. BREADTH.--a. The problem of movement of the fighters from the principal control point to the proper sub-control point, prior to initial illumination, directly affects the determination of total breadth of the searchlight intercept unit, i.e., how many sub-control points its maximum practicable breadth can include. This depends upon:

(1) The time available, before initial illumination, to move the fighters from a principal control point in the center of the line of sub-control points, to a sub-control point in the vicinity of the boundary most distant laterally. The time available, in turn, is directly dependent upon the number of minutes of warning afforded, with reasonable certainty, by the AAAIS Detection and Plotting System, which under the worst condition for plotting prior to initial illumination is, as we have seen, 1 3/4 minutes. The most distant sub-control point must consequently be within approximately 1 3/4 minutes of flying time for the fighter from the principal control point.

(2) The time required by the fighters to reach that point, i.e., the speed of the fighters. With target speeds of 300 MPH, and a margin of speed on the part of the fighters of 20%, this speed is taken as 360 MPH, or 6 miles per minute. Although the most modern fighters will exceed this speed somewhat, it is desired always to be on the conservative side.

b. Under the above conditions, the maximum allowable distance from the principal control point to the most distant sub-control point is seen to be 1 3/4 x 6 or approximately 10 miles. With an orbiting radius of 2 1/2 miles, the lateral boundaries are 2 1/2 miles farther distant, or 12 1/2 miles from the principal control point. This fixes the overall breadth of the searchlight intercept unit at 25 miles.

13. GENERAL CHARACTERISTICS.--a. It is thus seen that where open and unobstructed terrain permits, the Searchlight Intercept Unit should be approximately 25 miles in breadth. It should have a depth of never less than 10 miles from the outer row of searchlights to the defended objective, in order to afford a reasonable guarantee of interception and destruction of enemy targets, before they reach the bomb release line, in multiple plane raids consisting of coordinated attacks by individual planes. For heavy mass attacks or for attacks by planes flying in formation, greater depths, up to 25 miles, will be required. A line of sub-control points should be established about 7½ miles inside of the outer row of searchlights and about 5 miles apart; one principal control point should be established in such a location that it is not more than 10 miles from any sub-control point in the Searchlight Intercept Unit. The shape of the Searchlight Intercept Unit, and the number of sub-control points located therein, will depend upon the shape of the searchlight area.

b. Where the Searchlight Intercept Unit is part of a continuous

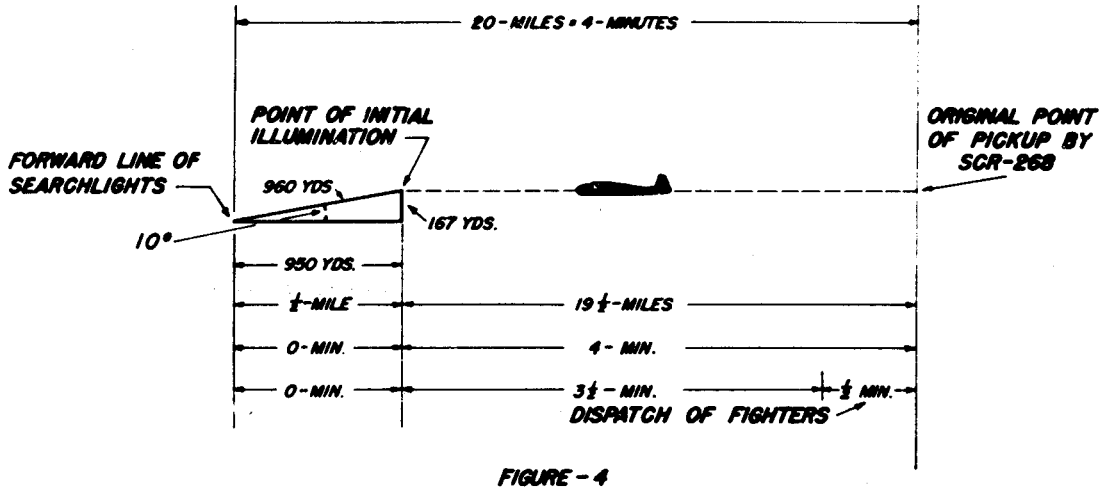


FIGURE - 4

TIME DISTANCE DIAGRAM
for
MINIMUM RANGE OF INITIAL ILLUMINATION

Altitude 500 ft. Angular Elevation 10°
(Assumed speed of enemy plane 300 MPH)

1 — Fighter should be placed at proper sub-control point prior to initial illumination.
2 — Four minutes total available for movement to sub-control points.
3 — 1/2 minute dead time (for beginning of plotting and dispatch of fighters.)
4 — 3 & 1/2 minutes net travel time available to move fighters from principal control point to farthest sub-control point before initial illumination.
5 — 3 & 1/2 x 6 mi/min. = 21 miles.
6 — Farthest sub-control point cannot be farther than 21 miles from principal control point.

NOTE: This represents the worst condition for interception by fighters from sub-control point AFTER initial illumination. It governs the location and spacing of sub-control points.

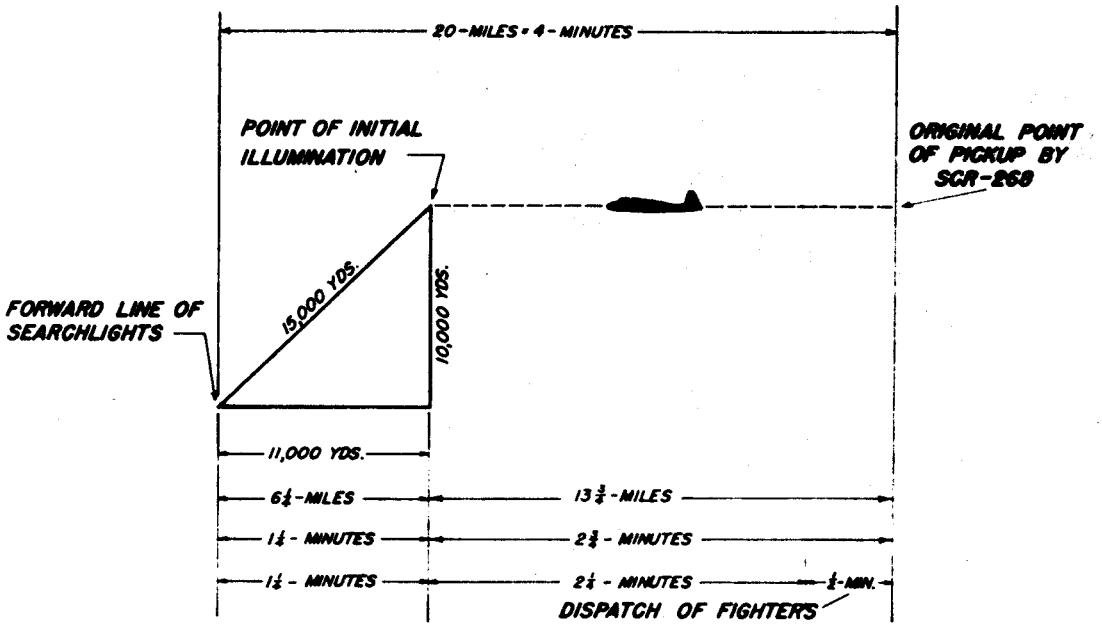


FIGURE-5

TIME DISTANCE DIAGRAM for MAXIMUM ALTITUDE

Altitude 30,000 Feet. Assumed speed of enemy plane - 300 MPH

1.-- Fighters should be placed at proper sub-control point prior to initial illumination.
2 -- 2 3/4 minutes total available for movement to sub-control points.
3 -- ½ minute dead time. (For beginning of plotting & dispatch of fighters.)
4 -- 2¼ minutes net travel time available to move fighters from principal control point to farthest sub-control point before initial illumination.
5 -- 2¼ m x 6 Mi/min. = 13½ Miles.
6 -- Farthest sub-control point cannot be farther than 13½ miles from principal control point.

fighter-searchlight belt stretched along a frontier, with the defended objectives in the rear thereof, it should be approximately square, 25 miles in breadth and 25 miles deep. It should be two-sided, in order to permit operation against outgoing enemy targets which may have escaped destruction on the inward passage. Under this condition, a second identical line of sub-control points should be established 7½ miles inside the rear boundary.

c. Under the conditions more generally to be encountered in this country in the near future, availability of equipment will necessarily result, in most cases, in the establishment of a searchlight defense which consists of a single blanket spread over a local objective and extended as far out in all directions as the available equipment will allow. In such an all around defense of a local objective, the principles herein described will be found applicable and adaptable to such situations.

d. Within any Fighter Control Area, the searchlight intercept units therein should be given code designations, as "Hickory", "Beech", "Oak", etc., to facilitate identification by fighters operating therein. These designations should be coordinated throughout the Wing, to prevent duplication near adjacent Fighter Control Area boundaries.

Section III

THE BELT DEFENSE, FOR FIGHTER COOPERATION ONLY

14. LOCATION.--a. A continuous belt of searchlights intended for fighter cooperation consists of a continuous succession of Searchlight Intercept Units. Such a belt has application only where fighter aviation is operating in "general defense" as opposed to "local defense". Where many objectives lie comparatively close together in the interior of an area, it is possible, with the aid of an effective Aircraft Warning Service, to employ fighter aviation to its greatest advantage. By suitably disposing and operating it along the frontier, it is possible to give a measure of defense to all objectives in rear of the line of fighter operation. This makes most effective use of the outstanding advantage of fighter aviation, its tactical mobility, and constitutes the most effective manner of employment of fighter aviation.

b. Where fighter aviation is so employed, the establishment of a continuous belt of searchlights along the frontier would be advantageous. Such a belt should be located with a view to the locations of the existing fighter operating airdromes, preferably including the airdromes within its boundaries, or be located a short distance outside of them. The belt should cover the frontier continuously, with its ends extending far enough beyond the limits of the defended area as to make it impracticable for the enemy to avoid it by circumvention. In localities where it is impossible to keep it in front of all defended objectives, as where

such objectives lie on the seacoast, it must be merged and coordinated with the local defenses thereof.

15. CONTROL.— The searchlight belt should be subdivided into searchlight control areas, the boundaries of which coincide with those of the Fighter Control Areas. Each control area consequently contains a grouping of as many Searchlight Intercept Units as fit within its boundaries. The searchlight communications within the Fighter Control Area net, including the data lines of the AAAIS Detection and Plotting System, center in the AAA Operations Room. This room is located in the same building as, immediately adjacent to, and, if possible, where space permits, combined with, the main Operations Room of the fighter Control Area. From the AAA Operations Room the Intercept Officer controls the fighters operating over the searchlights at night. Operational control is covered in Part Two.

Section IV

THE COMBINED SEARCHLIGHT DEFENSE

16. THE LOCAL DEFENSE.—a. Where the locations of objectives do not fulfill the requirements for the establishment of a general defense band of fighter aviation, local defenses about vital objectives must be established. This has particular application where the defended objectives are located on or near the frontier, with comparatively little to defend in rear of that frontier. It also applies in the case of any vital objective which is widely separated from the main group of defended objectives in a given area. Such local defenses must be oriented against attack from any direction, i.e., an all around defense must be set up.

b. Where Antiaircraft Artillery is employed as a part of such a local defense, as would normally be the case with important objectives, its employment and operation must be coordinated with that of fighter aviation and the other means of air defense.

c. Fighter aviation normally should take advantage of its tactical mobility to operate as far outside the limits of the defended area as practicable, in the attempt to accomplish as large a percentage of destruction as possible before the enemy can drop his bombs. Situations may exist, however, such as in the case of objectives located directly on the coast, where the fighters may, on occasion, be forced to operate over, and from airdromes located within, the gun defended area. Under such conditions, the overall defense must be so organized as to coordinate the employment of all means of air defense into a single, unified whole.

17. COORDINATION OF SEARCHLIGHTS IN A LOCAL DEFENSE.—a. The points covered in par. 16 have particular application to such Fighter-Search-

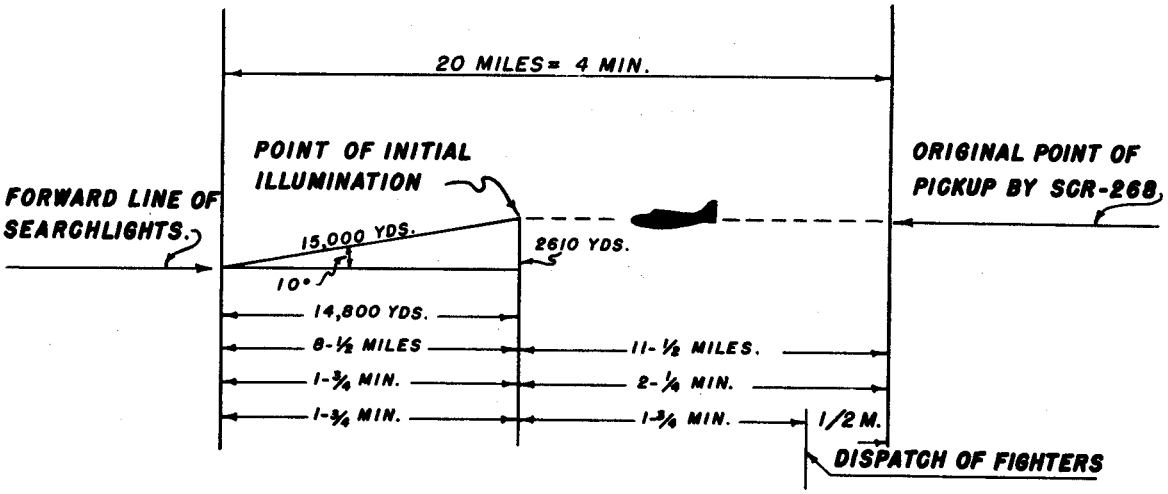


FIGURE-6.

TIME DISTANCE DIAGRAM FOR MAXIMUM RANGE OF INITIAL ILLUMINATION

Altitude 7830 feet — Angular Elevation 10°

1 — Fighters should be placed at proper sub-control point prior to initial illumination.
2 — 2¼ minutes total available for movement to sub-control points.
3 — ½ minute dead time. (For beginning of plotting and dispatch of fighters.)
4 — 1 3/4 minutes net travel time available to move fighters from principal control point to farthest sub-control point before initial illumination.
5 — 1 3/4 M x 6 Mi/min. = 10 Miles (approx.)
6 — Farthest sub-control point cannot be farther than 10 miles from principal control point.

(Assumed speed of enemy plane -- 300 MPH)

NOTE: This represents the worst condition for time available for the movement of fighters from the principal control point before initial illumination. It governs the maximum permissible width of the searchlight intercept unit.

light Defenses as can be expected to be set up in the near future in this country. Because of lack of equipment, it will not be possible to set up searchlight defenses except in the immediate vicinity of important objectives. In such cases, all searchlight units in the area should be organized into a single, coordinated, area searchlight defense. The dispositions should be made with searchlights at normal intervals and with the requirements of the whole defense for illumination, in mind. It should be spread uniformly over the gun defense, and extended outwards therefrom as far as the available searchlights, including those of separate searchlight battalions, will allow. See Figures 11 and 12.

b. It is imperative that a basic fact be not lost sight of, that the mission of AA searchlights is simple and uncomplicated -- the illumination of targets. This must be accomplished before the target arrives within effective AA gun range, and before either gun or fighter action can begin. Fundamental is the consideration that there is no direct connection between the work of AA guns and searchlights, while any attempt to impose one artificially could only result in slowing down, perhaps fatally, the work of the lights. A searchlight defense, once organized with the requirements of both AA guns and fighters in view, and the personnel trained in the few, simple special requirements of illumination for fighter cooperation, can furnish fully adequate illumination for either. It is wholly unnecessary for the searchlight personnel even to know in advance what use is to be made of the illumination, once produced, whether guns are to fire, or fighters are to attack.

c. The searchlight defense should be organized tactically into a searchlight group, headed by a searchlight group commander. The entire searchlight defense thus functions as a coordinated tactical unit, regardless of battalion designations. The command post of the searchlight group is in the AAA Operations Room, overlooking the AAA Operations Board. The searchlight group, or the searchlight battalion if there is but one in the area, operates the AAAIS Detection and Plotting System, employing therefor its organic radio locators on the outer borders of the area.

18. SEARCHLIGHT INTERCEPT UNITS WITHIN AN ALL AROUND LOCAL DEFENSE.-- In an all around defense of a local objective, the principles outlined in Section II should be applied. A line of control points approximately 5 miles apart should be established completely around the searchlight defense, approximately 7½ miles inside the outer boundary thereof, with approximately each fifth control point designated as a principal control point. Each principal control point should not, however, be more than 25 miles distant from the adjacent principal control points. Each principal control point thus establishes the center line of a Searchlight Intercept Unit, the precise shape of which will vary with the contours of the local defense. See Figure 13.

CHAPTER THREE

SEARCHLIGHT ORGANIZATION FOR FIGHTER COOPERATION

Section I

SEARCHLIGHT DISPOSITION IN AN AREA DEFENSE

19. INTERVALS.—a.—(1) In any disposition of searchlights in an area defense, whether for fighter cooperation only, or in combination with a gun defense, searchlights should be disposed at the normal interval of approximately 6000 yards between adjacent lights of a given row, and with approximately 6000 yards between adjacent rows. When faced with only one target at a time in a given area, spacing at greater intervals will be found adequate when radio locators are available for the directing of at least the outer lines of lights. Even under these conditions, spacing at much greater intervals is likely not to produce sufficiently bright illumination for the fire control instruments of a gun battery.

(2) The most critical requirement, however, is that imposed by the necessity of being able to cope with the multiple or continuous wave attack, which can be expected as the normal service condition. With such a type of attack, which presents a given area of the defense with many targets at the same time, distributed laterally and in depth, spacing the light at much wider intervals than 6000 yards will be found to thin the defense down so greatly as to diminish seriously its ability to handle it. It would be likely to result in there being an insufficient number of lights within range to handle any effective proportion of the targets of such an attack. For fighter cooperation, it would have the additional serious disadvantage of requiring beams to reach over from long range at low, flat angles of elevation in order to reach the targets. Such flat,low-lying beams tend to interfere seriously with effective operation of fighters. For these reasons, a greater spacing than 6000 yards is to be avoided.

b. In cases where a material proportion of attacks are to be expected at extremely low altitudes -- below 1000 feet — a spacing of approximately half this interval will be required. Even in comparatively flat country, the interference of normal terrain features, such as trees, low ridges, etc., is likely to be such as to prevent continuous carry

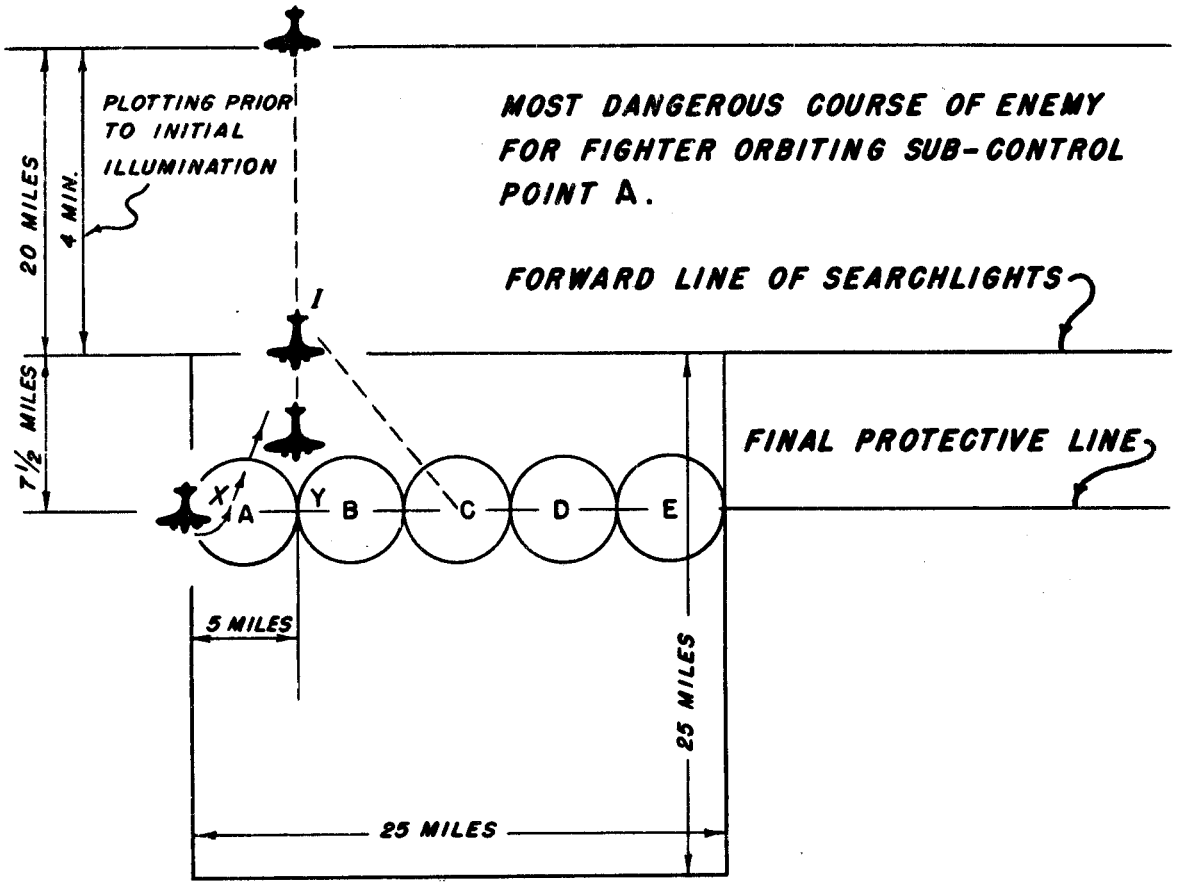


FIGURE-7.

INTERCEPTION DIAGRAM FOR FIGHTER AT PROPER CONTROL POINT

1 — Fighter at X must accomplish a lateral movement of 5 miles while enemy moves inward 7-1/2 miles in order to intercept enemy before he crosses the "Final Protective" line of sub-control point at Y.

2 — No matter which way the enemy may turn laterally fighter can move laterally faster.

3 -- If enemy changes course during 4 minutes of plotting prior to initial illumination fighter position is adjusted to new sub-control point.

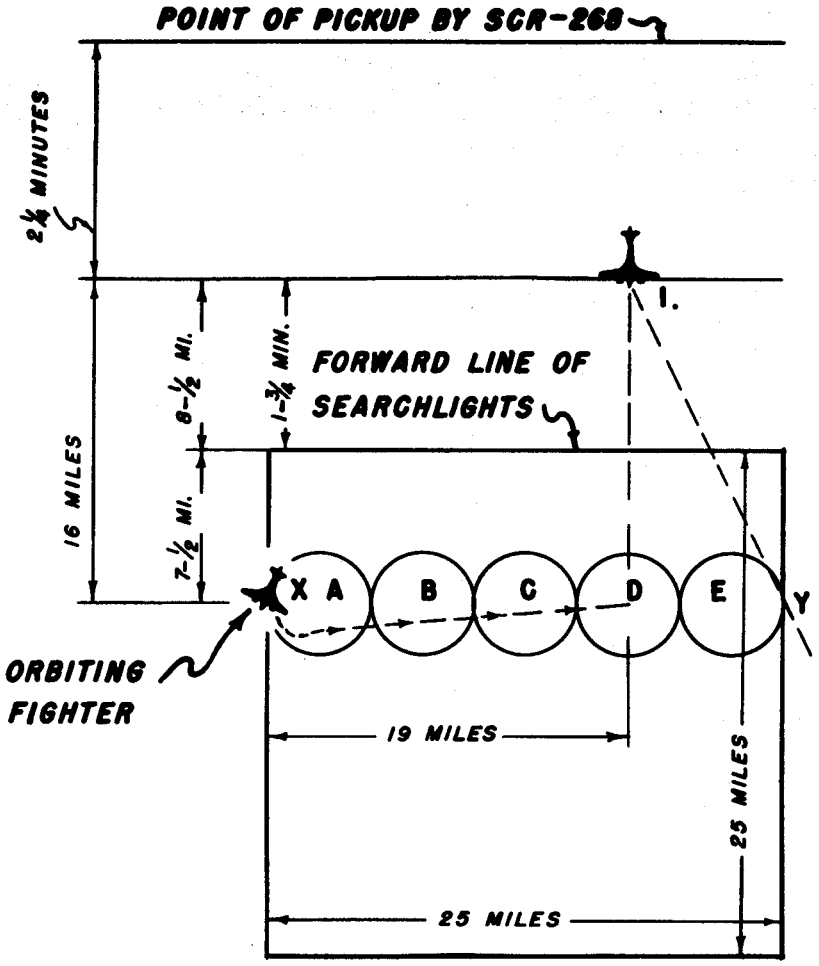


FIGURE - 8.

INTERCEPTION DIAGRAM

Fighter placed at wrong sub-control point A

1 — Interception for BEST condition of initial illumination — WORST condition of plotting PRIOR to initial illumination.
2 — Enemy initially illuminated approximately 8-1/2 miles in advance of forward line of searchlights.
3 — Fighter can travel laterally approximately 19 miles while enemy travels inward 16 miles.
4 — A diagonal course; such as I-Y will result in his earlier interception, since the fighter can move laterally faster than the enemy can.

(Assumed speed of enemy plane — 300 MPH)

from light to light, with a spacing of 6000 yards or greater. Under conditions of the extreme low altitude attack, a spacing of 3000 yards should be adopted.

20. DEPTH.-- The question of depth of defense must be determined on the basis of two factors:

a. Intercept and combat time required by the fighters, which is determined, as covered in par. 10, Chapter 2, to be five minutes.

b. Searchlight and locator equipment available. Obviously, where insufficient equipment is available to afford five minutes of continuous illumination for the fighters, the searchlight disposition should be so planned, following the principles described in Section II of Chapter 2, as to give the maximum practicable period of continuous illumination. It should be laid out, beginning with the defended objective, if in a local defense, and working outward as far as the equipment available will allow. Where separate searchlight battalions are available, they should be incorporated into the overall searchlight defense. The increased total number of lights, considered as a unit, thereby allows the extension of the blanket further beyond gun range, for fighter cooperation primarily.

Section II

TACTICAL ORGANIZATION OF SEARCHLIGHT UNITS

21. BASIC TACTICAL UNIT.--a. The basic tactical searchlight unit is the individual searchlight section itself. Speeds of modern aircraft, and the rapidity and complexity of action required of searchlight sections if they are to cope effectively with the modern type of continuous wave attack, require decentralization of control to the utmost practicable extent. Tactical control during action by individual detector and light commanders, previously thoroughly trained and indoctrinated, is the only control adequate to handle the problem. This requires that the light and detector commanders have the qualifications of intelligence, decision and good judgment, and that they be given thorough training and indoctrination in the principles of tactical control, if they are to accomplish their jobs. A sufficient proportion of men with the necessary qualifications will always be found in the average group of enlisted men.

b. The largest tactical searchlight unit is the platoon of six searchlight sections. The highest tactical commander who is capable of exercising effective control, and who is close enough to a given place

of action to know to any material degree what action is required, is the lieutenant commanding the platoon. Even he, however, cannot possibly make all the tactical decisions required in the case of a multiple-plane attack over his platoon, even if he could be informed rapidly enough of the situation existing at each of his light sections to enable him to make correct decisions in the time available. There are occasions when choices must be made which the platoon commander is in the best position to make, and to give orders accordingly. However, a light or detector commander who has to be given many such orders is not properly trained, or not qualified.

c. The battery is primarily an administrative unit. The battery commander is fully responsible, however, for the training and functioning of his platoons. It is direct tactical control during action which is limited to platoon, detector and searchlight commanders.

22. CONTROL.— Control by all higher echelons is limited to that of the broader decisions as to "Conditions of Readiness for Action" or of general restriction or release. That is, detectors and lights are ordered either to remain out of action beginning at a certain time, or, at a certain time, are released to take such action as the situation may require. The normal condition for searchlights, in the absence of reasons to the contrary, should always be that of being released unless and until, specifically restricted. The reverse policy, that of normal restriction unless and until specifically released, could easily prove disastrous by nothing more than a communications failure, whether by sabotage or accident. Beyond the above, communication between the searchlight platoons and higher commanders consists primarily of the downward flow of intelligence.

Section III

THE SEARCHLIGHT COMMUNICATIONS NETS

23. COMPONENTS.— A searchlight telephone communication system has three components: the platoon command net, the area intelligence net, and the data lines. These three parts of the communication system are entirely independent, there being no direct telephonic connection whatsoever between them. The telephone lines may be commercial wires, Army field wires, or, as is usually the case, a combination of both. The telephones used in the field by the searchlight platoons are usually of standard field types.

24. THE PLATOON COMMAND NET.— The normal platoon command net connects

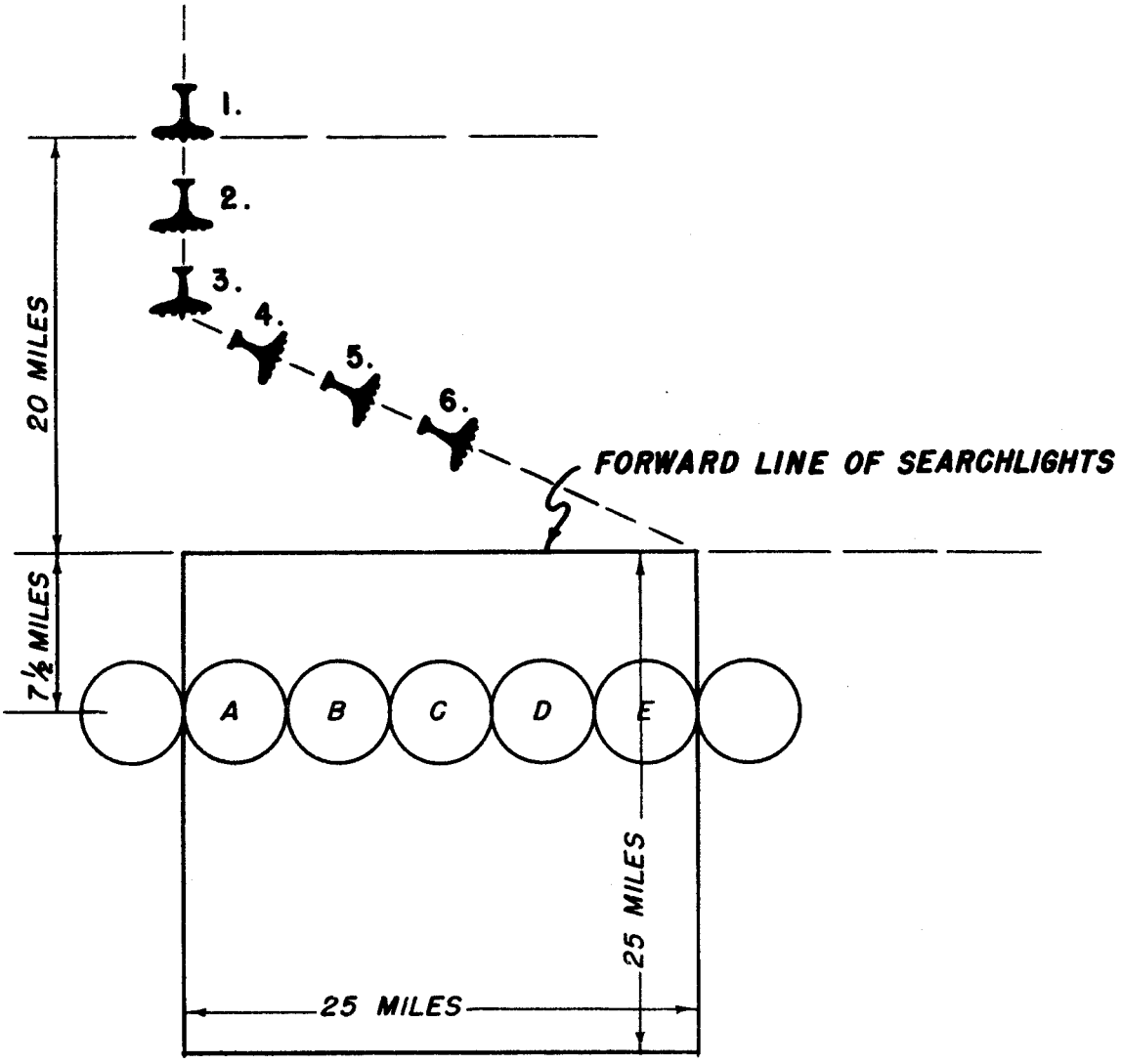


FIGURE-9.

TARGET CHANGING COURSE PRIOR TO INITIAL ILLUMINATION
(Assumed speed of enemy plane — 300 MPH)

1 — Point of pickup by SCR-268.
2 — Dispatch of fighter to sub-control point A.
3 — Point of change of course by enemy prior to initial illumination.
4 — Fighter stopped at sub-control point B.
5 — Fighter recalled to central control point C.
6 — Fighter dispatched to sub-control point E.

NOTE: Fighters are stepped along the line of sub-control points in keeping with the enemy's movements.

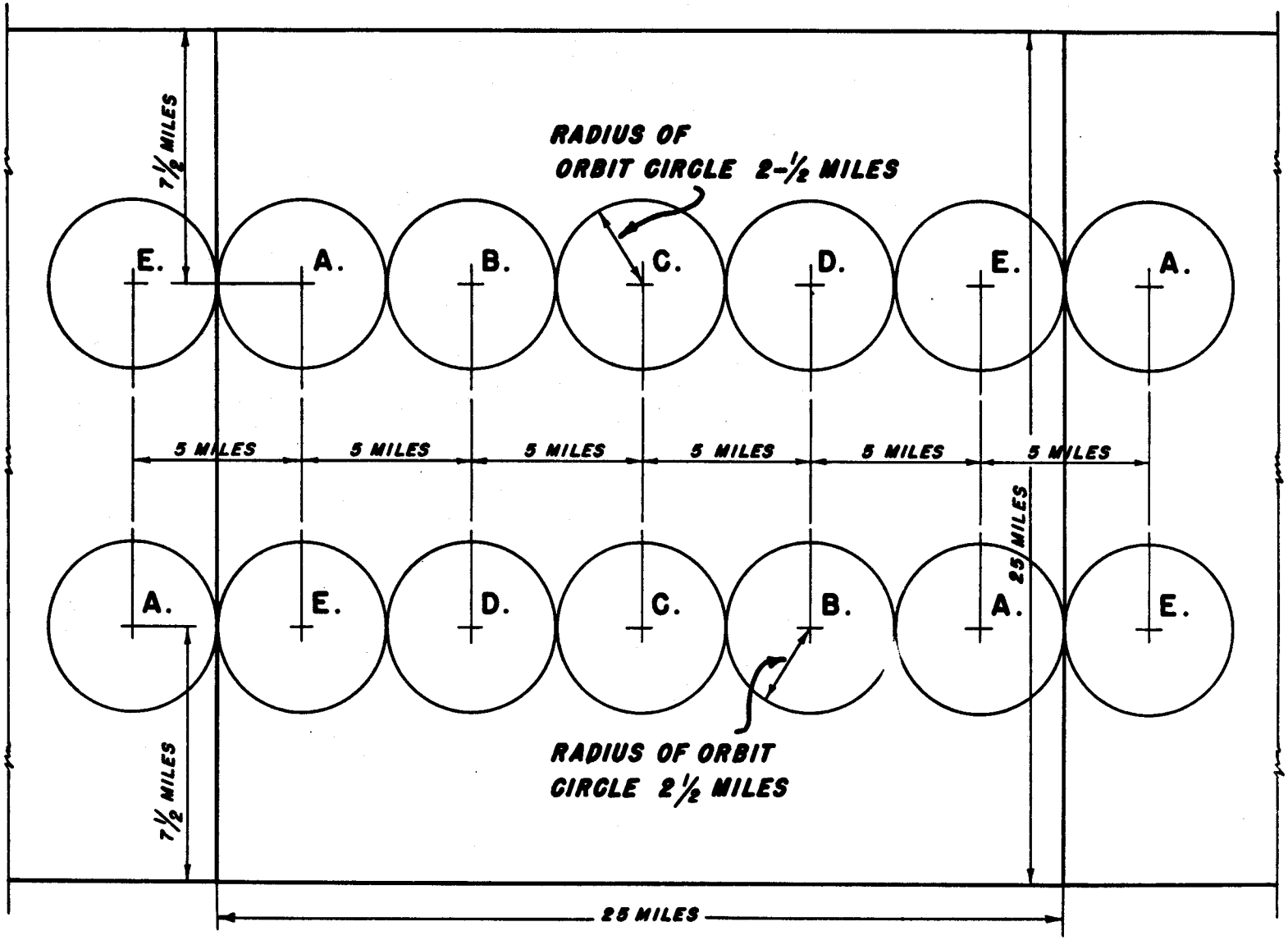


FIGURE-10.

COMPLETE SEARCHLIGHT INTERCEPT UNIT

(Part of a continuous searchlight belt.)

the six sections of a platoon with each other and with the platoon CP. (See Figure 15). There are normally 10 telephones on this net -- one at each control station, one at each detector, and one at the Platoon CP. The phones at the control stations are numbered to agree with the lights in their respective sections, i.e., 1 to 5, while the phones at the detectors are numbered to agree with the respective detector designations, D1 to D3. The phone at the platoon command post is designated CP.

25. THE AREA INTELLIGENCE NET.-- The area intelligence net connects the searchlight plot observer in the AAA Operations Room with all the platoon command posts in the area. This net is used principally to advise the platoons of the approach of enemy aircraft. Like the platoon command net, it is an open net, with all telephone operators wearing head and chest sets so that ringing is unnecessary. The platoon phone on this net takes the platoon code designation, such as 2 Fox, this designation being used in calling or answering this phone.

26. THE DATA LINES.-- The data line provides communication between a radio locator and the corresponding plotter on the AAA Operations Board. Over this line azimuth and range data from the radio locator is furnished the plotter, who uses this data to plot on the board the course of the target being tracked. Altitude data is also furnished over this line for transmission to the fighter pilots in the air. At the radio locator end of the data line two telephones are provided -- one for the azimuth reader and one for the range reader. The range reader also transmits altitude data. Both of these readers, as well as the plotter, wear head and chest sets during operation.

CHAPTER FOUR

THE SYSTEM OF FIGHTER-SEARCHLIGHT TEAM CONTROL

Section I

THE AAAIS AND THE OPERATIONS BOARD

27. THE SYSTEM.— The system of fighter-searchlight team control is based directly upon, and its effectiveness stems directly from, the ability of the SCR-268 to produce dependable data, accurate both in space and time, upon the course, approximate number, and altitude of approaching targets, for several minutes before such targets arrive within searchlight range. This ability makes it possible to establish an effective, close-in, relatively precise intelligence service as a secondary function of the organic SCR-268's assigned to the outer line of searchlights. It requires no additional detection equipment and does not infringe in any way upon the primary mission of the SCR-268's employed, which is that of directing accurately the beam of the searchlight of each upon the target. It requires only the addition of one data telephone line from each SCR-268 involved, connected to a centrally located operations room, the provision of a suitable operations board, of one plotter at the operations board and of 2 data readers at the detector for each SCR-268 so employed. The plots thus produced make timely, accurate, information available on enemy targets, including the prospective point of penetration of the defended area and the point of initial illumination to the following:

(1) Intercept Officer. (For the dispatch of fighters to a sub-control point near the point of initial illumination.)

(2) The searchlight Plot Observer. (For the alerting of searchlight Units.)

(3) The Gun Plot Observer (for giving intelligence to gun batteries where they are present in a combined defense.)

Since the system provides close-in, relatively precise, relatively non-delay intelligence, as opposed to the long range information of the

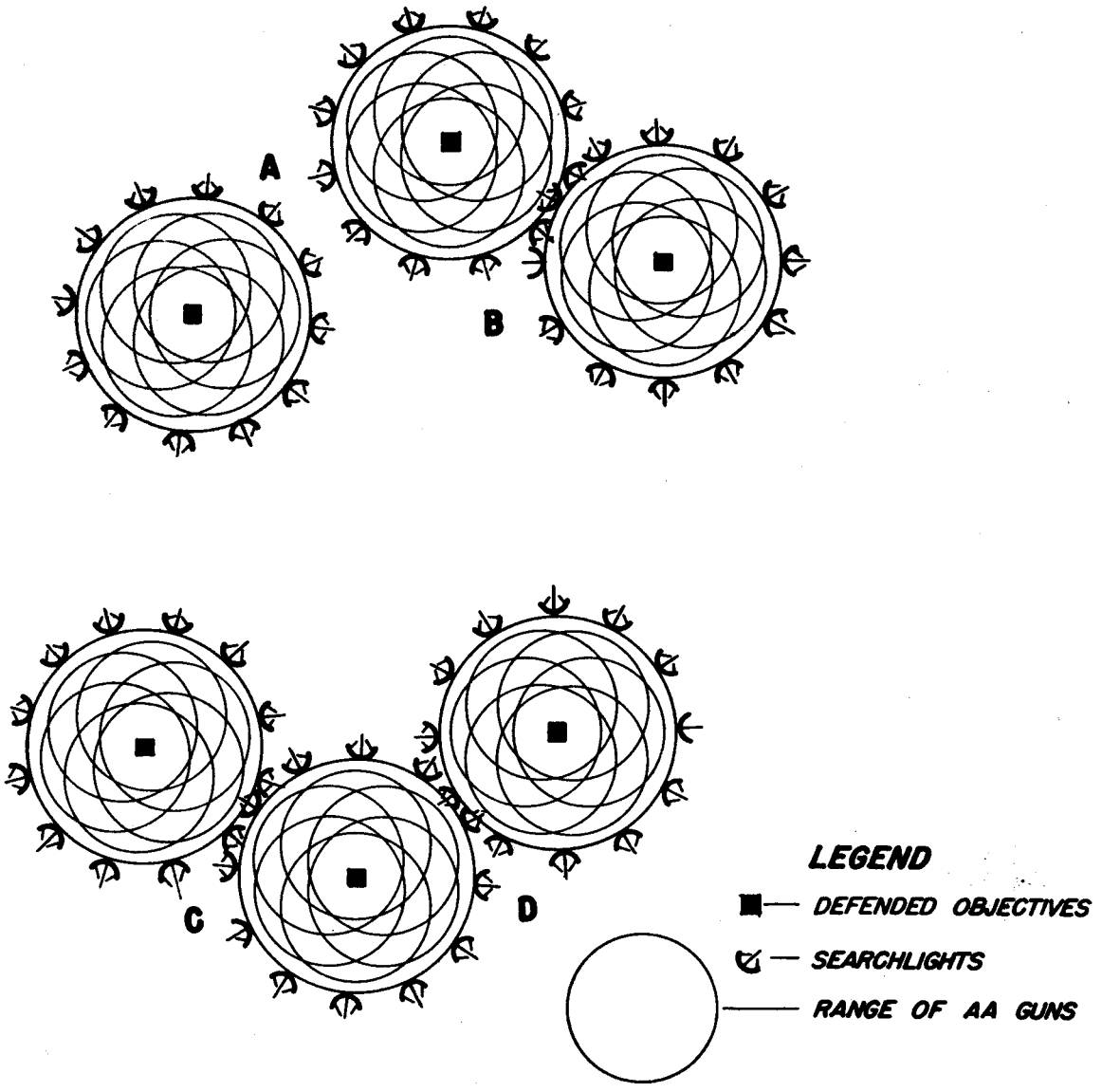
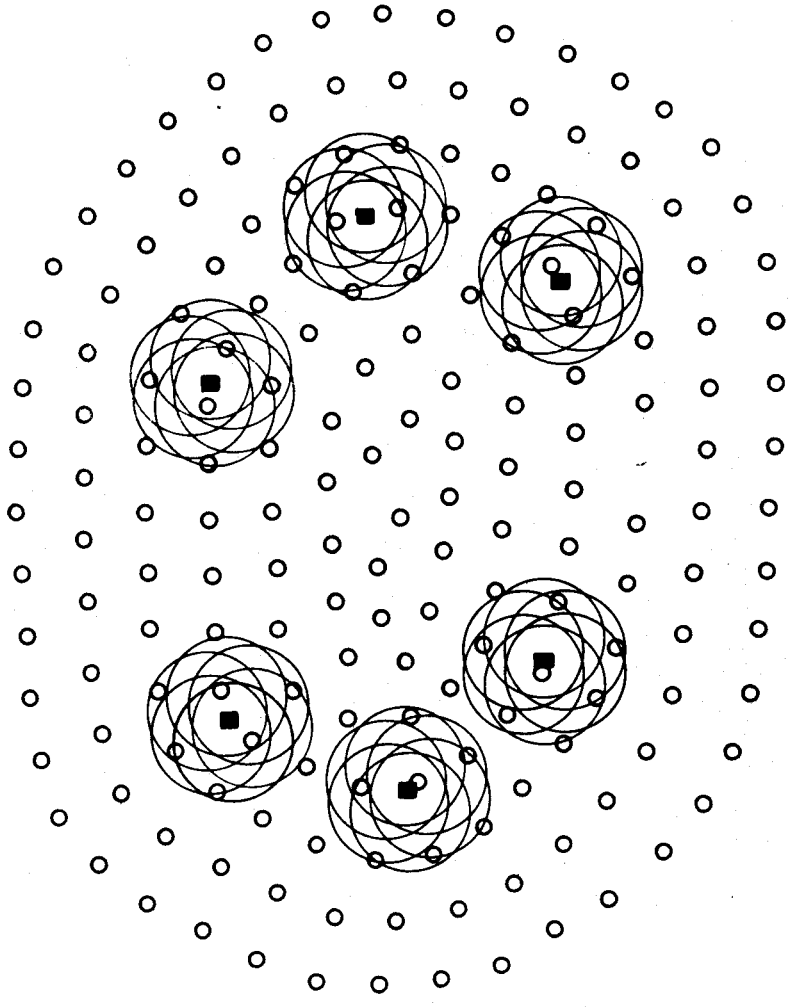


FIGURE-11.

DISPOSAL OF SEARCHLIGHTS AROUND DEFENDED OBJECTIVES

1 — Searchlights too close together at A, B, C and D.
2 — Holes of darkness between defended objectives.
3 — Same searchlights could be spread into a uniform blanket with greater economy and effectiveness.
4 — Searchlights in normal proportion — 36 Gun Batteries — 180 lights. (Inner lights not shown)



LEGEND

■ DEFENDED OBJECTIVES

○ SEARCHLIGHTS

RANGE OF AA GUNS

FIGURE-12.

UNIFORM SEARCHLIGHT BLANKET OVER ENTIRE AREA

1 — Greater effectiveness of illumination results from the same number of lights.
2 — Can be fitted into fighter searchlight defense.
3 — Illumination equally available for guns or fighters.
4 — Separate searchlight battalions can be used as available to extend searchlight defense outward for fighter cooperation.

Aircraft Warning Service, it is designated as the Antiaircraft Artillery Intelligence Service, or AAAIS, since its characteristics correspond to the characteristics and fill the requirements of the latter.

28. THE OPERATIONS BOARD.--a. The paramount requirements of the system are that the plots be non-delay and not easily liable to mistakes. With modern bombers traveling at speeds in excess of 4 miles per minute, a delay of 15 seconds results in an error in position of over a mile. If the target changes course at any time, it is necessary for the Intercept Officer to know it at once, in order to accomplish timely movement of his fighters to the vicinity of the new prospective point of initial illumination. Delays and liability to mistakes in plots are consequently intolerable. For this reason, conversion from polar to rectangular coordinates by charts or graphs under field conditions is not sufficiently dependable, and plotting in polar coordinates, by azimuth and range, is accomplished directly on the central operations board in the Area AAA Operations Room. The appearance of the board is complicated by the requisite azimuth circles and plotting arms, but these cause no practical difficulties in operation. Plotting in this manner can, however, be kept under rigid control, whereas conversion in the field by the use of charts cannot, and it is not subject to the delays and possibilities of mistakes of the latter, which cannot be tolerated for this mission. With the future provision of a Selsyn-driven converter at the SCR-268, these objections will be eliminated, and plotting can then be accomplished in rectangular coordinates, with its obvious advantages in keeping the operations board more clear.

b. (1) A convenient operational scale for the board has been found to be 1200 yards to the inch.

(2) On the board is plotted the searchlight disposition for the Fighter Control Area covered, including the borderline overlaps into any existing adjacent Fighter Control Areas.

(3) The locations of antiaircraft gun, automatic weapon, and barrage balloon installations, the position of each searchlight, and the boundaries of all searchlight platoons with their code names are shown.

(4) Plotting arms, graduated in range to the scale of the board, to a least reading of 500 yards, are pivoted at the position of each detector operating in the AAAIS.

(5) Concentric about each such position an azimuth circle is drawn, graduated to a least reading of 10 mils. In order to avoid confusion between intersecting and adjacent azimuth circles, they are alternated in coloring and suitably staggered in radii.

(6) Prominently shown on the board, for the use of the Intercept Officer, is the location of the principal ground control point for each searchlight intercept unit, and of each sub-control point. If distinctively colored searchlight beams are used as marker beacons for the control points, the positions displayed on the board should be of corresponding colors, respectively.

(7) Superimposed upon the board, to scale, is the Air Defense Grid for the use of a teller who tells over plots from the board to the Wing Filter Room.

c. (1) At each Plotters' position on the board, a telephone jack is installed, to which is connected the data line from its corresponding detector in the field. A telephone head and chest set is provided for each plotter. To minimize error, the detector position shown on the board, and the plotting arm, azimuth circle and telephone jack pertaining to that position, are all assigned the same color.

(2) On the opposite side of the board a telephone jack is provided for the Searchlight Plot Observer, who disseminates intelligence to the searchlight platoon commanders over the Intelligence Net (Platoon CP's in conference.)

(3) Adjacent to the position of the searchlight plot observer is placed a jack for the D/F Plotter who may be required to plot on the board the positions of the friendly fighters when their positions are otherwise unknown.

(4) A similar jack is placed nearby for the teller, who is required to tell over to the Wing Filter Room plots appearing on the AAA Operations Board.

d. For an all around or a two-sided defense, it will be found advantageous to split the board into sections with control personnel stationed in the center, on the floor. See Figure 18. It is possible for them in this position, on the inside looking out, to turn to face a plot coming in from any direction, to align it by eye and to determine with a minimum of delay and a high degree of accuracy its probable point of penetration of the illuminated area. It is not possible for them to do this with comparable speed and accuracy from a distant position on a balcony. Each section of such a split board should carry an overlap into the areas of the adjacent sections.

c. (1) It is to be noted that, since the SCR-268, as at present designed, reads in slant range rather than horizontal range, slant range

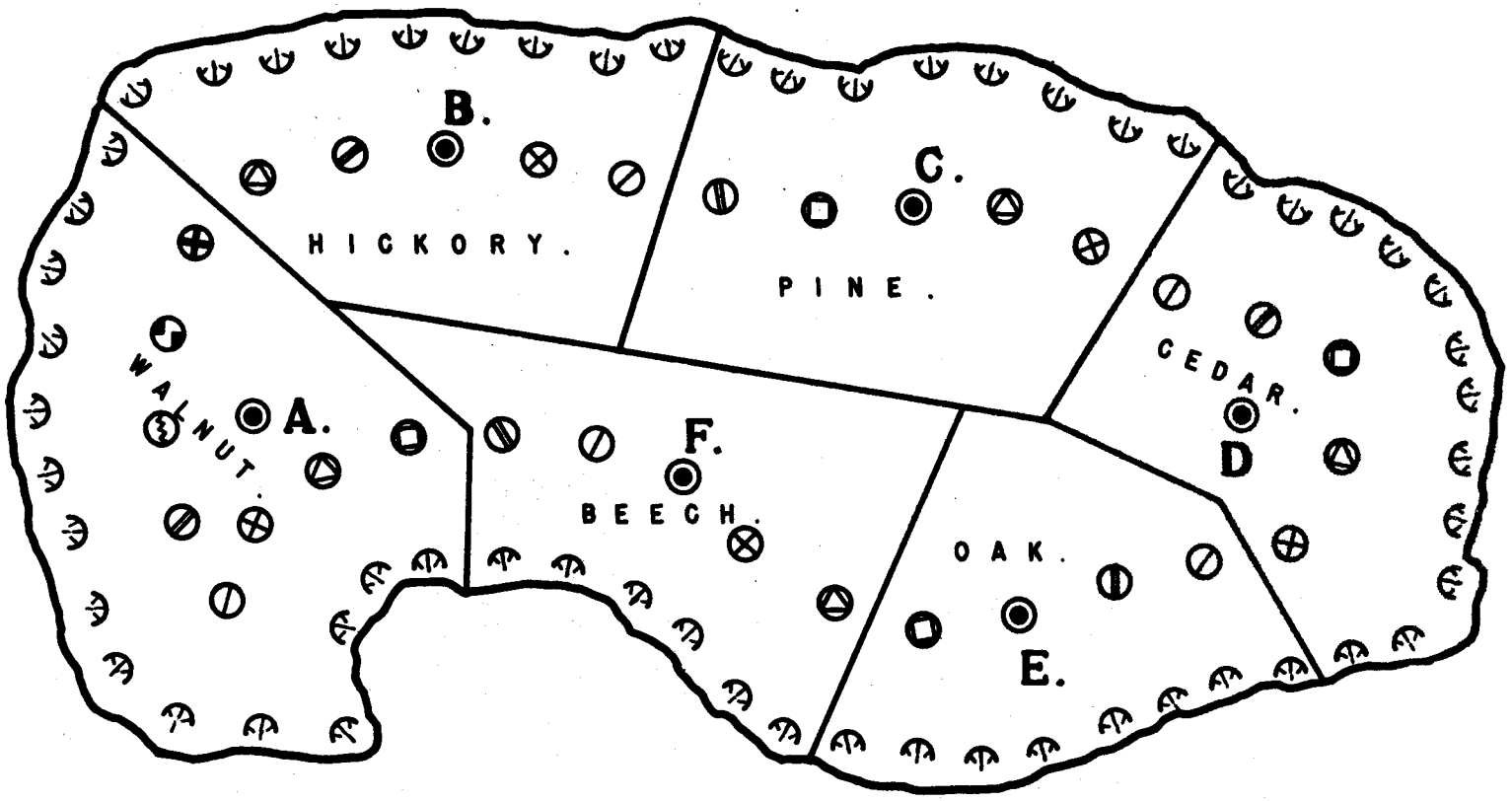


FIGURE-13.

IRREGULAR ALL AROUND DEFENSE

LEGEND

Principal Control Points

Sub-Control Points

Outer line of Searchlights

Boundary of Unit Searchlight Areas

Oak)
Beech)
Walnut) Designation of a
Hickory) Searchlight Intercept
Pine) Unit
Cedar)

NOTE

Shape of Area dictates that the principal control points "A" and "D" are best placed inside line of sub-control points rather than on that line. Principal control points B, C, E, and F are placed on the line of sub-control points in the normal manner.

is plotted on the board as though it were horizontal range. This causes the plotted position of the target to appear on the operations board as being slightly farther out than is actually the case. With the long ranges and low angular elevation at which the principal part of the tracking is done, this discrepancy is of no material importance for the purposes of this work.

(2) The small range discrepancy has no material effect upon the direction of the target's course, which is the important factor for this work. The approximate point of initial illumination is the element of data most urgently required, in order that the fighters may be directed to, and begin orbiting, the nearest sub-control point. A conversion chart could be employed at the SCR-268 in the field, but at the cost of delay and chances of error, which are not justified.

(3) With the future provision of a Selsyn-driven converter, horizontal range can be used.

f. To facilitate cleanliness, and removal of old plots, it is desirable to cover the surface of the plotting board with a transparent material, such as cellulose acetate, having a surface which will take the mark of a wax pencil.

Section II

ORGANIZATION OF THE AAA OPERATIONS CENTER

29. THE COMBINED DEFENSE.--a. (1) In the combined defense, wherein the searchlight area set up in a Fighter Control Area for fighter cooperation includes within its boundaries gun defended areas, the Area AAA Operations Room is, by its nature, suited to all the requirements of Fighter-Searchlight Team Control and to those of the Antiaircraft Artillery elements of the defense for intelligence and control. Because of the vital importance of close and immediate contact, through personal conferences, between the Area Controller and the Area AAA Operations Officer, with consequent elimination of delays and promotion of understanding, the Area AAA Operations Room should, if at all possible, be located in the same building as, immediately adjacent to, and if possible, where space permits, combined with, the Fighter Control Area Operations Room. See Figure 19. Such location greatly facilitates the smooth coordination of all air defense means operating in the Fighter Control Area and facilitates the work of the Intercept Officer, who controls the fighters operating over the searchlight defense at night, from his station overlooking the AAA Operations Board. It eliminates the need for

an AAA Liaison Officer in the Fighter Control Area Operations Room, with improvement in understanding and elimination of delays, since immediate personal contact between the AAA Operations Officer and the Area Controller is available.

(2) Physical factors may make it definitely unavoidable that the AAA Operations Room be located at a distance from the Fighter Control Area Operations Room. Under these conditions, an AAA Liaison Officer should be provided in the Fighter Control Area Operations Room. Channels of communication and command should otherwise remain unchanged however, except for the provision of an additional line between the AAA Operations Officer and the AAA Liaison Officer. The Liaison Officer is provided as a consultant, not as a command channel. The speed of operation required does not permit of relays of information or commands, with attendant delays and mistakes, between the AAA Operations Officer and the Area Controller, through the AAA Liaison Officer.

(3) An AAA Liaison Officer is provided in the Wing Operations Room.

b. The general picture is one of complete coordination between all elements of air defense located in the Fighter Control Area: aviation, antiaircraft artillery, and aircraft warning service. Information and intelligence flow up and down and laterally with equal facility and smoothness.

(1) The normal channel of flow for long-range warning from the Aircraft Warning Service is down to the AAA Operations Room by way of the Wing Filter Room. To make this intelligence on long range targets readily available in the most lucid form, an AAA Situation Board is provided, set vertically, facing the control balcony. On this, the courses of incoming long range targets are plotted on the Air Defense Grid. Incoming courses move over this board, and then across the AAA Operations Board when the targets arrive within its range. In order to have intelligence available immediately on targets picked up by the adjacent Area AAAIS Systems, tracks on such targets are also plotted on the AAA Situation Board.

(2) It is desirable to make immediately available to the other elements of the Fighter Command, intelligence on targets picked up by the AAAIS system, but which may have beem missed by the Aircraft Warning Service. For this purpose a teller is stationed at the AAA Operations Board (Sta. 34, Figure 18), with a direct line to the Wing Filter Board. On the AAA Operations Board is superimposed the Air Defense Grid. From this, the teller tells over all plots to the Wing Filter Room. In order to give this data promptly to the adjacent Area AAA Operations

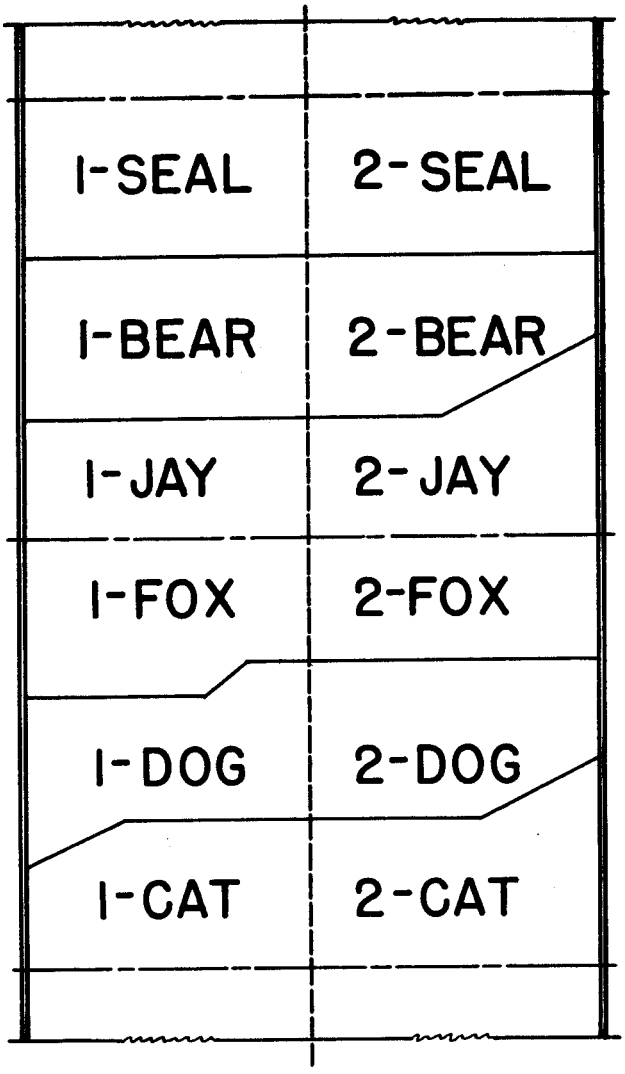


FIGURE-14.

AREA BOUNDARY

BATTALION BOUNDARY

BATTERY BOUNDARY

PLATOON BOUNDARY

TYPICAL DIVISION OF AREA INTO BATTERIES & PLATOONS

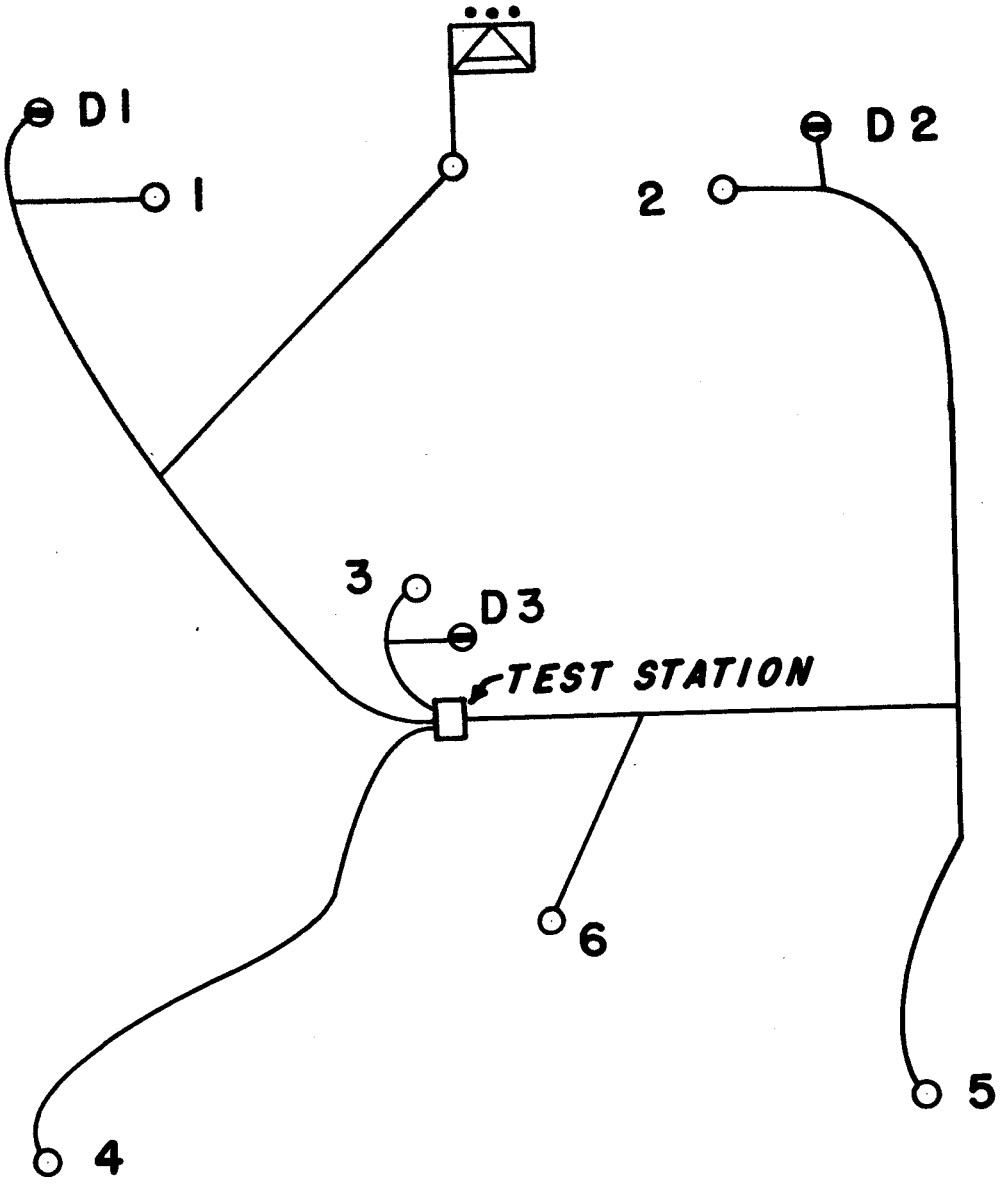


FIGURE-15.

DIAGRAM OF A TYPICAL PLATOON COMMAND NET

⊖ Telephone at Radio Detector or Sound Locator.

○ Telephone at Control Station.

Telephone at Command Post.

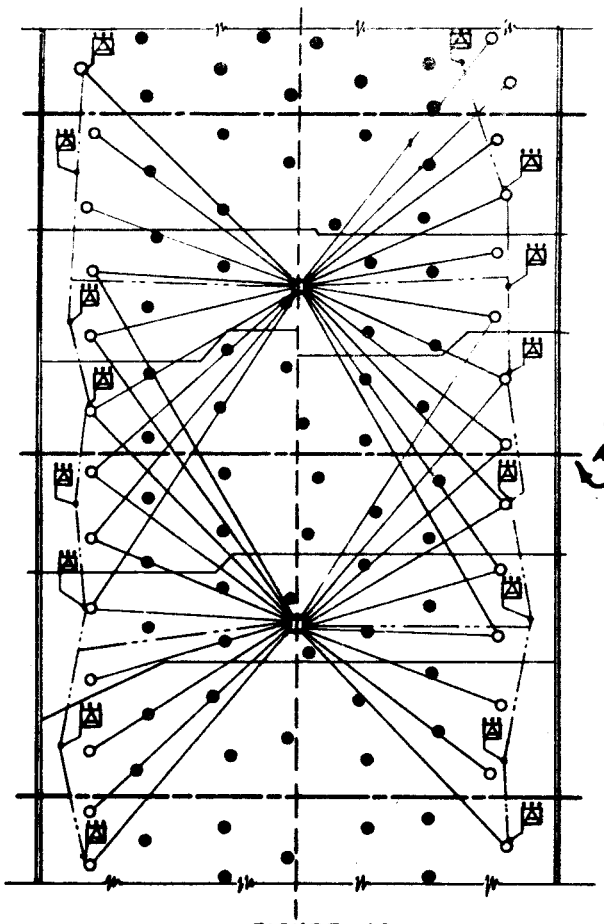


FIGURE-16.

DIAGRAM OF INTELLIGENCE NET AND DATA LINES

(Showing overlap along the boundary between two adjacent Fighter Control areas.)
(Radio Detectors located in the overlap are tied both ways.)

- O — Searchlight Position, Radio Detector operating in AAAIS.
- ● — Searchlight position (Non-AAAIS).
- Command Post.
- ——— Data Lines.
- —- - —- Intelligence Net.
- AAA Operations Room.

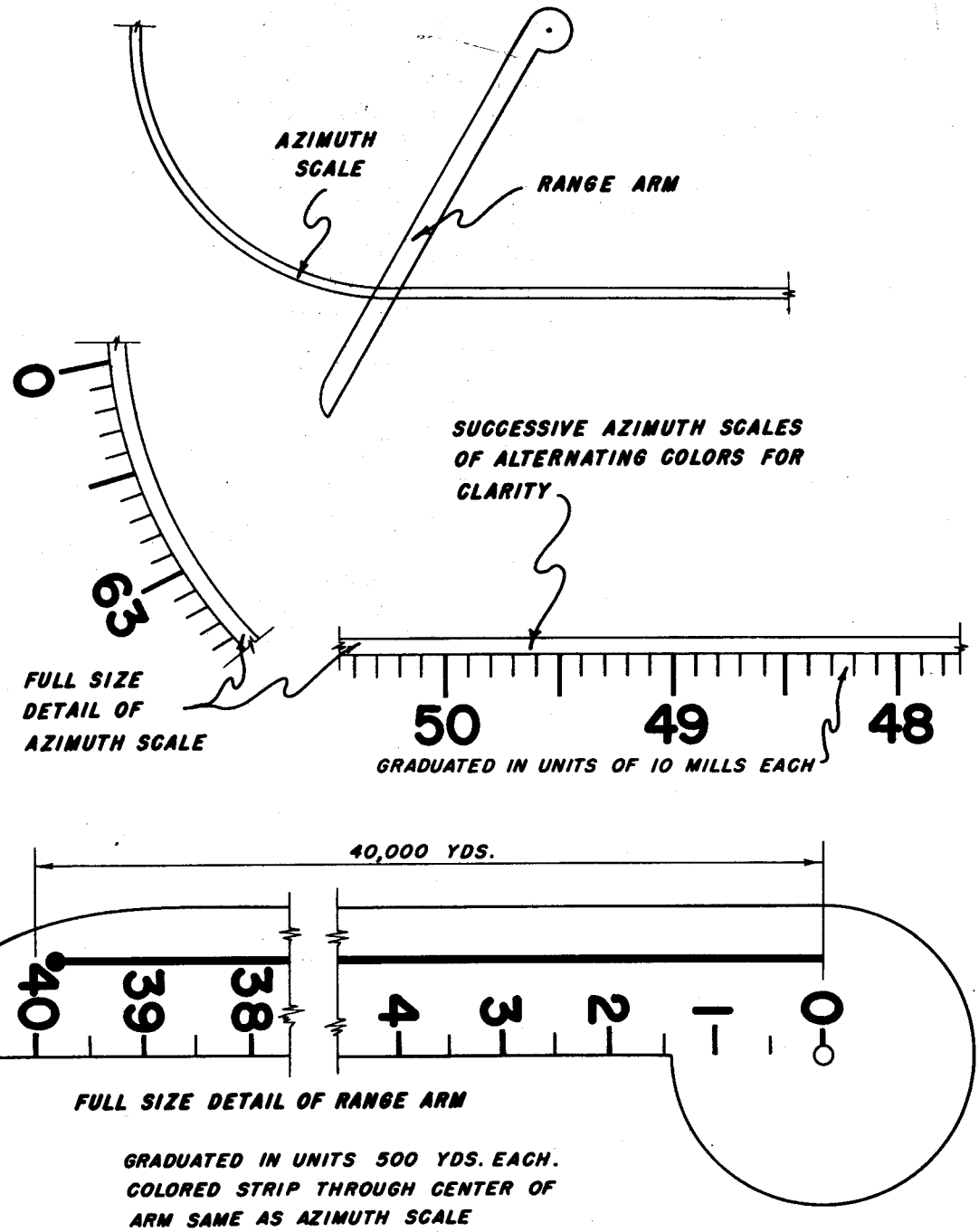

AZIMUTH SCALE
RANGE ARM
0
63
FULL SIZE DETAIL OF AZIMUTH SCALE
SUCCESSIVE AZIMUTH SCALES OF ALTERNATING COLORS FOR CLARITY
50
49
48
GRADUATED IN UNITS OF 10 MILLS EACH
40,000 YDS.
40
39
38
4
3
2
1
0
FULL SIZE DETAIL OF RANGE ARM
GRADUATED IN UNITS 500 YDS. EACH.
COLORED STRIP THROUGH CENTER OF
ARM SAME AS AZIMUTH SCALE

FIGURE-17.

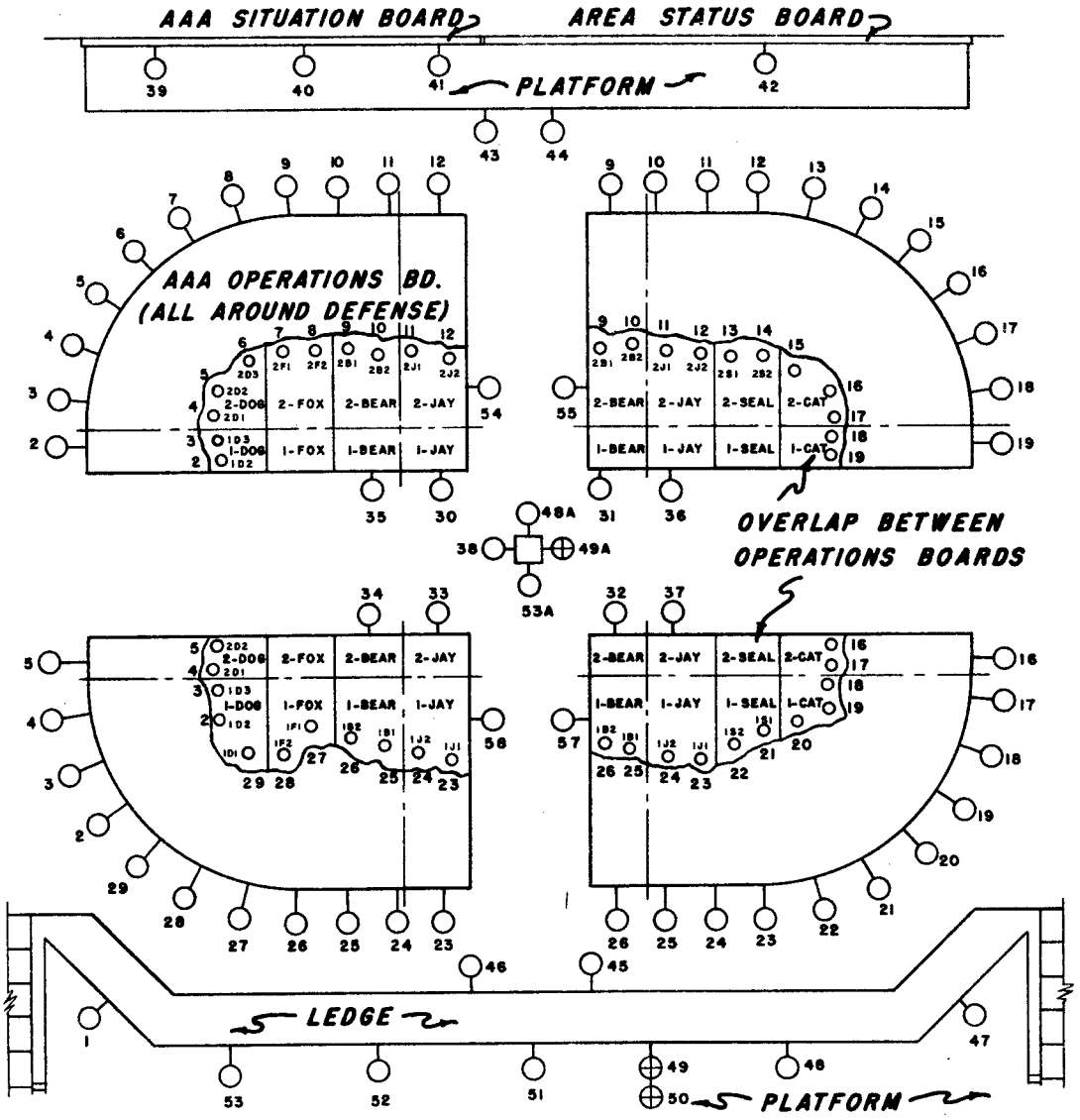


FIGURE-18.

DIAGRAM OF AAA OPERATIONS ROOM LAYOUT
(All around defense)

1. Communication Officer.
2-29. Data Line Plotters.
30-33. Searchlight Plot Observers.
34-37. Wing AAAIS Telliers.
38. D/F Plotter.
39-41. Situation Board Plotters.
42. Status Board Plotter.
43-46. Raid Orderlies.
47. Balloon Barrage Liaison Off.
48-48a. Intercept Officer.
49-49a. VHF Radio Control Unit.
50. PBX Hand Set.
51. AAA Operations Officer.
52. Searchlight Operations Off.
53-53a. Gun Operations Officer.
54-57 Gun Plot Observers.

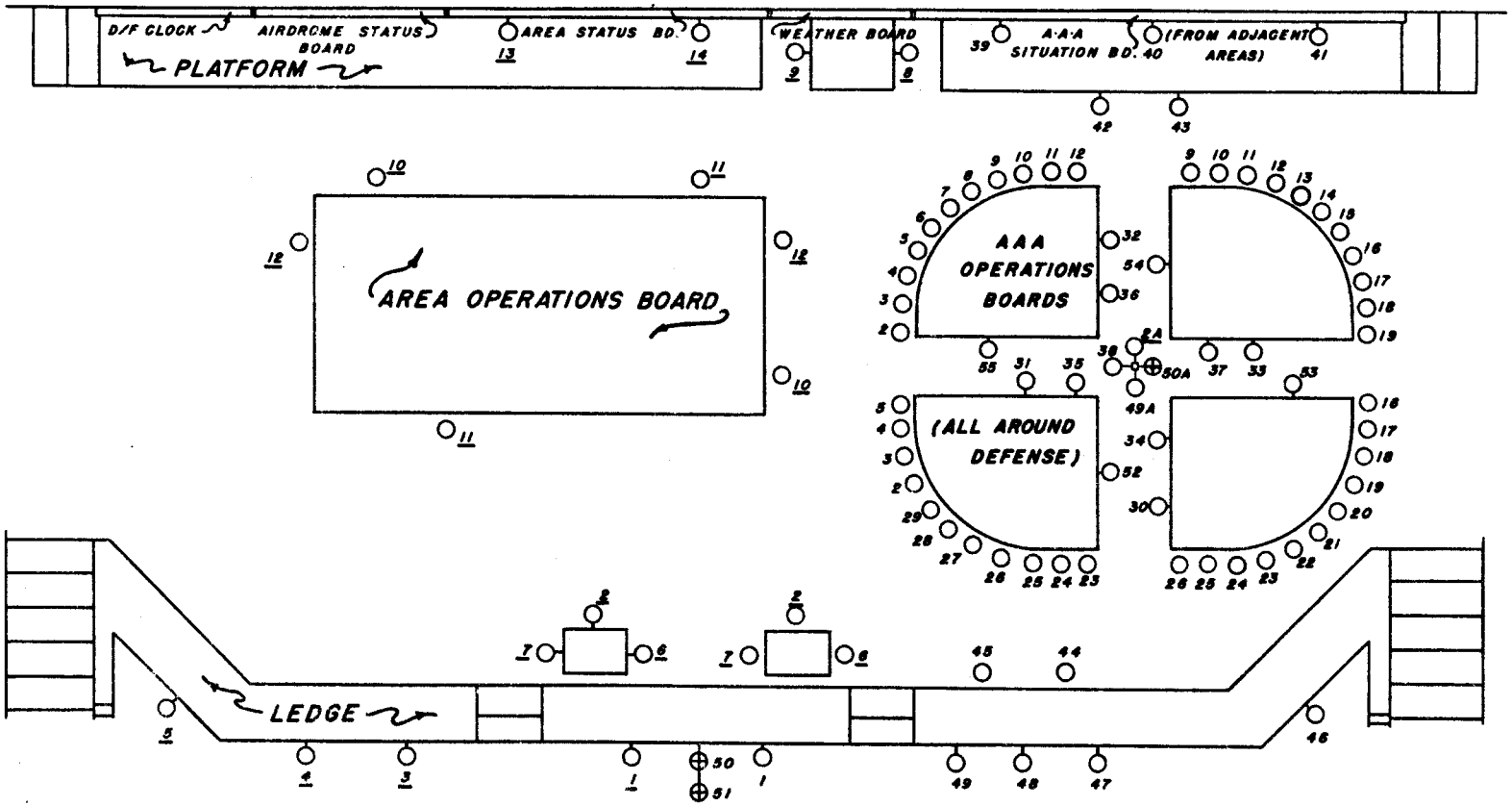


FIGURE-19.

AREA OPERATIONS & AAA OPERATIONS
(Combined in one operations room)

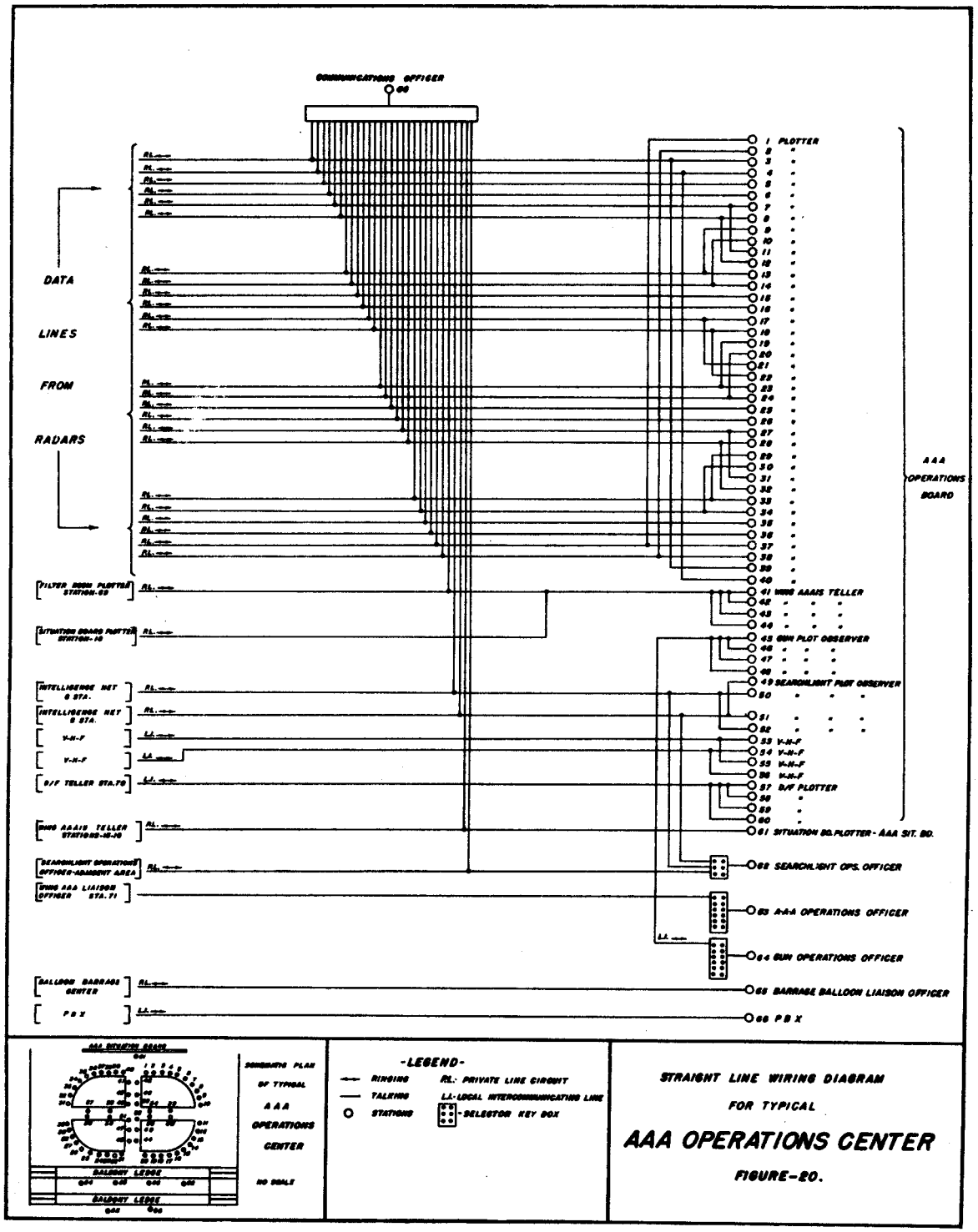
Area Operations

1. Controller
2-2a. Intercept Off.
3. Liaison Teller.
4. Operations "A".
5. Operations "B".
6. Raid Plotters.
7. Fighter Plotters.
8. Floor Supervisor.
9. Raid Orderly.
10. Radar Plotters.
11. Observer Corps Plotters.
12. Fighter Plotters, Ops. Bd.
13-14. Status Board Plotters.

(Note: Station numbers for Area Operations underlined thus, 2)

AAA Operations

1. AAA Operations Off.
2-29. AAAIS Plotters.
30-33. Searchlight Plot Observers.
34-37. Wing AAAIS Tellers.
38. D/F Plotter.
39-41. Situation Board Plotters.
42-45. Raid Orderlies.
46. Communication Off.
47. Balloon Barrange Liaison Off.
48. Searchlight Operations Off.
49-49a. Gun Operations Off.
50-50a. VHF Radio Control Unit.
51. PBX Hand Set.
52-55. Gun Plot Observers


COMMUNICATIONS OFFICER
66
DATA
LINES
FROM
RADARS
AAA
OPERATIONS
BOARD
1 PLOTTER
41 WBBB AAAIS TELLER
45 GUN PLOT OBSERVER
49 SEARCHLIGHT PLOT OBSERVER
53 V-H-F
54 V-H-F
55 V-H-F
56 V-H-F
57 D/F PLOTTER
61 SITUATION BD. PLOTTER - AAA SIT. BD.
62 SEARCHLIGHT OPS. OFFICER
63 A-A-A OPERATIONS OFFICER
64 GUN OPERATIONS OFFICER
65 BARRAGE BALLOON LIAISON OFFICER
66 P B X
FILTER ROOM PLOTTER STATION-09
SITUATION BOARD PLOTTER STATION-10
INTELLIGENCE NET 6 STA.
INTELLIGENCE NET 5 STA.
V-H-F
V-H-F
D/F TELLER STA.70
WBBB AAAIS TELLER STATIONS-40-48
SEARCHLIGHT OPERATIONS OFFICER-ADJACENT AREA
WBBB AAA LIAISON OFFICER STA. 71
BALLOON BARRAGE CENTER
P B X
RL.
L.L.
AAA OPERATIONS BOARD
BALLOON LEDGE
BALLOON LEDGE
DIAGRAM PLAN OF TYPICAL AAA OPERATIONS CENTER
NO SCALE
-LEGEND-
RINGING
TALKING
STATIONS
RL.- PRIVATE LINE CIRCUIT
L.L.- LOCAL INTERCOMMUNICATING LINE
- SELECTOR KEY BOX
STRAIGHT LINE WIRING DIAGRAM
FOR TYPICAL
AAA OPERATIONS CENTER
FIGURE-20.

combined with the Fighter Control Area Operations Room, which should always be done if practicable, the organization and telephone connections outlined in Paragraph 29 are modified as indicated in Figure 19.

33. WIDELY SEPARATED DEFENSES.-- In cases of neighboring Fighter Control Areas wherein the AAA defenses of one area are widely separated from the AAA defenses of the other, the direct intercommunication lines between the AAA Operations Room of one and that of the other, are of little value and can be eliminated. This applies to the following, listed in Paragraph 29c, above:

Station 14, 14a. (Tellers' line, sta. 34-37, to Wing Filter Room only.)
Line No. 2, Station 52.
Line No. 4, Station 51.