c. A telephone operator should be thoroughly trained in trouble shooting; it is his responsibility to begin checking immediately from h end of the line as soon as trouble develops, while the men from the reg lar communication section start checking from the other end. This is extremely important in order to insure the re-establishment of communic tions at the earliest possible moment after a breakdown, and should be strongly emphasized during training.

68. THE PLATOON COMMAND NET.--a. The platoon command net normally connects the six sections of a platoon with each other and with the pla toon CP. (See Figure 15.) There are normally 10 telephones on this ne one at each control station, one at each detector, and one at the Pla toon 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 desig nated CP.

b. Since the net is always open during operation, it is unnecessa to ring in order to call any phone. All operators wear head and chest sets, and can be immediately contacted by calling the desired phone de signation over the net. When a phone is called, its operator should instantly respond by repeating his station designation in answer to the call. For example, if a platoon commander desires to call the detector phone at section 3, he calls over the net "D3", and the telephone operat immediately answers "D3". To contact all control station phones simul taneously, the call "All lights" is used, and the control station opera tors should respond immediately and in sequence, "1", "2", "3", "4", "5" Likewise, to the call "All detectors", the detector phone operators should answer promptly and in sequence, "D1", "D2", "D3".

c. All commands or information given by a section chief or detec tor commander are immediately transmitted over the platoon net by the telephone operator. In each case, the telephone operator prefixes the command he is repeating with his station designation, for identificatio For example, if the detector commander in section 2 announces "On tar get", his telephone operator immediately transmits over the platoon net, "D2, On target", Or if the section chief in section 5 commands "In", his telephone operator announces over the phone, "5, In".

d. The telephone operators keep the section chiefs and detector commanders informed of the general situation by repeating aloud all in formation and commands which they hear on the platoon net. For instance if the detector in section 2 makes a contact, the D2 telephone operator will call over the net, "D2, Contact", and immediately each telephone

perator should repeat, "D2, Contact" in a voice loud enough to be heard y his respective section chief or detector commander. Operators must e careful to keep the switch open on their transmitters while repeating nformation in this manner, to avoid jamming the net with constant repe- itions.

e. Information or commands which do not pertain directly to his ection should be repeated by a telephone operator in a conversational one, although it should be loud enough to be heard by the section chief r detector commander. Commands pertaining to a particular section should e repeated by the telephone operator of that section with more emphasis nd in a tone of command, so as to promote instant action. It must be mphasized, however, that action is taken by the members of the section nly on the command of the section chief or detector commander and not on ommands repeated by the telephone operator.

f. (1) It is a further duty of the control station telephone opera- or to maintain a log in which is recorded the time of each illumination, irection of flight, approximate altitude, and type of plane. A sample og entry is as follows:

2016:30 - In - NW to SE - 6000 - B26
2017:15 - Out

(2) This log may also be used to record such items as time section s ready for action, time section is out of action due to breakdown, re- arboning, etc., changes of status and condition of alertness, time of arch Order, etc.

9. THE INTELLIGENCE NET.--a. The intelligence net connects the search- ight plot observer in the AAA Operations Room with the platoon command osts in the area. Its use is discussed in Paragraph 25.

b. The maximum number of platoon command posts which should be onnected to the same intelligence net will vary from about six to ten. n large areas, where there are more than approximately ten platoons in peration, it will be necessary to use several intelligence nets, each aving its own searchlight plot observer in the AAA Operations Room. t will usually be the case that in such large areas the plotting board ill be subdivided as shown in Figure 18, with a searchlight plot obser- er for each segment of the board; in this case, the intelligence net ill be divided into as many different parts as the plotting board itself s divided.

70. THE DATA LINE.-- The use of the data line is discussed in Paragraph 26, and the operating procedure for the data readers is explaine in Paragraph 35d.

Section IV

BASIC RADIO DETECTOR AND SEARCHLIGHT OPERATION

71. ORGANIZATION OF THE SEARCHLIGHT SECTION.— The following table wi serve as a guide to the personnel required for efficient operation of Radio Detector-Searchlight Section:

a. The radio detector squad:

(1) Chief Radar Operator (Detector Commander).
(2) Range oscilloscope operator.
(3) Azimuth oscilloscope operator.
(4) Elevation oscilloscope operator.
(5) Power plant operator.
(6) Azimuth data reader.
(7) Range data reader.
(8) Telephone operator.
(9) Four relief operators.
(10) Chauffeur.

b. The sound locator section requires the following personnel fo operation:

(1) Detector commander.
(2) Azimuth listener.
(3) Elevation listener.
(4) Acoustic corrector operator.
(5) Telephone operator.

c. The Searchlight Section (in either radio detector or sound locator section):

(1) Light commander (Section Chief).
(2) Chief controller.
(3) Azimuth controller.
(4) Elevation controller.
(5) Telephone operator.
(6) Lamp operator.
(7) Power plant operator.

d. The searchlight section for a carry light position having no detector consists of the following:

(1) Light commander.
(2) Chief controller.
(3) Azimuth controller.
(4) Elevation controller.
(5) Power plant operator.
(6) Lamp operator.
(7) Telephone operator.

e. The detector section and the searchlight section are the two components of a unified searchlight team, under the control of the section chief. For reasons which will be explained later, the section chief acts as light commander, and is responsible for the operation of the entire section. The chief radar operator, who is also the detector commander, is second in command, and is charged with the tactical operation of the detector.

2. THE LIGHT COMMANDER.--a. (1) The most important job from a tactical point of view in a searchlight section is that of the light commander. With the principle of decentralization of control placing the responsibility upon the light commander for selecting targets, choosing the proper time to go in and out of action, and making decisions concerning changing from one target to another, the light commander is required to make a greater number of important tactical decisions than the detector commander. The detector commander has a more or less fixed routine to follow in the tactical operation of the detector. For the light commander, however, no two situations will be exactly the same; he must be capable of facing each new situation as it arises, and then, without delay, making the proper tactical decision and taking immediate action. For these reasons, it is very important that the section chief, who normally will be the most capable man in the section, be assigned the position of light commander and not that of detector commander.

(2) Never, under any circumstances, should the light commander operate the binoculars at the control station during action. The necessity for his being constantly aware of every aspect of the general situation absolutely prohibits the confining of his attention to the relatively minute view which can be seen through the binoculars. The adoption of decentralized control is futile unless the light commander is freed from any duties which prevent his using in an intelligent manner the tactical control given him, and in order to make intelligent use of this control, he must have a thorough knowledge and complete understanding

of the situation confronting him. Modern searchlight tactics are based upon the expectation of multi-plane attacks, and these attacks create such a rapidly changing problem that it would be impossible for the light commander to make an adequate estimate of the situation at any given time if he were occupied with any other duties.

b. (1) The light commander's post should be in the vicinity of the control station, and about ten or fifteen feet from it -- where he will not be distracted by the operation of the control station itself. His primary job is to watch the skies for signs of action, so that he can keep himself constantly aware of the general situation. He must NEVER make the mistake of confining his attention to his own searchlight beam when it is in action, but rather should be sizing up the situation in general, including frequently scanning the sky behind him, so as to prepare himself in advance for the next action which will be necessary. He will receive from the telephone operator at the control station information on targets which are contacted and tracked by his own detector, and also general information concerning the operation of all the other sections in his platoon. The platoon command post will relay to him, also through the control station telephone operator, information on approaching targets which are being plotted on the AAA Operations Board, but which have not yet been illuminated.

(2) The light commander must use all these mediums of information - his own personal observation, reports from other sections of the platoon and reports from the operations center, relayed through his platoon command post -- to the fullest advantage, so that he will be well acquainted at all times with all possible aspects of the general situation. This is extremely important during multiple plane attacks.

c. The searchlight should be put in or out of action only on direct orders from the light commander. He gives the command "In" or "Out" from his position off to one side of the control station, and the chief controller relays the commands to the lamp operator by means of the buzzer system connected between the control station and the searchlight. Even when the telephone operator at the control station receives the command "In" or "Out" from the platoon CP, and repeats it aloud for the benefit of the light commander the chief controller still must wait for the light commander to give the order himself before he (the chief controller) signals the lamp operator. The same principles apply to the command "Change target". Likewise, when the detector has been tracking a target, and the control station telephone operator receives the announcement, "Range" and repeats it aloud, the light must not be put in action until the light commander himself gives the order.

d. When the command "Change target" is given, the chief controller may not know to which of several possible targets he should swing the searchlight beam. As a matter of fact, since he is already following one target through his binoculars, his field of view will be so small that in general he will not know that there are other targets in the vicinity until he hears the command. In order that the command "Change target" may be executed with a minimum of delay, and that the searchlight beam be traversed to the proper target selected by the light commander, the latter, upon giving the command, "Change target", should immediately run over to the chief controller and actually point out to him the target selected, so that there can be no mistake or delay. In the event that the new target has not yet been illuminated by any searchlight beams, but is being tracked by the detector and is within searchlight range, the light commander should follow the "Change target" command with the announcement "On data", to inform the controllers that they should go back on detector data by zeroing the azimuth and elevation needles.

e. The light commander should know the direction of all adjacent searchlights, as this information is sometimes very important in making tactical decisions. In order to locate definitely these adjacent lights, he should set stakes out around the position he occupies during action, to indicate their direction. These stakes should be marked with the appropriate light designations which he can see with the aid of a flashlight; cat's eye reflectors with the designations painted on them make excellent markers, which can easily be fastened to the stakes.

73. THE DETECTOR COMMANDER.--a. (1) The detector commander, under the supervision of the section chief, is responsible for the tactical operation of the detector. His tactical duties are the same, regardless of whether he is in command of a radio detector or of a sound locator, although if he is a radio detector commander, he has some additional duties to perform.

(2) A detector commander, during action, should station himself 10 or 15 feet from the detector, where he can perform his duties without being distracted by the actual operation of the detector. He should be alert at all times, and constantly keep himself aware of the general situation by scanning the skies. The detector telephone operator on the platoon command net will keep the detector commander informed of action being taken by other sections in the platoon, by repeating aloud all the commands and announcements which are transmitted over the net. Information on approaching targets being plotted on the AAA Operations Board will also be relayed to him through the platoon CP. The detector commander should NEVER allow himself to be distracted from his primary concern of keeping in touch with the whole aspect of the situation and possible

future action in the area, by becoming absorbed in watching the searchl beam in his own section while it is in action.

b. In a sound locator section, the detector commander should move a position in front of the horns when giving commands, so that he can b clearly heard. When the order "Change target" is given, he should indi cate the direction to which the horns are to be turned by using the com mands, "Traverse right", "Traverse left", "Elevate", "Depress". This i important because the azimuth listener has his back toward the directio in which the horns are pointing. In a radio detector section, it is no necessary for the detector commander to move out in front of the radio detector to give commands, but he must indicate the direction of change after "Change target" has been given, by using the commands mentioned above.

c. Like the light commander, the detector commander should know the direction of all adjacent searchlights, and should set stakes out around the position he occupies during action, to assist him in deter- mining these directions.

74. THE CHIEF CONTROLLER.--a. The duty of the chief controller is to watch for "flicks" when a searchlight goes into action, and to take ove the DEC controls as soon as a flick is observed, in order to maintain illumination of the target by visual tracking. Even before the light goes into action, he should watch the sky through the binoculars when t detector is on target and transmitting data on an approaching plane. The azimuth and elevation controllers, by keeping their needles at zero will train the binoculars in the direction indicated by the data from the detector, and the chief controller occasionally may be able to pick up a target by seeing it blot out stars or cross in front of the moon. If the chief controller should happen to pick up a target in this manne before the light is put in action, he should immediately take over the controls and continue to track the target; he should not, however, give the signal to put the light in action unless the light commander so orders.

b. (1) The chief controller should insure that his binoculars are properly alined with the searchlight beam at all times, i.e., that the apparent end of the beam is in the center of the field of view of the binoculars. Also, he should keep a target being tracked as near to the center of the field of view as possible. Otherwise, a chief controller may track a target by the illumination produced by other beams, complete unaware of the fact that his own beam is not centered upon it. The limited field of view of the binoculars renders it difficult, if not impossible, for the chief controller to distinguish his own beam from

others on the same target. All he can do is to keep the target in the center of his field of view and depend upon the alinement of the binoculars to keep the beam on the target.

(2) If the beam does not follow the target properly, as it may not if the binoculars are accidentally knocked slightly out of alinement, it is the responsibility of the light commander to detect this fact and inform the chief controller immediately, so that the latter may make the necessary re-adjustment.

c. When he receives the command "Change target", the chief controller should cease looking through the binoculars and determine from the light commander the direction of the new target. He then swings the beam, without using binoculars, as rapidly as possible to the new target; when the beam is approximately on the target, he picks it up in the binoculars and resumes tracking.

d. The chief controller should be thoroughly trained in the identification of aircraft by silhouette views. Since he has the clearest view of the illuminated planes of anyone in the section, due to his use of binoculars, he is the logical man to rely upon for identification of targets.

75. THE OSCILLOSCOPE OPERATOR.--a. The ability of the radio detector to accurately direct a searchlight beam to an aerial target depends largely upon two factors:

(1) The degree of accuracy maintained in leveling and synchronizing the radio detector and searchlight.

(2) The ability of the radio detector oscilloscope operators to track the target accurately.

b. The importance of the first factor has been fully discussed in Section II. The second factor, the ability of the oscilloscope operators to track the target accurately, concerns chiefly the azimuth and elevation scope operators, since azimuth and elevation are the two elements of data used to direct the searchlight.

c. The azimuth and elevation oscilloscope operators track a target by splitting the echo on the oscilloscope screen into two separate echoes or "pips", as illustrated in Figure 28. When these two "pips" are exactly the same height, as shown in steps 2 and 4 of Figure 28A, the radio detector is centered on the target in azimuth or elevation, as the case may be. As the target plane moves along on its course, the

radio detector must be traversed at the same angular rate as the angular rate of travel of the plane in order to keep the "pips" continuously balanced. To do this, requires a state of training of the oscilloscope operators which is very seldom, if ever, achieved. Excellent results, however, can be obtained if the oscilloscope operators keep the average heights of the "pips" balanced, and this can be done without difficulty if the operators are properly trained.

d. The oscilloscope operator, if not corrected, will usually track a target in the manner shown in Figure 28A. He will slow down the rate of rotation of the handwheel until one "pip" definitely drops below the height of the other (step 1, Figure 28A). Then, he will speed up the rotation until the "pips" are approximately balanced, as shown in step 2. Again he will slow down, and allow the same "pip" to lag behind (step 3) and will repeat this process continually. In other words, he is always "catching up" to the target. Since the searchlight follows the data transmitted to it by the radio detector, it will follow the same procedure — lag behind the plane, gradually catch up to it, and fall behind again. The beam will always be "catching up" with the plane. The plane may occasionally be illuminated by the fringe of the approaching beam, but very few real flicks will be obtained.

e. The correct procedure in tracking is illustrated in Figure 28B. Here the oscilloscope operator turns his handwheel in such a manner that first one "pip", and then the other, is the higher. When he brings up a low "pip", he continues to increase its height until he "pushes it over the top" of the other. Then, he allows it to drop back until it becomes the lower of the two again. Thus, on the average, the heights of the two "pips" will be the same. The searchlight beam, as it did in the case above, will follow the movements of the pips". In azimuth, it will lag behind the plane, sweep across it, and pass out to the front. In elevation, it will pass from above the target to below it, and vice versa. The beam will constantly be moving up and down, back and forth, with the target in the approximate center of its movements. Frequent real flicks will inevitably result.

f. The habit of "lagging" is a commonplace error among oscilloscope operators, as was mentioned above, and must be fully eradicated before efficient operation of the radio detector can be expected.

76. THE DETECTOR SEARCH.—a. (1) The search is that part of detector operation in which the detector continuously traverses back and forth across its normal front in an attempt to locate new targets. The search should normally be made at a fixed angle of elevation and between prescribed limits in azimuth. These azimuth limits constitute the boun-

ries of the normal front which will be selected in conjunction with
e normal fronts of the other detectors operating in the same area, in
der to insure complete coverage with an adequate amount of overlapping.
interference conditions for the radio detectors are uniform over the
ea, equal normal fronts can be assigned each radio detector. Under
ese conditions, a normal front of about 90° extending 45° on each side
a line from the radio detector perpendicular to the nearest border
the area will give ample coverage, and is satisfactory.

(2) When interference conditions are such that some of the radio
tectors have unavoidable interference in certain sectors toward the
ont, then a survey must be made of the possible maximum limits of
arch of all the radio detectors in the area, and normal fronts assigned
such a way that the normal front of each detector is in a sector in
ich the interference will not prevent picking up and tracking targets,
d which also will give an adequate degree of overlap between detectors.

b. (1) It is generally advantageous to limit the number of radio
tectors in an area which are searching at any given time, in order to
duce the total amount of mutual interference and thereby increase the
ck-up range. See Paragraph 35b. Initially, all that is required is
e warning that an attack is imminent, and this warning can be ade-
ately assured even with the use of fewer detectors. With every other
dio detector standing by, or, perhaps, with even two out of three
dio detectors standing by, the mutual interference between radio detec-
rs will be greatly reduced, and the radio detectors which are conduct-
g the search will be capable of making initial contact at longer ranges
e to the reduction in interference. Therefore, it usually will be the
se that longer range warning will be available if only part of the
dio detectors conduct the search.

(2) While the search is in progress, the radio detectors which are
anding by should be in operation, but should have their high voltage
itches turned off, and the crew standing by at their posts, ready for
mediate action. As soon as a contact is made and the location of the
tacking planes determined, the searchlight plot observer will notify
e platoon CP's, over the intelligence net, and the platoon commanders
ill then immediately order their standby radio detectors to commence
ransmitting and searching. In the event that there is a breakdown in
mmunications between the AAA Operations Room and the platoon CP, the
latoon commander should immediately order his standby radio detectors
nto action. Likewise, if communication is lost between a standby radio
tector and the platoon CP, the detector commander should immediately
rder that the high voltage switch be closed and the search be begun.

c. While searching, a radio detector should be elevated to 10° — which is about three and a half turns of the elevation handwheel. This elevation should allow the greatest capability of detection of longer range targets, providing at the same time, good detection up to an angle of elevation of 30°. In mountainous terrain, the elevation angle for searching should just clear the angle of mask of the frontal screen. The search should be conducted at a rate of about one turn of the azimuth handwheel per second. It is important that a minimum time be spent in stopping to examine fixed echoes that resemble targets, as such action may delay a contact on an actual target. During the search, the azimuth oscilloscope operator should vary his scope sensitivity occasionally, to allow search for both weak and strong targets.

77. TRACKING THE TARGET.—a. (1) When a contact has been made by the radio detector, the operator who first observes it immediately calls "Contact" loud enough to be heard by the other two oscilloscope operators, the data readers, the telephone operator, and the detector commander. The azimuth data reader immediately repeats this announcement over the data line to the plotter in the AAA Operations Room, and the telephone operator also repeats it over the platoon net. The other two oscilloscope operators endeavor to locate the echo produced on their respective oscilloscope screens. All three operators then get their scopes on target as soon as possible, the range operator by alining the echo with the center line on the oscilloscope screen, and the azimuth and elevation operators by splitting the echo and balancing the two resulting "pips".

(2) As each operator gets his scope on target, he announces "Range on target", "Azimuth on target", or "Elevation on target", whichever is appropriate. In most cases, it will be found that the elevation operator will not be able to get on target as soon as the range and azimuth operators, due to the fact that the radio detector is not accurate in elevation at angles below 150 to 250 mils above the angle of mask, and, in many cases, the angle of elevation will be 150 to 250 mils below the angle of mask for some time after the contact is made. However, the data which are required immediately after contact are azimuth and range, since these are the only two elements of data which are used to plot the course of the approaching target on the AAA Operations Board. Altitude data is required later, in order to enable the fighters to start the interception at an altitude greater than that of the targets they are intercepting, but initially, the main concern is to determine the probable point at which the attack will penetrate the searchlight area, so that the fighters may be moved to the proper sub-control point without delay. Therefore, as soon as the range and azimuth operators are on target, regardless of whether or not the elevation operator is on target, the announcement, "On target" is transmitted over the data line by the azimuth

data reader, and the reading of data is then begun as explained in Paragraph 35d.

(3) The above-indicated announcement over the data line. "on target", refers to the fact that the detector is able to track a target with the requisite accuracy for the plotting of its course on the operations board. It does NOT indicate that its altitude data is yet sufficiently accurate, either for the determination of accurate altitudes or for the accurate direction of its searchlight beam. As soon as the angular elevation rises to the minimum accurate angle, altitude will be transmitted over the data line, as discussed in Paragraph 35d. As soon as both of the following conditions exist, i.e., the range is not over 15,000 yards, and the angular elevation is above the minimum accurate angle, the data is sufficiently accurate to allow of putting the light in action.

b. While the data is being read and transmitted to the operations room, the detector telephone operator should repeat occasional ranges, about every 5,000 yards, over the platoon command net, in order to keep the section chief, the platoon commander, and the other sections in the platoon aware of the progress of the incoming target. The detector telephone operator should also transmit over the platoon command net a range reading at about 16,000 or 17,000 yards, in order to warn the light commander that searchlight action is imminent.

c. (1) The detector commander should always confine the search of his radio detector between the assigned limits of his normal front. If, however, during the search over the normal front, a target is picked up and tracked to one of the limits of the normal front, the target should not be dropped. On the contrary, the detector should remain on target and continue to track, and the data readers should continue to send in data until the target is illuminated or lost, or until notice is transmitted from the operations room over the data line to cease giving data. This notice should not be construed by the detector commander, however, as an order to cease tracking the target. It is merely notification that the operations room is not interested in the data being transmitted by this radio detector -- which means that one or more other radio detectors are sending data on the same target. If the range readings indicate that the target is getting close to searchlight range, the detector commander should CERTAINLY continue to track the target, in order that the light may be in a position to assist in the attempt at initial pick-up. If it appears that the target will not come within searchlight range of his unit, it would be better for the detector commander to order his detector to change target and resume search over the normal front.

(2) Once an attempt is made at an initial pick-up, the target should never be dropped by either the searchlight or the detector until report is received that the target has been illuminated, or until the light has been properly relieved, or until the target has passed beyond the limits of illuminating range. In this way, the intersection will be continuously maintained, even though illumination has not been produced, and this intersection will be sufficient to guide the fighter pilot to the target. The principle outlined here applies to both periods of good and bad visibility. Normally, the second line radio directed lights will go into action early enough to relieve the front line lights by the time the target enters the searchlight area, thus relieving the front line detector where illumination has not been produced. Where targets approach inside of the 2000 yard minimum range of detection for the radio detector, it will, of course, be necessary for that detector to report "Off target" and not allow the accompanying searchlight to wave helplessly through the sky and interfere with friendly pursuit. The principal advantage to be gained by maintaining a continuous intersection, once an attempt has been made, is the economy in the use of fighters. Initially, the fighters will be dispatched out to the interception immediately on report of "Bandit Hot from West", etc., regardless of whether illumination has been produced. If a target were to be dropped because of failure of illumination then a fighter would be dispatched needlessly and may or may not be able to regain his position at a control point.

(3) With the approval of the platoon commander, the radio detector may occasionally track a target inside the searchlight area for the purpose of checking synchronization.

Section V

TACTICAL OPERATION

78. THE INITIAL PICK-UP.--a. (1) The initial pick-up is ordinarily made by the first or second row of lights. In all phases of fighter-searchlight tactics, the second row of lights functions in exactly the same manner as the first.

(2) The range at which a searchlight should go into action in an attempt for an initial pick-up should not exceed 15,000 yards, because visibility at longer ranges, particularly for camouflaged targets, is so reduced that chances are great that flicks will not be observed, and the searchlights will merely prematurely disclose their locations. When the range of the incoming target has dropped below 15,000 yards, and the angle of elevation has risen to the minimum angle at which the elevation data

becomes accurate, the detector telephone operator calls "D-2, Range" over the platoon command net, and the control station telephone operator repeats it to the light commander. The minimum angle of elevation at which altitude data becomes accurate varies with different radio detectors, but will be between 150 and 250 mils if the normal front of the radio detector is over level ground or the ocean. If a terrain or other type mask exists in the normal front, then the minimum angle of elevation at which altitude data becomes accurate will be 150 to 250 mils above the angle of mask. The minimum angle can be determined for each radio detector by tracking an outgoing, illuminated target with the radio detector, and determining the angle of elevation at which the elevation needle of the zero reader on the searchlight begins to materially deviate from zero.

(2) The light commander, if he is satisfied that his controllers have their needles at zero, and that the chief controller is ready for action, should then immediately order "In". The chief controller notifies the lamp operator by the buzzer signal system and the lamp operator puts the light into action. The controllers continue to keep the azimuth and elevation needles at zero; there should be no searching by the controllers in a radio detector section.

(4) When the light goes into action, the detector commander should then watch for the formation of an intersection by another light, and as soon as he sees that one has been formed he calls "Intersection". "Intersection" is announced whether or not the target is actually illuminated: the two lights may still be searching for the target, or they may be illuminating a target which cannot be seen from the ground due to poor visibility. The azimuth data reader repeats the announcement "Intersection" over the data line, and it is called aloud in the plotting room by the plotter. The Intercept Officer uses this information to dispatch a fighter to make the interception.

(5) When the chief controller can see the illuminated target he announces "Target illuminated", and this announcement is repeated by the telephone operator over the platoon command net. The detector telephone operator then repeats aloud the announcement "Target illuminated" and the azimuth data reader immediately transmits this information over the data line.

b. (1) When a searchlight goes into action for an initial pick-up, the chief controllers of all adjacent lights in the first and second rows should intently watch the beam to see whether it is illuminating a target. Due to angles of reflection, the chief controllers of adjacent lights will sometimes be able to see a target which has just been picked

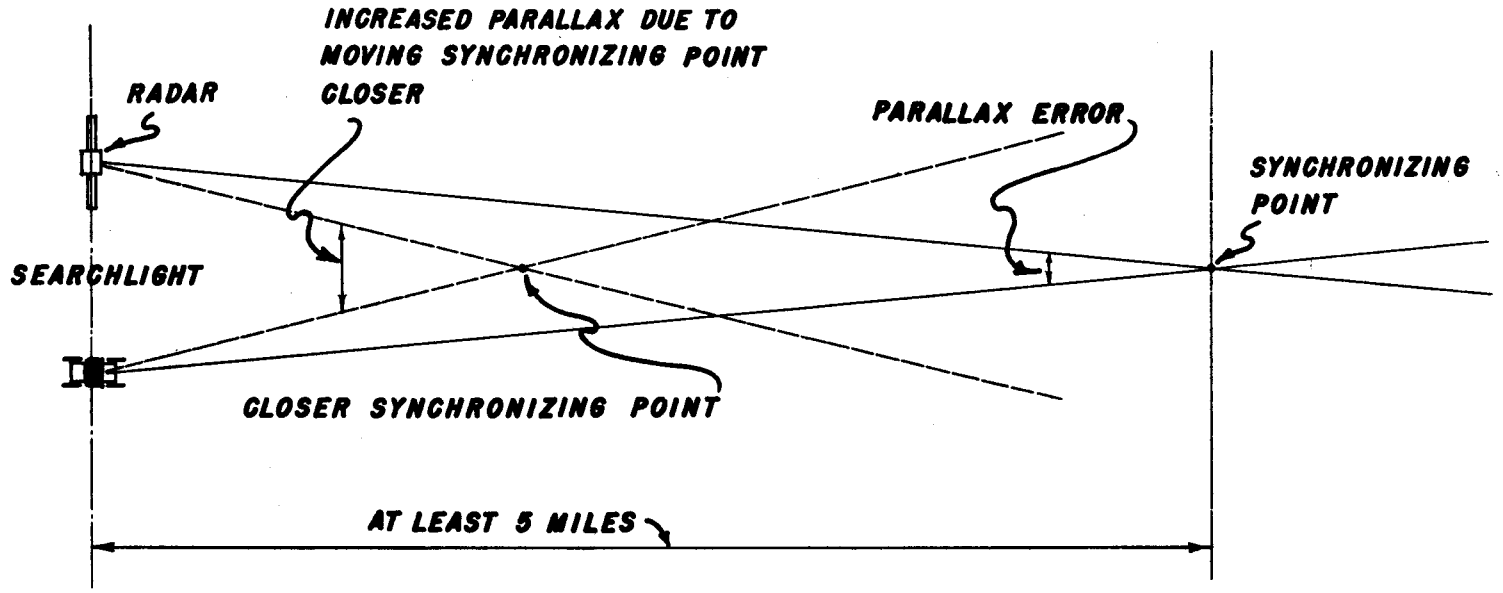


FIGURE-23.

DISTANT POINT METHOD OF SYNCHRONIZATION

RESTRICTED

up in a beam before the chief controller of the searchlight which is illuminating the target sees it. The chief controller of an adjacent light may spot the target more easily by scanning with his binoculars up and down the other searchlight beam.

(2) As a target is observed, the chief controller should, without delay, inform the light commander, who should immediately put his light in action to form the intersection even though his own detector may be sending in data on another target. The formation of an intersection should be given priority over the picking up of an additional target. However, after other beams go into action on the target, the light commander of the forward light should then change to the new target, if it is at the proper position, by going back on data. If his detector is tracking a target which has not yet reached the proper position, the light commander should continue to illuminate the first target, until the new target does get within 15,000 yards, and reaches an angle of elevation of 150 to 250 mils above the angle of mask, or until he is properly relieved by other lights. Although it is highly desirable to keep three or four beams on each illuminated plane, this should not be done at the expense of losing a new incoming target. In summation, the priority for the first and second rows of lights is as follows:

(a) To pick up an initial target.

(b) To produce and maintain a two-beam intersection.

(c) To pick up succeeding targets.

(d) To maintain the prescribed maximum number of beams on each target.

79. NUMBER OF BEAMS REQUIRED ON A SINGLE TARGET.--a. The number of beams required for illumination of a single target depends upon the following factors:

(1) Illumination must be sufficient to enable the fighter pilot to locate the target, proceed to the point of interception, and press home the attack. See Paragraph 4a.

(2) The illumination should be provided in such a manner that it in no way interferes with the fighter as he makes his attack.

(3) Illumination must be sufficient to render the target visible to the chief controller in the searchlight section, so that he can track the target visually.

b. (1) Requirement a(1), providing sufficient illumination for the fighter pilot to locate the target, proceed to the point of interception, and press home the attack, can normally be met with two searchlight beams.

(2) The fighter pilot does not have to see the target itself in order to locate it; if he can see the intersection, that will be all he needs to direct him to the target. As he approaches the intersection, the illuminated target will become visible to him, and the illumination produced by two searchlight beams is sufficient to enable the fighter pilot to press home the attack.

(3) As more and more beams are directed at the target, the apex of the cone of lights becomes coarser and coarser, with a larger ball of light being built up around the target, as shown in Figure 29. Also, the more beams there are on the target, the greater will be the possibility that one or more of them are not exactly alined with the binoculars, or that one of the chief controllers will track a little off the target—which tends further to increase the diameter of the ball of light around the illuminated plane. This condition may reach the point at which the fighter pilot will have to fly into the illuminated zone around the target in order to close to effective range, which would have the adverse effects of not only blinding the pilot, but also illuminating the fighter so that it becomes an easy target for the rear gunner of the enemy.

(4) Therefore, as far as the fighter pilot is concerned, two beams on a target, or possibly three at high altitudes, are all that is desired.

c. (1) However, on a well camouflaged plane at altitudes greater than 15,000 feet, three searchlights may not provide sufficient illumination to insure that the chief controllers will be able to track the target visually. Therefore, since the fighter pilot requires only two or three beams, as explained above, the total number of searchlights required to illuminate any given target will be the minimum number which will enable the chief controller to track the target visually. With well camouflaged planes at 15,000 feet altitude, four beams will usually be sufficient. At higher altitudes, or under conditions of poor visibility, one or more additional beams may be required. It is the responsibility of the local searchlight defense commander to prescribe the maximum number of beams that may be employed on a single target at one time, although this authority is usually delegated to the platoon commanders, since atmospheric conditions may vary in the different sections of the searchlight defended area. But in any case, the important thing to remember is that the number of lights used should be kept to the minimum which will insure adequate visibility to the chief controllers.

80. GOING INTO ACTION.—a. Initial pick-up.—(1) Initial pick-ups should be limited to the first two rows of lights. Lights in the third row and beyond should act as carry lights and should illuminate only those targets picked up by the outer rows and passed in. This principle must be rigidly enforced, as it is the means which enables friendly fighters to fly through the searchlight area unilluminated. The fighters stay within the boundaries of the searchlight area at all times, in order to avoid being picked up and illuminated, as explained in Paragraph 11a. If the inner lights attempt to pick up unilluminated planes flying inside of the searchlight area, they are certain to illuminate friendly fighters which are orbiting around the control points, or flying from one control point to another.

(2) The outer lights (first two rows) should make new pick-ups on only those targets which are approaching the area. Occasionally, a fighter may be pursuing an illuminated enemy target which has passed through the area and is about to leave it. Having reached its near vicinity, he may be able to continue to follow it after illumination ceases, and should be permitted to do so.

(3) The oscilloscope operators should be taught that if a target suddenly appears on their scopes at close range behind another target which has been tracked in from long range, then the second target is a friendly fighter which has gone out too far, and should not be illuminated.

(4) Outer lights should not go into action for an initial pick-up at ranges in excess of 15,000 yards. At longer ranges, visibility decreases to a point at which it will be doubtful whether flicks will be observed by the chief controller. It is much better to wait until the range drops to 15,000 yards, where the chances of a pick-up without delay are greater.

b. Carry.—(1) Lights in the first or second row should go into action on an illuminated target as soon as possible after it has been picked up. If available, the prescribed maximum number of beams should be used to illuminate the target, the lights in action being those closest to the target, as explained in Paragraph 78b. However, if any of these lights are receiving data on a second target from their respective radio detectors, they should not pass up the new target when it gets to the proper position, in order to maintain four beams on the first target. The light commander should continue to illuminate and carry the first target until he hears the telephone operator announce "Range", at which time he should immediately order "Change target — On data"; upon receipt of this command, the elevation and azimuth

controllers take over the DEC from the chief controller, and swing the searchlight beam, without putting it out of action, to the direction indicated by the radio detector data. See Figure 35.

(2) If one of the prescribed maximum number of beams illuminating an enemy plane changes target in order to pick up a second incoming plane, the next nearest light in the first or second row should go into action, to replace the one which changed target, thereby maintaining the illumination. In other words, until the target has passed into the third row of lights, the first two rows should endeavor to keep the prescribed maximum number of beams on the target at all times, but should not pass up new targets in order to do so. It is extremely dangerous, however, to attempt to bring the target into the third row with less than three carrying beams, and under no circumstances should an attempt be made to carry a target in with a single beam.

(3) The interior lights, beginning at the third row, are strictly carry lights. These lights, as explained in Paragraph 80a(1), above, should never attempt initial pick-up. They have a single criterion for going into action: that the approaching target be at a proper point in relation to the position of the light, as explained in the following paragraph. The number of searchlight beams already illuminating the target should have no bearing whatsoever on the time at which a carry light goes into action. When an illuminated plane becomes a legitimate target for any particular light, that light must go into action, and commence its carry, regardless of the number of beams already in action on it.

(4) The point at which an approaching plane becomes a legitimate target for a carry light is based upon the necessity of illuminating targets in such a manner that the illumination produced does not interfere in any way with the ability of the fighter pilot to make the interception and press home the attack. A fighter pilot should have a large unilluminated zone in the rear of the target, as shown in Figure 30, to enable him to close in for the attack without being illuminated himself. This unilluminated zone in the rear of the target should be as large as possible, so that the movements of the friendly fighter will not be hampered.

(5) If a carry light goes into action at low angles of elevation on a target directly approaching it, or nearly so, the light beam will strike the front of the approaching plane and project out beyond the rear of the plane into the zone in which the fighter is moving. See Figure 31. For this reason, when an illuminated plane is approaching directly toward a carry light, the light commander of that light should

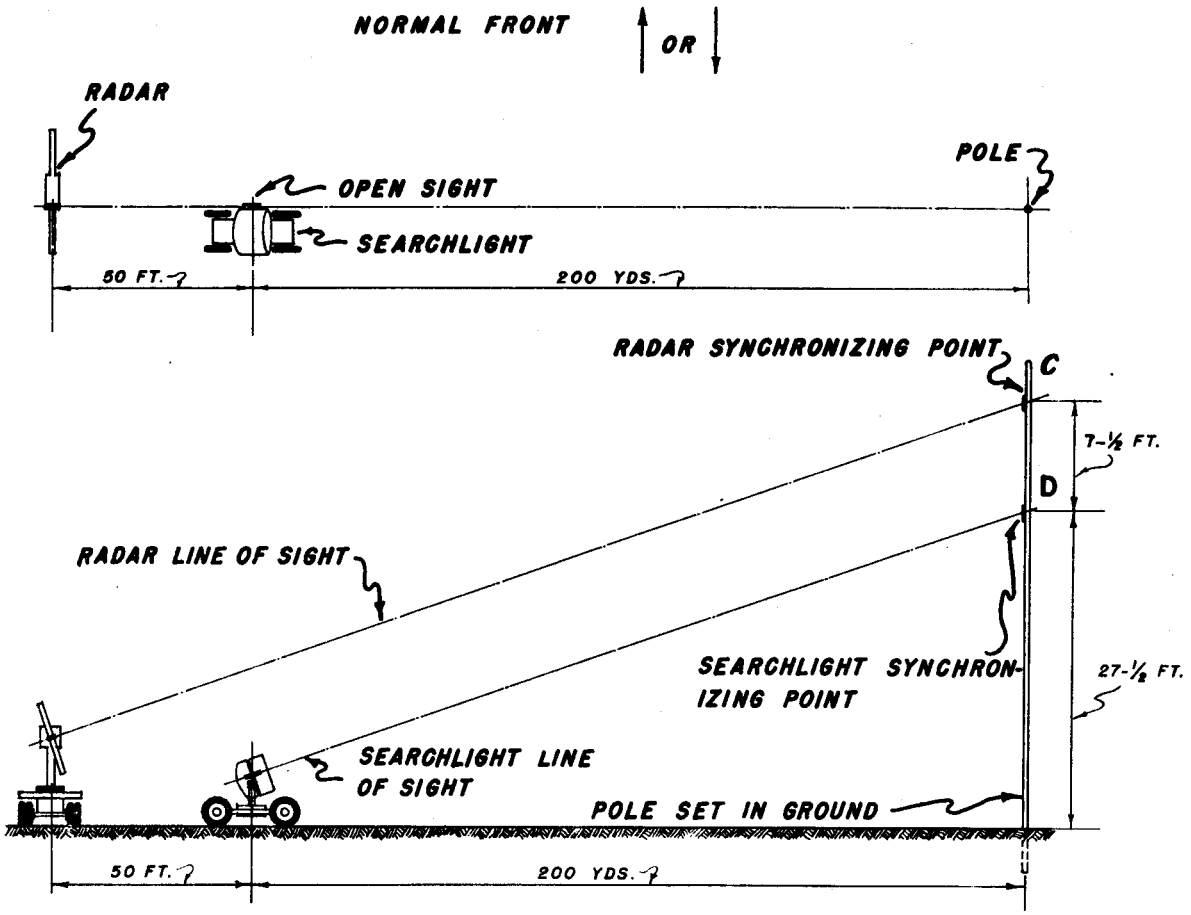


FIGURE-24.

COINCIDENCE METHOD OF SYNCHRONIZATION

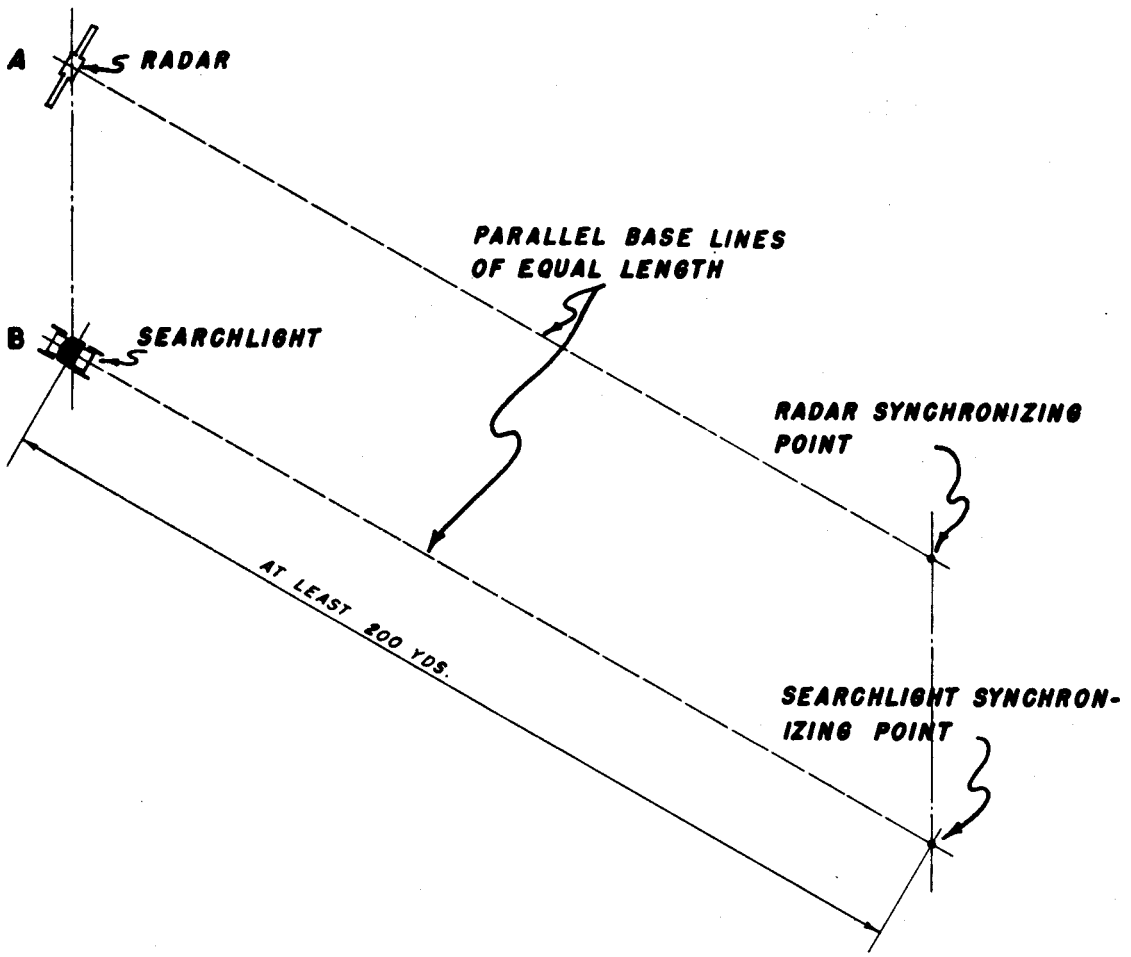


FIGURE-25

TWO POINT SYNCHRONIZATION METHOD

AC and BD must be parallel and of equal lengths.
AB and CD must be parallel and of equal lengths.
Target at "C" must be about 5 feet higher than target at "D".

wait until the angle of elevation of the light reaches about 70° to 75° before he orders his light into action. Then, when the light goes into action, it will strike the bottom of the plane and project up above it, and thus will be in a position where it will not interfere with the fighter pilot who may be maneuvering in the rear of the enemy plane. If the approaching illuminated target is flying such a course that it will pass to one side or the other of the carry light which is waiting to go into action, the light commander may put his light into action at a somewhat lower angle of elevation, since in this case the light beam will be striking more or less against one side of the plane and projecting out to the rear. In this case, however, the light should not be put into action until the plane has reached a point where the light beam will be at a horizontal angle of 25° or 30° to a line from the light to the nearest point of approach, as shown in Figure 32.

(6) The angles mentioned in the preceding paragraph are merely for illustrative purposes and should not be construed as being rigid requirements for the proper time for a light to go into action. They are figures which in general should produce good results, but the light commander should have a thorough understainding of the principles of illumination involved, rather than memorize a specific set of angles of elevation, or angles of approach, at which he should put his light into action. The two principles that should be remembered and applied when putting a carry light into action are these:

(a) That a carry light must illuminate a target in such a manner that there is no interference with friendly pursuit;

(b) That a carry light must go into action when the target arrives at the proper position, regardless of the number of beams already on the target.

81. GOING OUT OF ACTION.--a. Except for the special cases concerning lights in the first two rows, as explained in Paragraph 80b, a searchlight, once it has gone into action and is carrying a target, should continue to carry the target until both of the following conditions exist simultaneously:

(1) There are more beams on the target than the minimum number required.

(2) The light in question is the farthest removed from the target.

b. (1) If only one, but not both, of the above conditions exists, then the light should continue to carry the target. For example, if

there are too many beams on a target, it is the responsibility of the light commander whose light is farthest from the target to go out of action first; the other lights must continue to carry the target until each in turn becomes the one carrying at the greatest distance. No light should go out of action when there is a more distant light in action on the same target. Referring to Figure 33, light #1 should go out of action since there are too many beams on the target, and it is the light which is farthest away. Light #3, on the other hand, should continue to carry the target, even though there are too many beams in action, until light #1 goes out.

(2) At times, a situation may arise where two lights, such as lights #1 and #10 in Figure 34, are so located with respect to each other that it may be difficult for the light commanders to decide which of the two is the more distant from the target. In this case, since both lights are carrying at long range, it will usually be found that there are other lights carrying the target at much closer range, such as lights #4, 6, 7, and 9 in Figure 34. If the light commanders of lights #1 and 10 are doubtful as to which of the two is the more distant, but each can see that there is a sufficient number of beams on the target, each of which is clearly much closer than the two carrying at long range, such as lights #4, 6, 7, and 9, then the light commanders of lights #1 and 10 should both order their lights out of action without attempting to decide who should go out first. It is in such cases that platoon commanders, who may be in a more advantageous position to see the situation, should exercise corrective control and order the lights out if the light commanders delay taking the proper action.

(3) It is important that lights go out of action in order from the rear, and accordingly that an intermediate light not go out until after those behind it have gone out, in order to obviate a sudden, inadvertent, extinguishing of too many beams, thereby causing the losing of the target. Unless this rule is followed, in general, it often happens, in practice, that the commanders of two or more intermediate lights decide to go out of action at almost the psychological moment that the commanders of the rear-most lights also decide to go out of action. This results in so few beams remaining on the target that it may be lost.

(4) When illuminating targets which are leaving the area, the chief controller should continue to track as long as the target is visible, except that the light commander should order "Change target" at the proper time if another target approaches which is still within the area. Targets which are just leaving the area, or which will leave the area soon if the continue on their course, should have priority over targets which are already a considerable distance away, and still moving out.

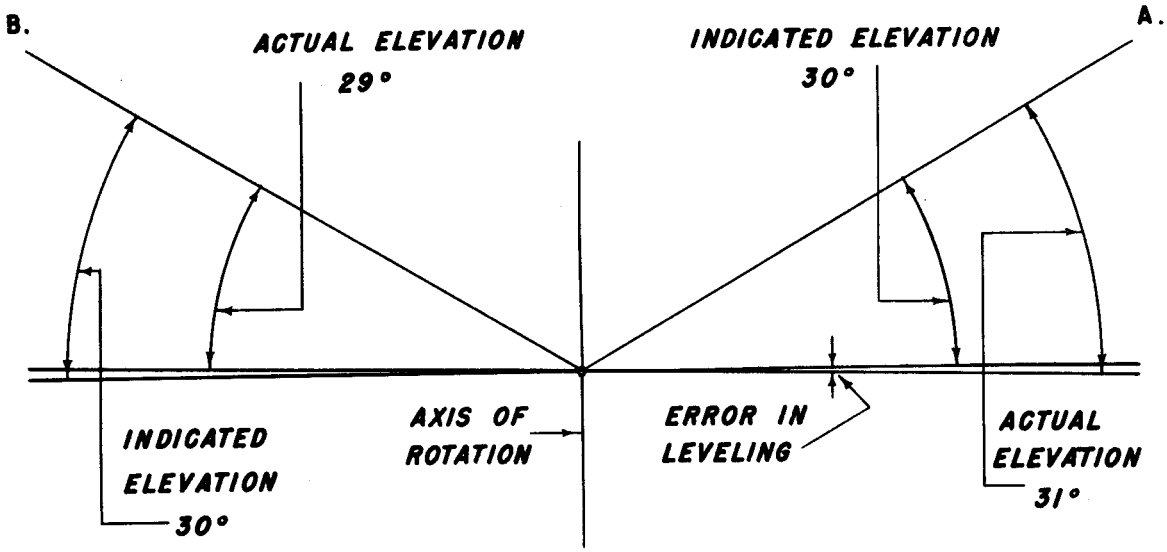


FIGURE- 26.

EFFECT OF IMPROPER LEVELING

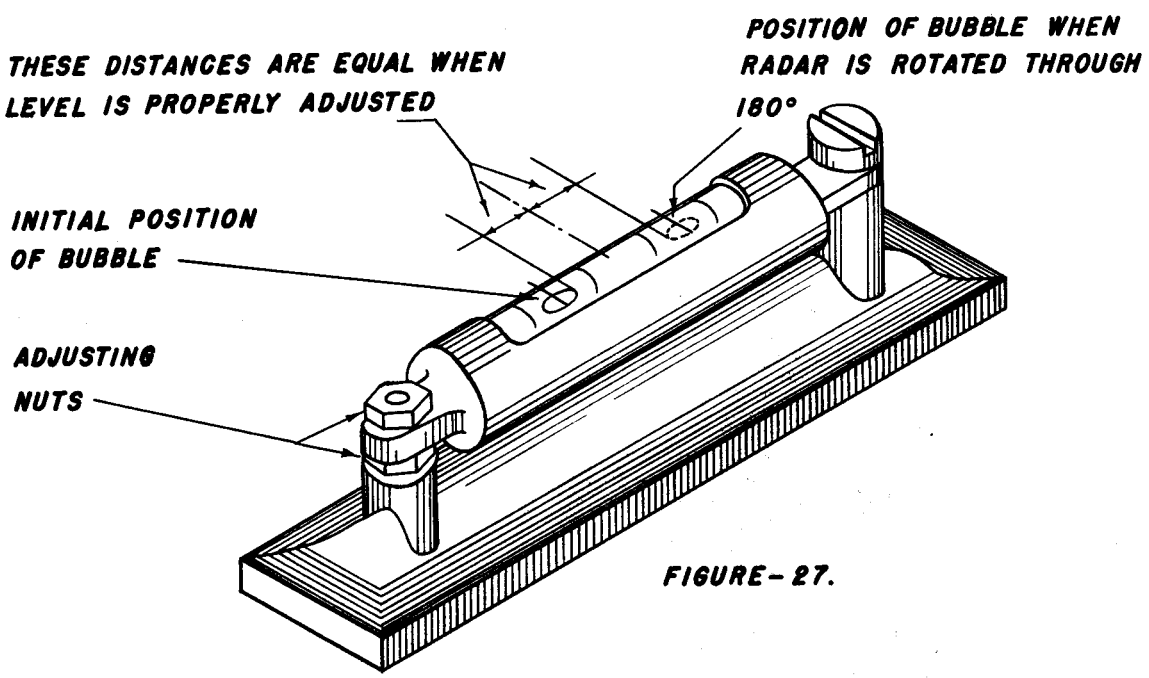
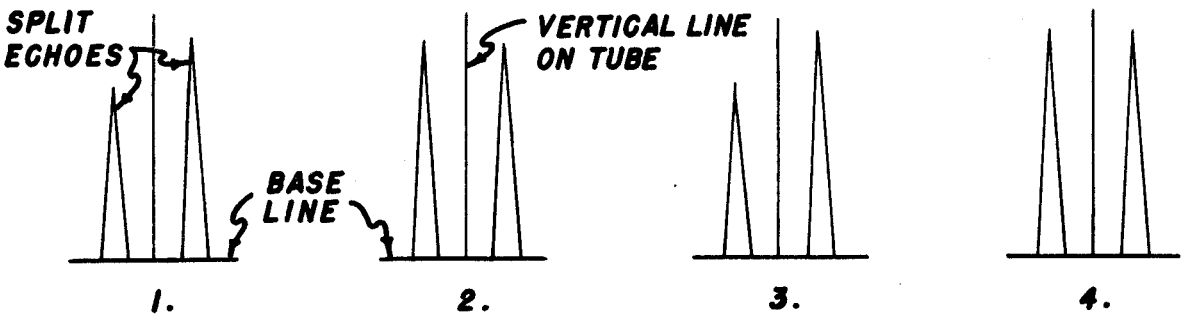


FIGURE- 27.

ADJUSTMENT OF SPIRIT LEVEL

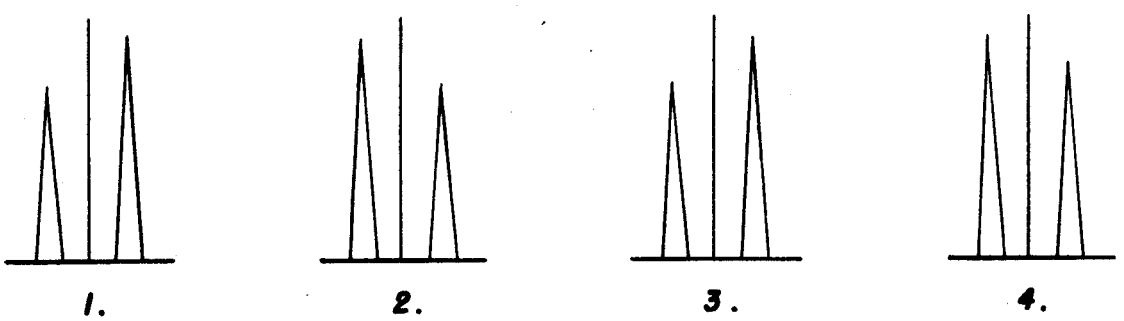


OSCILLOSCOPE OPERATION

Target traveling in such a direction as to cause right pip to rise.

A. WRONG

(1) Oscilloscope operators continually bringing left pip up to height of right pip, and then letting it fall below again. Left pip is always either lower than right one, or momentarily even with it, but never higher.
(2) Searchlight beam will act in similar manner, being behind or below plane most of time, gradually catching up with it, and then falling behind again. Beam never sweeps completely across plane from one side to the other.
(3) Target occasionally illuminated by fringe of approaching beam, but very few real flicks are made.



B. RIGHT

(1) Oscilloscope operators manipulate handwheels so that each pip is alternately higher than the other by a slight amount.
(2) Searchlight beam sweeps back and forth, up and down, with target at center of movement.
(3) Frequent definite flicks are made.

FIGURE-28.

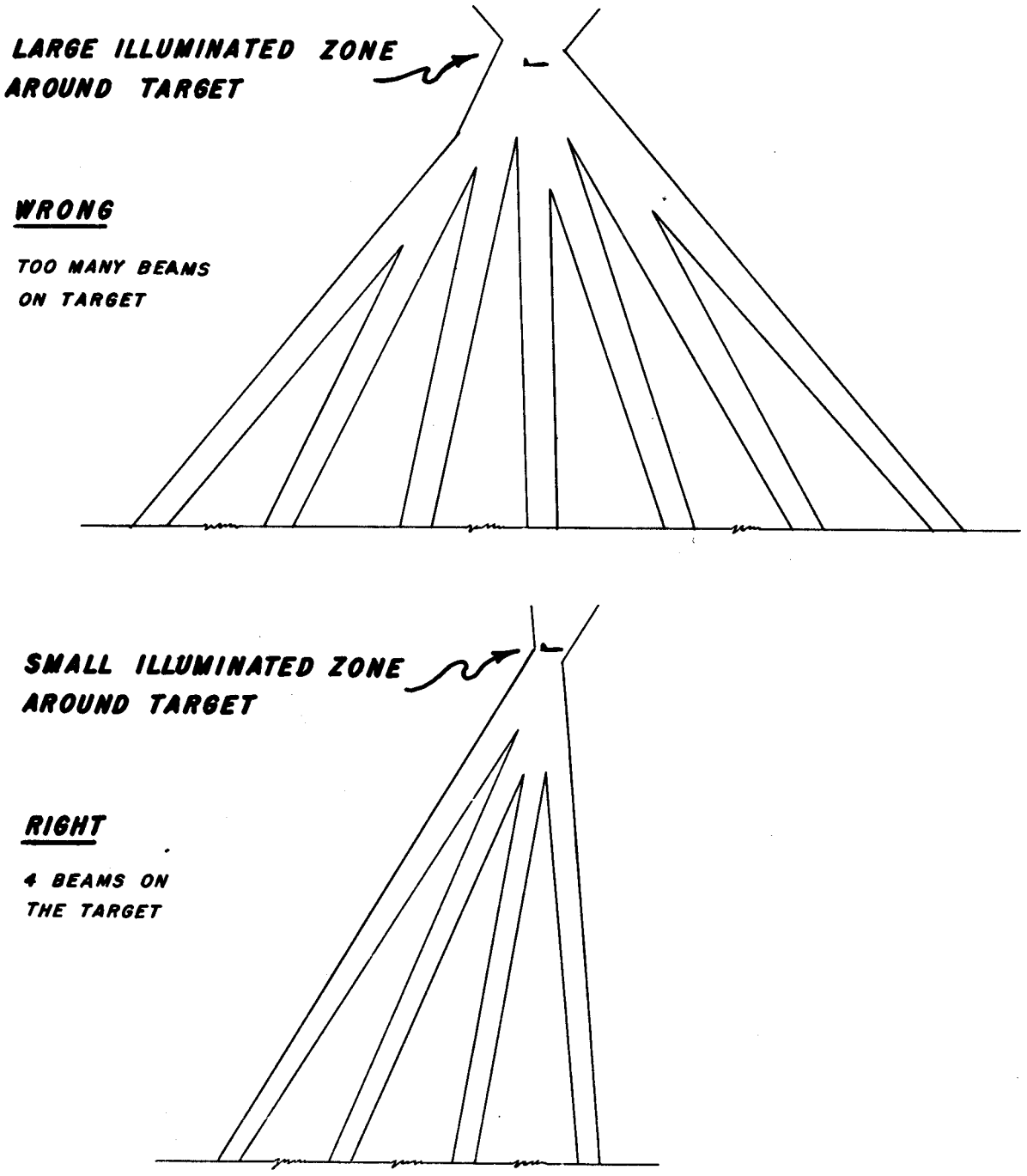


FIGURE-29.

SIZE OF ILLUMINATED ZONE AROUND TARGET

stacked up in altitude, then, the elevation operator must first determine which of the several echoes he sees is from the plane at the highest altitude; he then must call directions to the range operator, so that the latter can aline that echo with the center line of the elevation scope; finally, all three oscilloscope operaotrs must track that target.

(b) Normally, the heavy bombers with the greatest bomb-carrying capacity are flown at higher altitudes, to afford them greater protection from antiaircraft fire; therefore, if targets approach simultaneously at low, medium, and high altitudes, the chances are that the highest altitude plane will be the most profitable target. However, if the enemy adopts the practice of flying his major bombardment extremely low, the above-described tactics of selection whould be modified accordingly.

(4) Loose formations.--Planes attacking in loose formation, separated by several hundred yards, present a special case of the laterally spaced attack discussed in (2), above. The general solution is the same — each radio detector tracking the formation should center on the target closest to its normal front — but the actual selection of the target by the azimuth operators may be more difficult because the echoes from the individual targets may blend together into a single multi-peaked echo due to the relatively small separation of the planes. The azimuth operator, in this case, must be extremely careful in scrutinizing the multi-peaked echo as he traverses the radio detector so that he can determine which peak is closest to the center of his normal front, and direct the range operator accordingly. The greatest chance for error in handling a formation of this sort, in which the planes are close enough together so that the entire formation can pass between two adjacent first line lights, is the possibility of the first line radio detectors tracking the planes on the nearest side of the formation, and allowing the front, or point, of the formation to enter the area unilluminated. This is likely to happen unless the formation directly approaches one of the lights, so that the center of the formation is dead ahead. In order to decrease the possibility of the point of a loose formation slipping through unilluminated, the second line radio detectors should pay particular attention to the center of such a formation until the first line lights have gone into action and it can be seen whether or not any of the first line lights are directed at the center of the formation. If all the first line lights are apparently working on the sides of the formation, then the second line radio detectors should direct their lights to the center of it. After the formation has been illuminated and the total number of planes involved becomes more evident, the tactical problem of maintaining proper illumination should be handled in accordance with the principles explained in e, below.

(5) Close formations.-- When planes attack in close formation, the oscilloscope operators will be unable to track individual planes, but should be able to recognize from the appearance of the echo that there is more than one plane approaching. No attempt can be made to select individual targets in this case, but the formation as a whole can be tracked. After the formation is illuminated, the principles explained in Paragraph e(3), below, should be applied.

e. (1) As far as actual illumination is concerned, the tactical principles involved, as mentioned previously, are no different for multiple plane attacks than they are for single plane attacks, with the exception of a few additional rules to take care of attacks in formation.

(2) If planes attack in a loose formation, each plane being separated by a few hundred yards, it will generally be impossible to keep 3 or 4 beams on each plane in the formation due to the concentration of planes over a relatively small area. At least two beams must be maintained on each target, however, as illustrated in Figure 37, even at the cost of allowing some of the planes to enter the defended area unilluminated. If more than two beams can be maintained on each target, it should, of course, be done. Each light in action on a loose formation of this sort should illuminate the plane nearest to it, as shown in Figure 37.

(3) If planes attack in close formation, it will usually be found that several planes in the formation can be illuminated by the same searchlight beam. Nevertheless, the formation should not be treated as a single target, even if one beam can encompass the whole formation; there should be a total of two beams per plane. A three-plane formation should be illuminated by six beams. The purpose of this is to provide a sufficient number of beams so that if the formation should suddenly break, there will be two beams carrying each individual plane. See Figure 38. In order to prepare for the possible sudden "exploding" of a formation, each chief controller should select one individual plane as his particular target, even though his light is illuminating several of them simultaneously. Then, if the formation breaks, each chief controller continues to track the target he has previously selected. In order to insure that all the chief controllers are not concentrating on one or two of the planes, so that some of the targets would escape if the formation suddenly breaks, each chief controller should select a plane which occupies the same relative position in the formation that his searchlight occupies in relation to the other lights which are in action. In other words, the lights on the left take the planes on the left, the lights in the center take the planes in the center, etc., as illustrated in Figures 37 and 38.

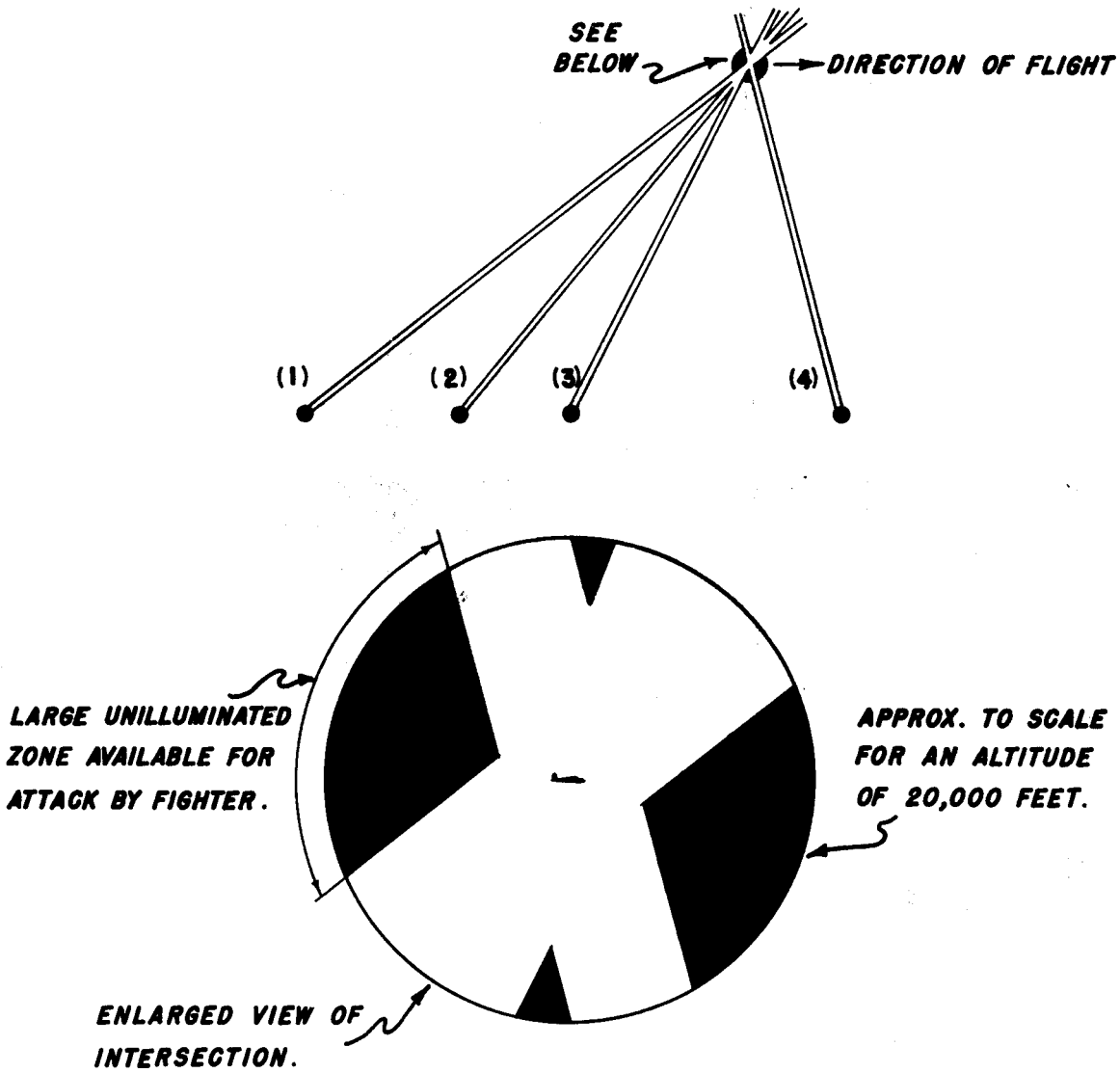


FIGURE-30.

CORRECT METHOD OF CARRYING TARGET

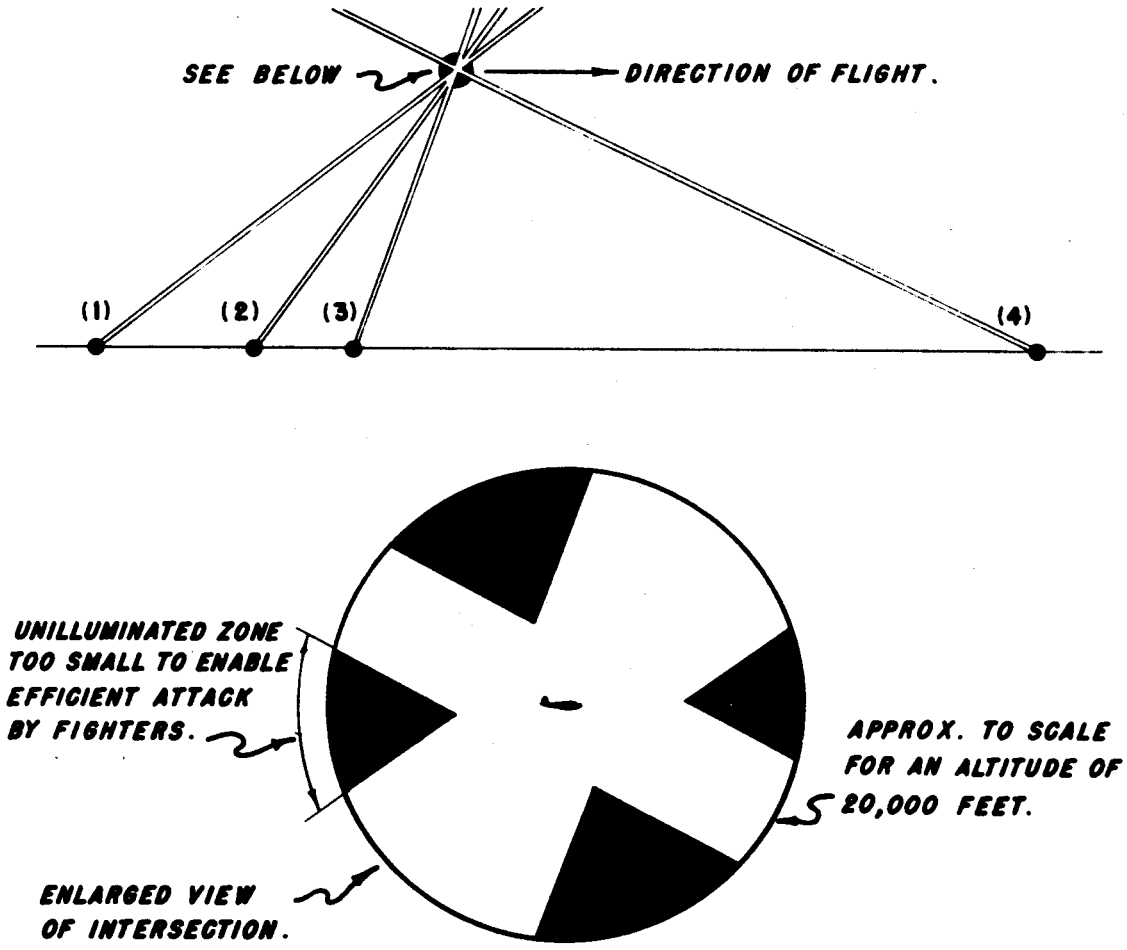


FIGURE-31.

SEARCHLIGHT GOING INTO ACTION TOO SOON

Beam #4 in action too soon, projecting behind and above bomber thereby reducing unilluminated zone available for attach by fighter.

(4) If a very large formation should approach, too large to illuminate all planes in the formation simultaneously, then priority should be given to the planes at the base, or rear, of the formation, since these will be the planes which will be attacked first by the fighters. The basis of the selection of individual targets should be the same as explained in (3), i.e., lights on the left take the planes on the left, etc. See Figure 40.

83. OPERATION OF ORBITING BEACON.--a. In order to identify to the fighter pilot the various control and sub-control points, as explained in Paragraph 9, a searchlight with the glass door covered with colored, transparent material may be used. If this be done, further use may be made of the orbiting beacon to assist the fighter pilot in determining which of several newly formed intersections is his proper target. The fighter pilot orbiting around the beacon may receive the announcement "Intersection" while he is at any point on his orbiting circle; he may be facing at the moment toward any point of the compass, and therefore may be momentarily confused as to the direction of the normal front. This may result in loss of time, rendering interception more difficult.

b. In order to assist the fighter pilot by guiding him to the proper intersection, the light commander of the beacon light should depress the beacon and point it directly at the intersection as soon as one is formed in the sector covered by fighters orbiting about that particular beacon. See Figures 41 and 42. This sector is an area the width of the diameter of the orbiting circle and extending from the beacon light out to the front of the searchlight area. The light commander should determine the azimuth limits of this sector from the beacon light to the points where sides of the sector intersect the front of the searchlight area. He should then mark these directions by the use of stakes driven into the ground to enable him to determine whether an intersection which he may see is within the azimuth limits of that particular beacon. Out in front of the searchlight area the azimuth limits will overlap, and an intersection may be within the limits of two beacon lights. However, no harm will be done if both beacons point out the intersection, since a fighter pilot at only one of them will receive orders to make the interception. When two or more intersections are visible at the same time within the azimuth limits of a beacon light, the light commander should select and point out to the fighter pilot the one nearest to the center of the sector.

c. The light commander should point out the proper intersection by depressing the beacon until it points directly at the intersection, keeping it depressed for 15 seconds, and then raising it to vertical position again.

d. It is emphasized that the beacon light signals do not constitute an order for the fighter pilot to proceed to the intersection indicated. The responsibility of making the interception rests upon the pilot, and he may make such use as he sees fit of the directions shown him by the beacon.

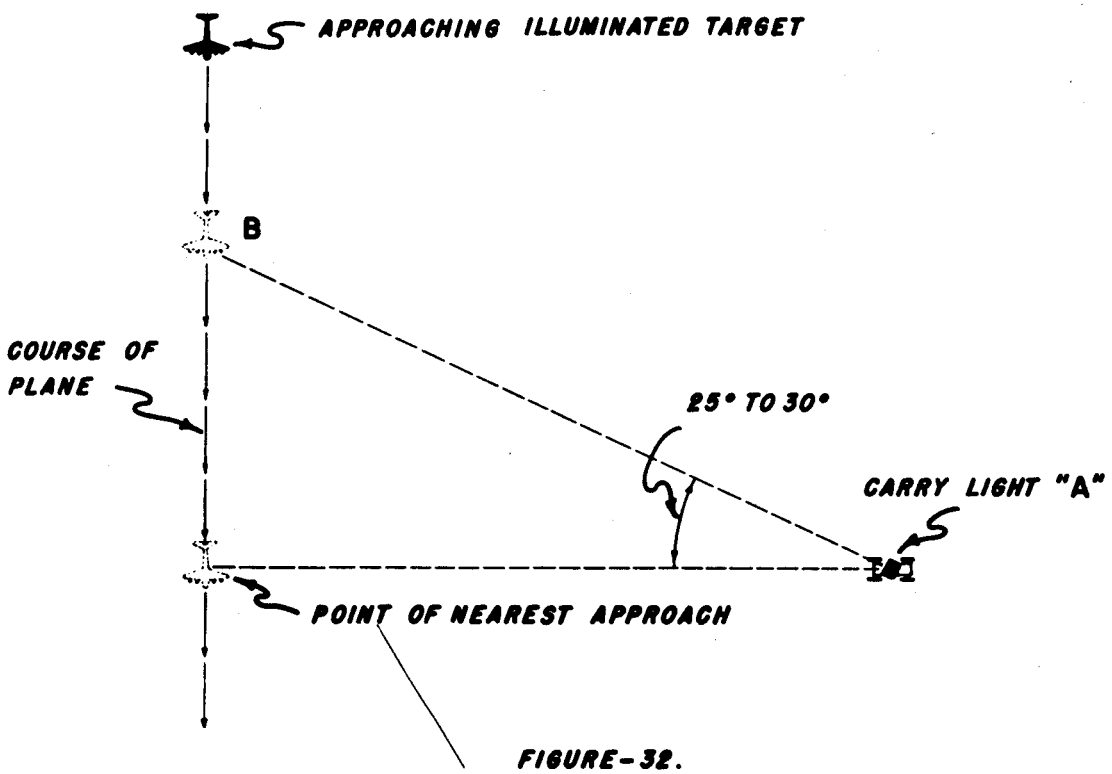


FIGURE-32.

CARRY LIGHT GOING INTO ACTION

1 — Light A is one of the four or five lights nearest to the target when the latter reaches point B.

2 — Light A should go into action when target reaches point B, <u>regardless</u> of the number of beams already illuminating it.

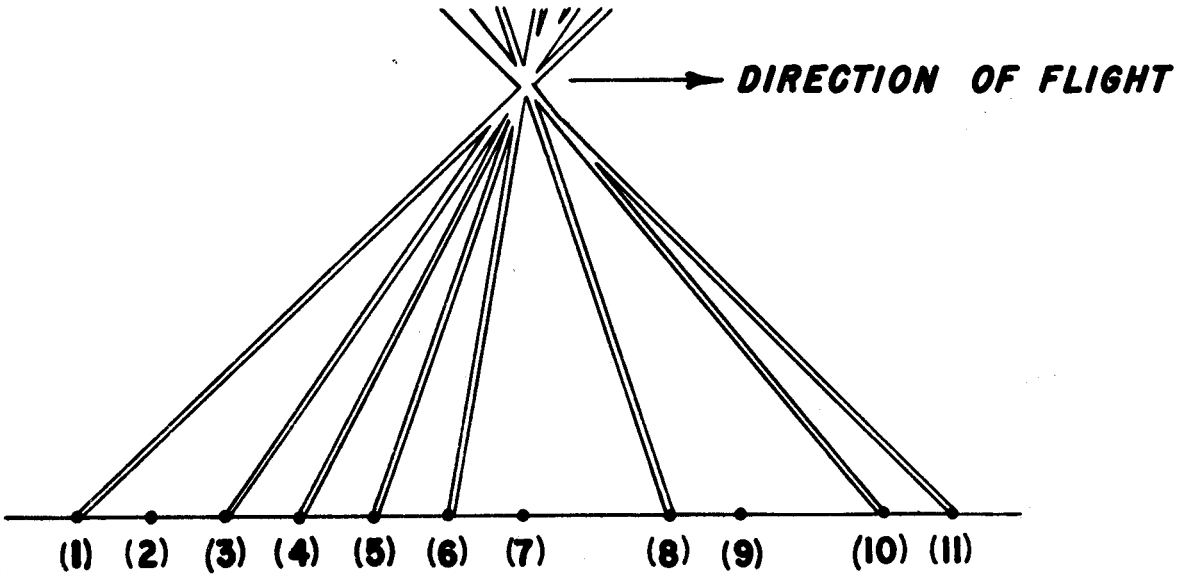


FIGURE-33.

TACTICAL HANDLING OF SEARCHLIGHT BEAMS -- VERTICAL PROJECTION
(Numbered dots represent searchlights)

A. Errors in Tactics Illustrated above.

(1) There are too many beams on the target.
(2) Light 1 should not be in action, since there are too many beams on the target and light 1 is the rearmost light.
(3) Light 2, which went out of action because there were too many beams on the target, should not have gone out until light 1, the rearmost light went out first.
(4) Light 7, which did not go into action because there were too many beams on the target, should have gone into action when the target reached the proper point, regardless of the number of beams on it.
(5) Lights 10 and 11 have gone into action entirely too soon.

B. Correct Tactics Illustrated above.

(1) Light 3 is properly continuing to carry the target while waiting for light 1 to go out, even though there are too many beams on the target.
(2) Lights 4, 5 and 6 are properly carrying the target.
(3) Light 8 (which we will assume has just gone into action) has started its carry at the proper time even though there are too many beams on the target.
(4) Light 9 is properly waiting before going into action, until the target gets a little closer.

PART THREE

TRAINING

CHAPTER ONE

THE TRAINING OF THE SEARCHLIGHT BATTERY

Section I

GENERAL

84.--a. The efficiency of a searchlight battery in the operation of its assigned tactical equipment -- searchlights, radio detectors, and sound locators -- will be a direct measure of the emphasis placed upon the thorough planning and careful execution of the battery basic training program. It is worse than useless to send an untrained, or improperly trained, searchlight battery into the field, because the tactical disposition of a searchlight battery, spread out as it is over so many square miles, precludes the possibility of accomplishing any satisfactory basic training after the unit has moved into the field, since the lack of constant supervision can only result in the formation of incorrect habits in operation which will be difficult to eradicate. All basic training, both in operation and in tactics, MUST be completed while the battery is still in the training camp. The battery must not move into the field until the state of training of its personnel has reached a sufficiently high level for the unit to derive some real benefit from training in field positions. If, at any time during the training program, some particular phase of the training has not produced satisfactory results, then, that phase should be prolonged, and the following parts of the program postponed until satisfactory results are obtained.

b. The training program should be laid out by the number of days and nights of training, rather than by specific dates. Delays and postponements will be inevitable, chiefly due to weather conditions, and lack of airplanes for training purposes. If, at the time the training program is arranged, no particular difficulties are foreseen which might hold up the training program, a safety factor of about 50% should still be added to the length of time called for on the schedule, in order to insure adequate time for the satisfactory completion of

training. If, on the other hand, bad weather or some difficulty in procuring planes, is anticipated, then, a safety factor of up to 100% should be added to the regularly scheduled time of training.

c. Too much emphasis cannot be placed upon this basic training period. The battery commander and the other battery officers must personally and continuously supervise the instruction. Mistakes should be corrected immediately after they have occurred, and the reasons for the corrections pointed out. The battery officers must bear in mind that the success or failure of the battery when it moves into the field will rest in the hands of the NCO's, not the officers, and the ability of the NCO's to do an efficient job will depend entirely on the adequacy of their training. In a searchlight battery, the officers, as far as operation is concerned, can play an important part only during the training period; when field operations begin the officers assume the roles of critics watching a show given by the NCO's, and the show they see will be good or bad depending upon the efficiency of the training program they (the officers) conducted.

Section II

TRAINING METHODS

85. RADIO DETECTOR BASIC TRAINING.—a. The most important part of the training of radio detector personnel consists in the training of the oscilloscope operators. Training in the mechanics of setting up a radio detector, putting it in operation, and preparing it for movement, involve no special training procedure, and the details of these operations are covered in Appendix A. Special attention, however, must be given to the training of the oscilloscope operators, as the efficiency with which the radio detector will pick up targets and direct accurately the searchlight beam will depend upon these men.

b. The training of the oscilloscope operators consists chiefly in supervised practice. An experienced officer or NCO can explain in a short time the fundamentals of tracking -- how to recognize an echo, how to adjust sensitivity, how to split the echo and balance the resulting twin "pips", etc. -- but it takes hours of supervised practice to teach the operators how actually to do these things properly. Supervision is extremely important; it is folly to tell a group of men how to track a target, and then leave them to their own devices during practice.

c. (1) After the new operators become familiar with their jobs,

82. ILLUMINATION OF MULTIPLE PLANE ATTACKS.—a. Once the principles of tactical operation of searchlights, discussed in the preceding paragraphs, are thoroughly understood, the illumination of targets during a multiple plane attack becomes merely a problem of the practical application of these principles. Light and detector commanders should be thoroughly indoctrinated with the principles of tactical operation, rather than taught a method of handling some specific form of attack. Due to the difficulty of maintaining accurate time schedules, of flying precise courses for long distances, and of maintaining given lateral or column spacing, no two attacks will be exactly alike even if the two attack plans are identical. Several seconds' difference in time, or a few hundred yards' difference in course may change the situation as it concerns any particular searchlight. A plane which is a proper target for some particular light might not be a proper target if it approached several seconds later or on another course several hundred yards away. Therefore, as mentioned above, the principles of tactical operation must be learned, and applied to each situation as it arises.

b. The efficient illumination of targets during a multiple plane attack involves the following three requirements:

(1) Decentralization of control.

(2) Proper selection of targets.

(3) Correct application of principles of tactical operation.

c. Decentralization of control was discussed in Paragraph 55, and, as was pointed out in that paragraph, is of absolute necessity during a multiple plane attack. The principles of tactical operation have been discussed previously, and their application to multiple plane attacks is exactly the same as for attacks by single planes. The question of proper selection of targets is discussed in the following paragraph.

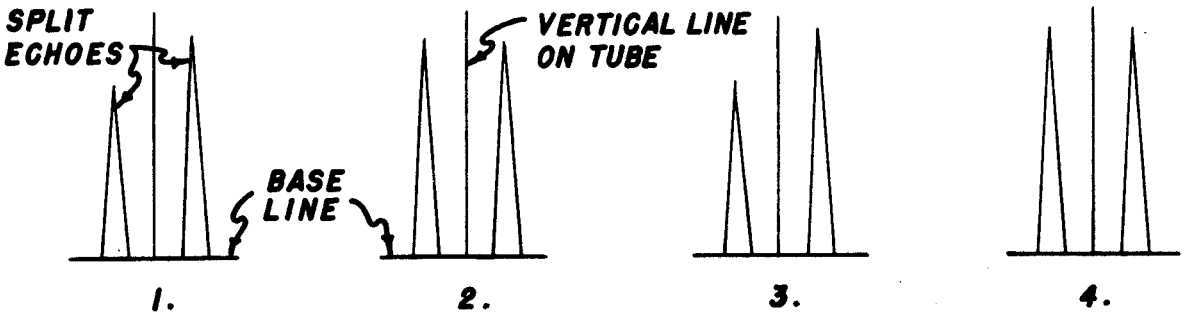
d. The selection of targets is primarily the responsibility of the detector commander, but since he cannot maintain constant supervision of the oscilloscope operators and at the same time efficiently perform his tactical duties as detector commander, the oscilloscope operators must be trained in the selection of targets in accordance with the following principles:

(1) Targets in column. — When several targets approach in column on the same flight path, they will usually be spaced far enough apart (20 seconds to a minute) so that there is a good chance to pick up all of them, one at a time. Therefore, the nearest target should be

selected by the range operator, and so on. See Figure 36.

(2) Targets spaced laterally.--When several targets which are separated laterally approach, the one nearest to the normal front should be selected by the azimuth operator, leaving the other targets to adjacent radio detectors. Targets approaching simultaneously on different flight paths, spaced laterally far enough apart so that they could not be considered a loose formation, will show up as separate echoes on both the range and the azimuth oscilloscope screens, provided they are not all at exactly the same range. The azimuth oscilloscope operator can determine which target is nearest to the center of the normal front by traversing the radio detector in azimuth and watching to see which echo gives the most response when the radio detector is facing closest to the center of the normal front. Usually, it will be found that the target nearest the center of the normal front will be the one at shortest range, and, therefore, its echo will be the one at the extreme left on the oscilloscope screens. The azimuth operator should give directions to the range operator to increase or decrease the range in order to aline the selected echo with the center line of the azimuth oscilloscope screen; if the selected echo is to the left of the center line, the range must be decreased; if it is to the right, the range must be increased. When the selected echo has been centered on the scope, all three operators will track in the normal manner.

(3) Targets stacked in altitude.-- (a) When several targets stacked in altitude, one directly above the other, approach, the target at the highest altitude should normally be selected by the elevation operator. The elevation operator is in the best position to make this selection, since the individual planes in such a formation would fail to appear as separate echoes on the azimuth oscilloscope screen, and would produce echoes very close together or even overlapping on the range oscilloscope screen, because the differences in range and azimuth between the individual planes would be small. On all oscilloscope screens, the individual planes would usually appear as separate echoes, since there would usually be appreciable differences in range between them. The elevation operator can tell which is at the highest elevation by elevating the antenna and noting which echo is the last to rise. The echo which rises last, i.e., which increases its height at the highest angle of elevation of the antenna, will be the plane at the highest altitude. From its position in relation to the center line on the oscilloscope, he can judge whether the range operator should increase or decrease the range in order to center that particular echo on the center line of the oscilloscope -- if the echo is on the left of the center line, the range must be decreased, while if it is on the right of the center line the range must be increased. Upon recognition of the approach of planes

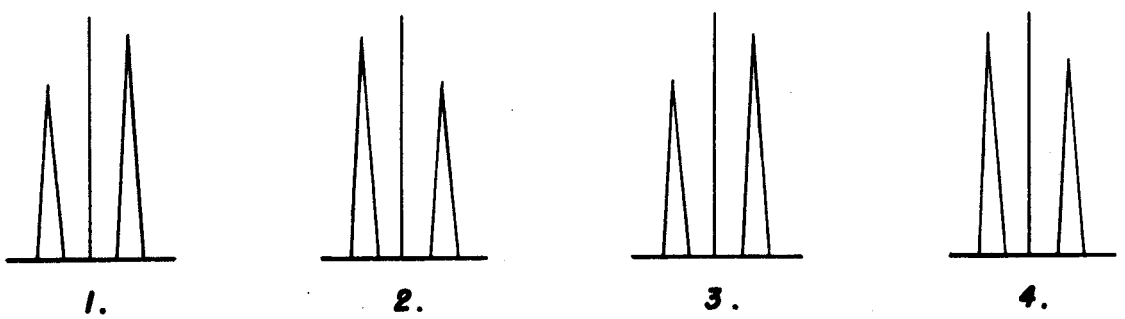


OSCILLOSCOPE OPERATION

Target traveling in such a direction as to cause right pip to rise.

A. WRONG

(1) Oscilloscope operators continually bringing left pip up to height of right pip, and then letting it fall below again. Left pip is always either lower than right one, or momentarily even with it, but never higher.
(2) Searchlight beam will act in similar manner, being behind or below plane most of time, gradually catching up with it, and then falling behind again. Beam never sweeps completely across plane from one side to the other.
(3) Target occasionally illuminated by fringe of approaching beam, but very few real flicks are made.



B. RIGHT

(1) Oscilloscope operators manipulate handwheels so that each pip is alternately higher than the other by a slight amount.
(2) Searchlight beam sweeps back and forth, up and down, with target at center of movement.
(3) Frequent definite flicks are made.

FIGURE-28.

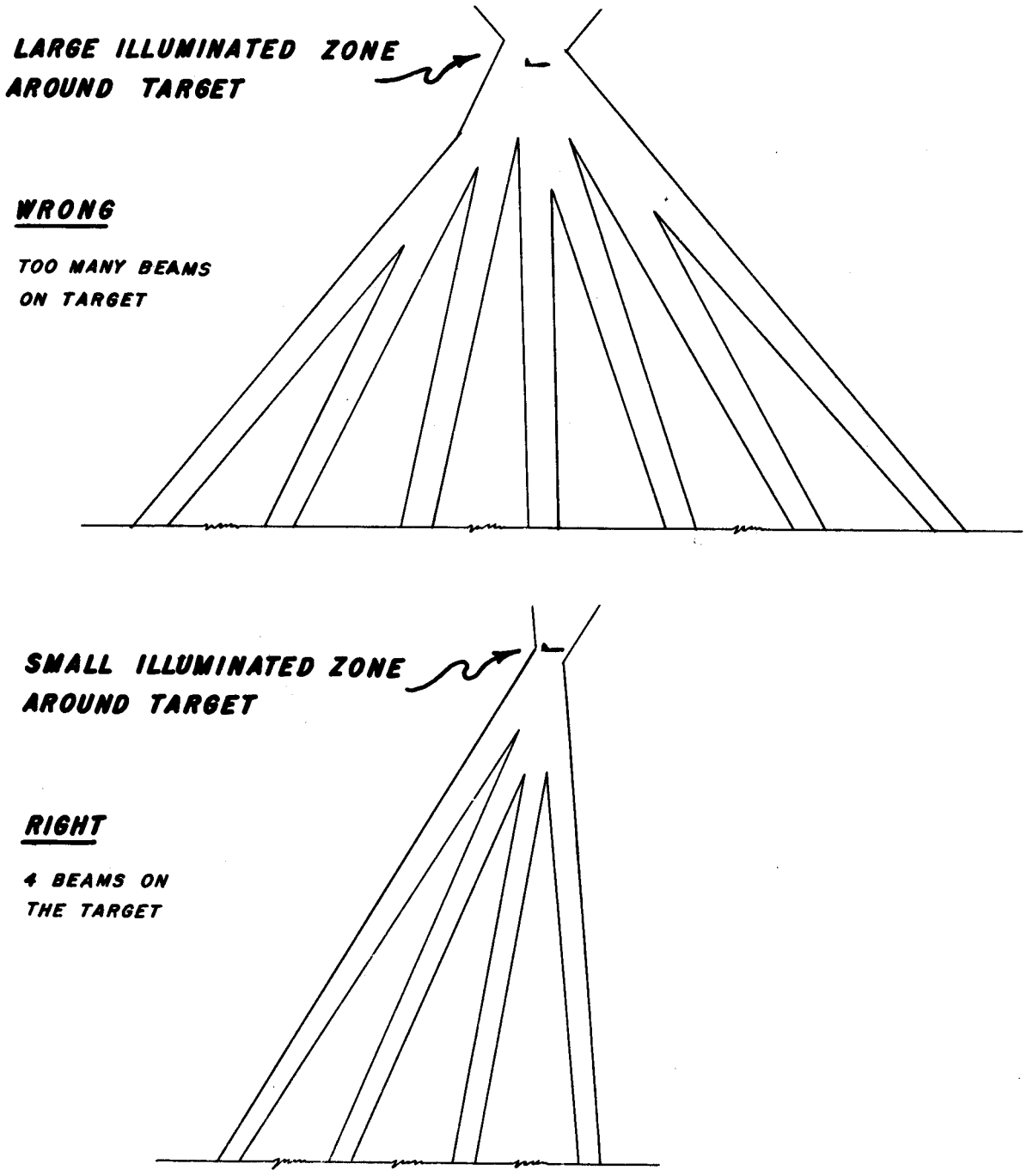


FIGURE-29.

SIZE OF ILLUMINATED ZONE AROUND TARGET

stacked up in altitude, then, the elevation operator must first determine which of the several echoes he sees is from the plane at the highest altitude; he then must call directions to the range operator, so that the latter can aline that echo with the center line of the elevation scope; finally, all three oscilloscope operaotrs must track that target.

(b) Normally, the heavy bombers with the greatest bomb-carrying capacity are flown at higher altitudes, to afford them greater protection from antiaircraft fire; therefore, if targets approach simultaneously at low, medium, and high altitudes, the chances are that the highest altitude plane will be the most profitable target. However, if the enemy adopts the practice of flying his major bombardment extremely low, the above-described tactics of selection whould be modified accordingly.

(4) Loose formations.--Planes attacking in loose formation, separated by several hundred yards, present a special case of the laterally spaced attack discussed in (2), above. The general solution is the same -- each radio detector tracking the formation should center on the target closest to its normal front -- but the actual selection of the target by the azimuth operators may be more difficult because the echoes from the individual targets may blend together into a single multi-peaked echo due to the relatively small separation of the planes. The azimuth operator, in this case, must be extremely careful in scrutinizing the multi-peaked echo as he traverses the radio detector so that he can determine which peak is closest to the center of his normal front, and direct the range operator accordingly. The greatest chance for error in handling a formation of this sort, in which the planes are close enough together so that the entire formation can pass between two adjacent first line lights, is the possibility of the first line radio detectors tracking the planes on the nearest side of the formation, and allowing the front, or point, of the formation to enter the area unilluminated. This is likely to happen unless the formation directly approaches one of the lights, so that the center of the formation is dead ahead. In order to decrease the possibility of the point of a loose formation slipping through unilluminated, the second line radio detectors should pay particular attention to the center of such a formation until the first line lights have gone into action and it can be seen whether or not any of the first line lights are directed at the center of the formation. If all the first line lights are apparently working on the sides of the formation, then the second line radio detectors should direct their lights to the center of it. After the formation has been illuminated and the total number of planes involved becomes more evident, the tactical problem of maintaining proper illumination should be handled in accordance with the principles explained in e, below.

(5) Close formations.-- When planes attack in close formation, the oscilloscope operators will be unable to track individual planes, but should be able to recognize from the appearance of the echo that there is more than one plane approaching. No attempt can be made to select individual targets in this case, but the formation as a whole can be tracked. After the formation is illuminated, the principles explained in Paragraph e(3), below, should be applied.

e. (1) As far as actual illumination is concerned, the tactical principles involved, as mentioned previously, are no different for multiple plane attacks than they are for single plane attacks, with the exception of a few additional rules to take care of attacks in formation.

(2) If planes attack in a loose formation, each plane being separated by a few hundred yards, it will generally be impossible to keep 3 or 4 beams on each plane in the formation due to the concentration of planes over a relatively small area. At least two beams must be maintained on each target, however, as illustrated in Figure 37, even at the cost of allowing some of the planes to enter the defended area unilluminated. If more than two beams can be maintained on each target, it should, of course, be done. Each light in action on a loose formation of this sort should illuminate the plane nearest to it, as shown in Figure 37.

(3) If planes attack in close formation, it will usually be found that several planes in the formation can be illuminated by the same searchlight beam. Nevertheless, the formation should not be treated as a single target, even if one beam can encompass the whole formation; there should be a total of two beams per plane. A three-plane formation should be illuminated by six beams. The purpose of this is to provide a sufficient number of beams so that if the formation should suddenly break, there will be two beams carrying each individual plane. See Figure 38. In order to prepare for the possible sudden "exploding" of a formation, each chief controller should select one individual plane as his particular target, even though his light is illuminating several of them simultaneously. Then, if the formation breaks, each chief controller continues to track the target he has previously selected. In order to insure that all the chief controllers are not concentrating on one or two of the planes, so that some of the targets would escape if the formation suddenly breaks, each chief controller should select a plane which occupies the same relative position in the formation that his searchlight occupies in relation to the other lights which are in action. In other words, the lights on the left take the planes on the left, the lights in the center take the planes in the center, etc., as illustrated in Figures 37 and 38.

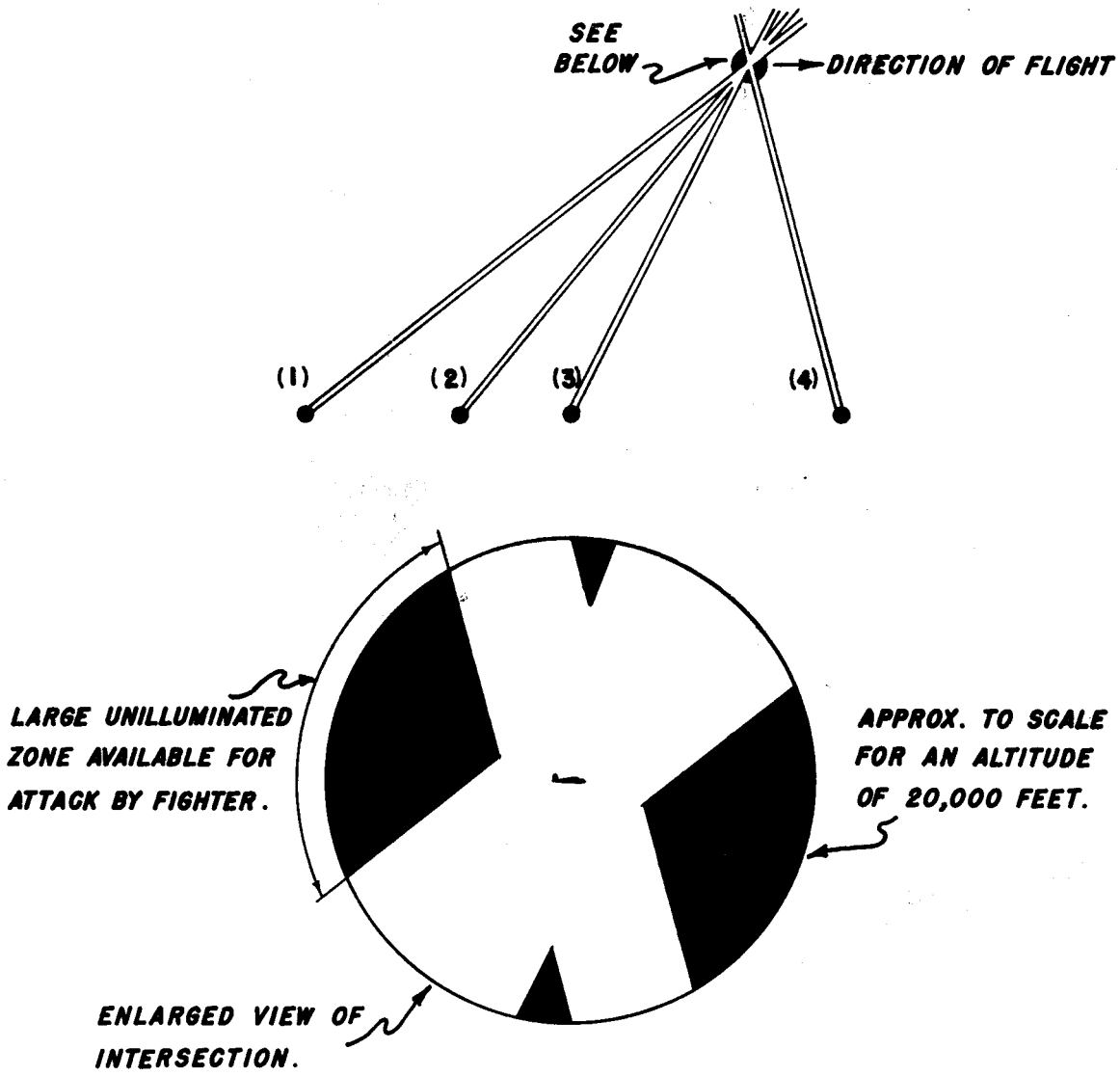


FIGURE-30.

CORRECT METHOD OF CARRYING TARGET

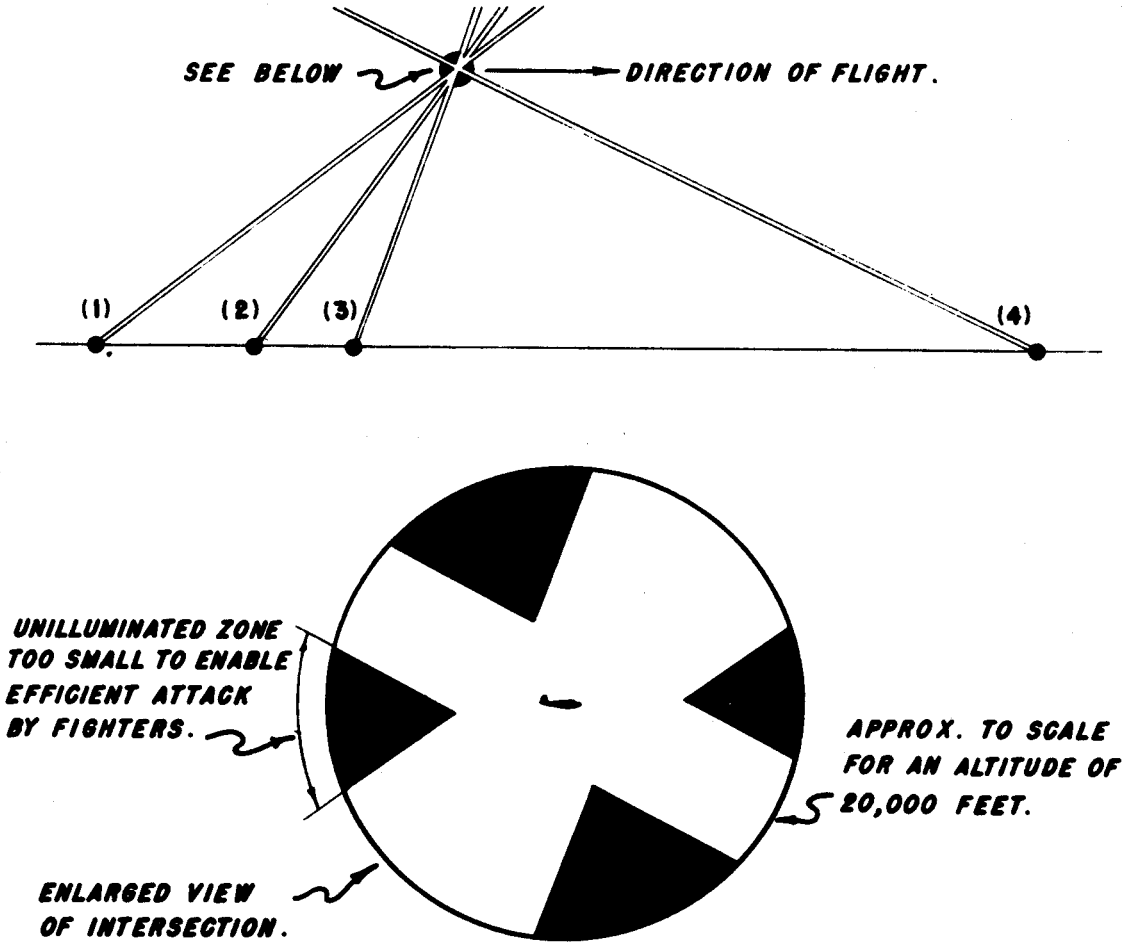


FIGURE-31.

SEARCHLIGHT GOING INTO ACTION TOO SOON

Beam #4 in action too soon, projecting behind and above bomber thereby reducing unilluminated zone available for attach by fighter.

(4) If a very large formation should approach, too large to illuminate all planes in the formation simultaneously, then priority should be given to the planes at the base, or rear, of the formation, since these will be the planes which will be attacked first by the fighters. The basis of the selection of individual targets should be the same as explained in (3), i.e., lights on the left take the planes on the left, etc. See Figure 40.

83. OPERATION OF ORBITING BEACON.--a. In order to identify to the fighter pilot the various control and sub-control points, as explained in Paragraph 9, a searchlight with the glass door covered with colored, transparent material may be used. If this be done, further use may be made of the orbiting beacon to assist the fighter pilot in determining which of several newly formed intersections is his proper target. The fighter pilot orbiting around the beacon may receive the announcement "Intersection" while he is at any point on his orbiting circle; he may be facing at the moment toward any point of the compass, and therefore may be momentarily confused as to the direction of the normal front. This may result in loss of time, rendering interception more difficult.

b. In order to assist the fighter pilot by guiding him to the proper intersection, the light commander of the beacon light should depress the beacon and point it directly at the intersection as soon as one is formed in the sector covered by fighters orbiting about that particular beacon. See Figures 41 and 42. This sector is an area the width of the diameter of the orbiting circle and extending from the beacon light out to the front of the searchlight area. The light commander should determine the azimuth limits of this sector from the beacon light to the points where sides of the sector intersect the front of the searchlight area. He should then mark these directions by the use of stakes driven into the ground to enable him to determine whether an intersection which he may see is within the azimuth limits of that particular beacon. Out in front of the searchlight area the azimuth limits will overlap, and an intersection may be within the limits of two beacon lights. However, no harm will be done if both beacons point out the intersection, since a fighter pilot at only one of them will receive orders to make the interception. When two or more intersections are visible at the same time within the azimuth limits of a beacon light, the light commander should select and point out to the fighter pilot the one nearest to the center of the sector.

c. The light commander should point out the proper intersection by depressing the beacon until it points directly at the intersection, keeping it depressed for 15 seconds, and then raising it to vertical position again.

d. It is emphasized that the beacon light signals do not constitute an order for the fighter pilot to proceed to the intersection indicated. The responsibility of making the interception rests upon the pilot, and he may make such use as he sees fit of the directions shown him by the beacon.

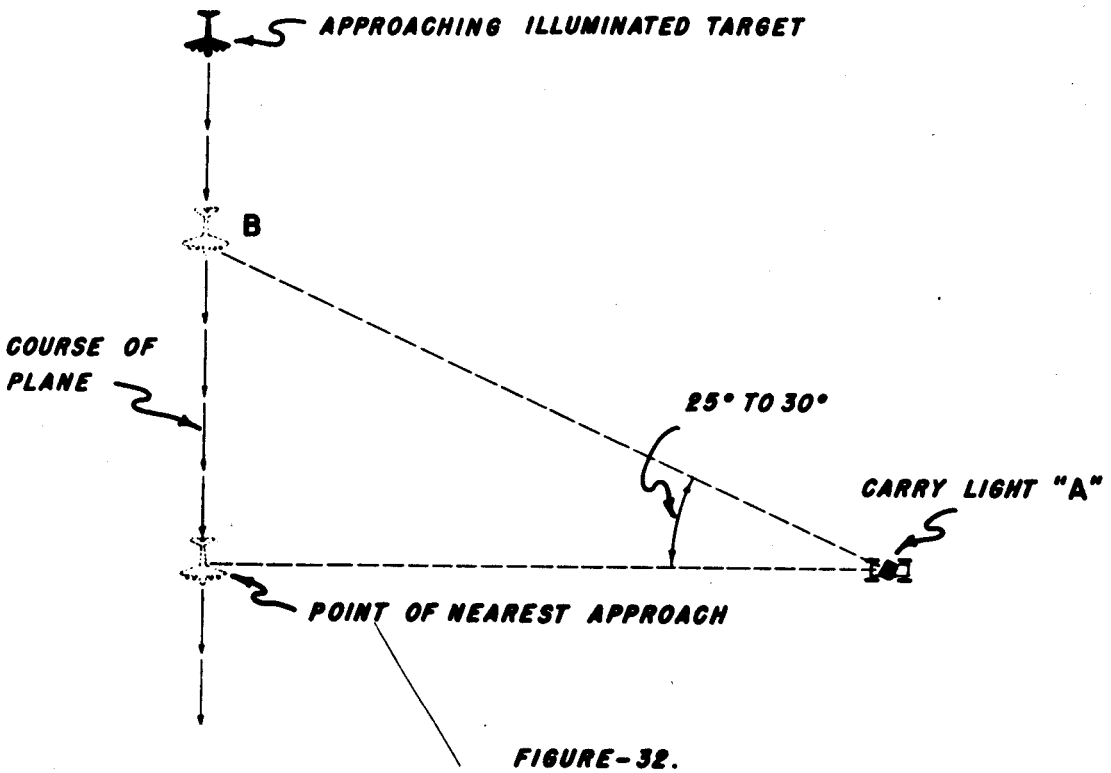


FIGURE-32.

CARRY LIGHT GOING INTO ACTION

1 — Light A is one of the four or five lights nearest to the target when the latter reaches point B.

2 — Light A should go into action when target reaches point B, <u>regardless</u> of the number of beams already illuminating it.

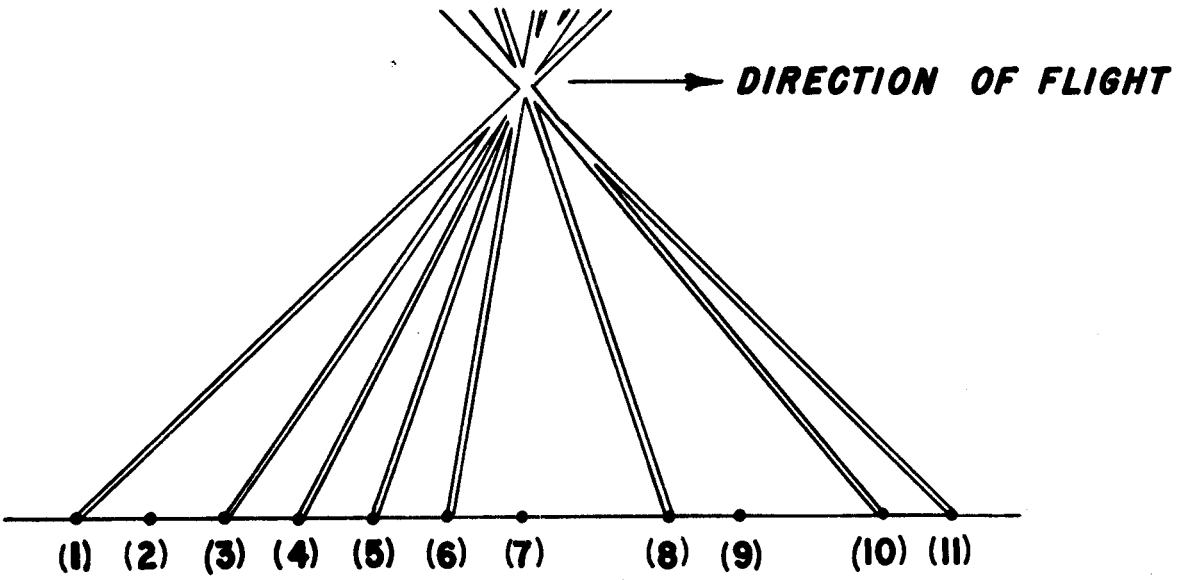


FIGURE-33.

TACTICAL HANDLING OF SEARCHLIGHT BEAMS -- VERTICAL PROJECTION
(Numbered dots represent searchlights)

A. Errors in Tactics Illustrated above.

(1) There are too many beams on the target.
(2) Light 1 should not be in action, since there are too many beams on the target and light 1 is the rearmost light.
(3) Light 2, which went out of action because there were too many beams on the target, ~~should not have gone out until light 1, the rearmost light went out first~~. Regardless whether #1 went out or not.
(4) Light 7, which did not go into action because there were too many beams on the target, should have gone into action when the target reached the proper point, regardless of the number of beams on it.
(5) Lights 10 and 11 have gone into action entirely too soon.

B. Correct Tactics Illustrated above.

(1) Light 3 is properly continuing to carry the target while waiting for light 1 to go out, even though there are too many beams on the target.
(2) Lights 4, 5 and 6 are properly carrying the target.
(3) Light 8 (which we will assume has just gone into action) has started its carry at the proper time even though there are too many beams on the target.
(4) Light 9 is properly waiting before going into action, until the target gets a little closer.

PART THREE

TRAINING

CHAPTER ONE

THE TRAINING OF THE SEARCHLIGHT BATTERY

Section I

GENERAL

84.--a. The efficiency of a searchlight battery in the operation of its assigned tactical equipment -- searchlights, radio detectors, and sound locators -- will be a direct measure of the emphasis placed upon the thorough planning and careful execution of the battery basic training program. It is worse than useless to send an untrained, or improperly trained, searchlight battery into the field, because the tactical disposition of a searchlight battery, spread out as it is over so many square miles, precludes the possibility of accomplishing any satisfactory basic training after the unit has moved into the field, since the lack of constant supervision can only result in the formation of incorrect habits in operation which will be difficult to eradicate. All basic training, both in operation and in tactics, MUST be completed while the battery is still in the training camp. The battery must not move into the field until the state of training of its personnel has reached a sufficiently high level for the unit to derive some real benefit from training in field positions. If, at any time during the training program, some particular phase of the training has not produced satisfactory results, then, that phase should be prolonged, and the following parts of the program postponed until satisfactory results are obtained.

b. The training program should be laid out by the number of days and nights of training, rather than by specific dates. Delays and postponements will be inevitable, chiefly due to weather conditions, and lack of airplanes for training purposes. If, at the time the training program is arranged, no particular difficulties are foreseen which might hold up the training program, a safety factor of about 50% should still be added to the length of time called for on the schedule, in order to insure adequate time for the satisfactory completion of

training. If, on the other hand, bad weather or some difficulty in procuring planes, is anticipated, then, a safety factor of up to 100% should be added to the regularly scheduled time of training.

c. Too much emphasis cannot be placed upon this basic training period. The battery commander and the other battery officers must personally and continuously supervise the instruction. Mistakes should be corrected immediately after they have occurred, and the reasons for the corrections pointed out. The battery officers must bear in mind that the success or failure of the battery when it moves into the field will rest in the hands of the NCO's, not the officers, and the ability of the NCO's to do an efficient job will depend entirely on the adequacy of their training. In a searchlight battery, the officers, as far as operation is concerned, can play an important part only during the training period; when field operations begin the officers assume the roles of critics watching a show given by the NCO's, and the show they see will be good or bad depending upon the efficiency of the training program they (the officers) conducted.

Section II

TRAINING METHODS

85. RADIO DETECTOR BASIC TRAINING.—a. The most important part of the training of radio detector personnel consists in the training of the oscilloscope operators. Training in the mechanics of setting up a radio detector, putting it in operation, and preparing it for movement, involve no special training procedure, and the details of these operations are covered in Appendix A. Special attention, however, must be given to the training of the oscilloscope operators, as the efficiency with which the radio detector will pick up targets and direct accurately the searchlight beam will depend upon these men.

b. The training of the oscilloscope operators consists chiefly in supervised practice. An experienced officer or NCO can explain in a short time the fundamentals of tracking -- how to recognize an echo, how to adjust sensitivity, how to split the echo and balance the resulting twin "pips", etc. -- but it takes hours of supervised practice to teach the operators how actually to do these things properly. Supervision is extremely important; it is folly to tell a group of men how to track a target, and then leave them to their own devices during practice.

c. (1) After the new operators become familiar with their jobs,

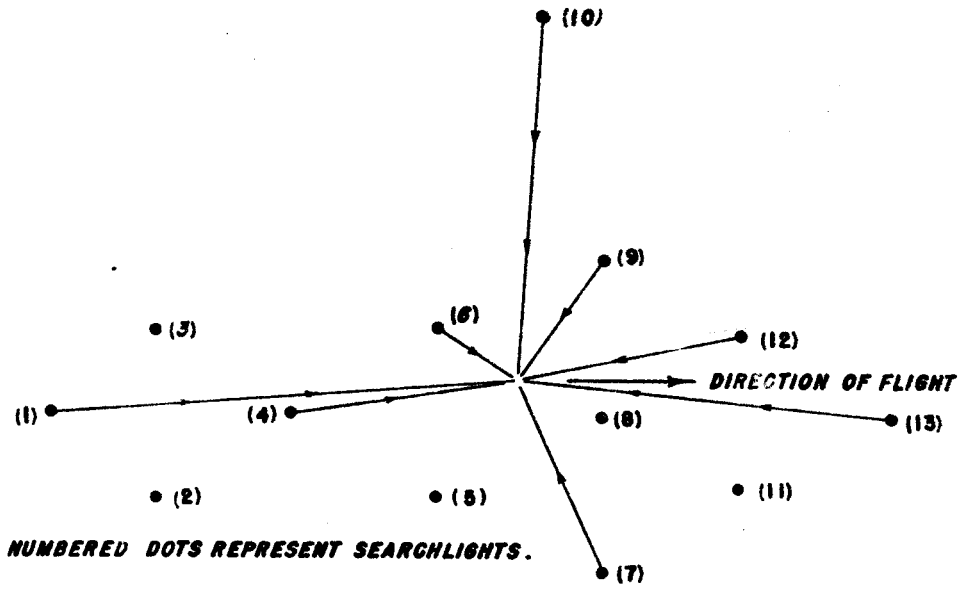


FIGURE-34.

TACTICAL HANDLING OF SEARCHLIGHT BEAMS — HORIZONTAL PROJECTION
(Numbered dots represent searchlights)

A. Errors in Tactics Illustrated Above.

(1) Lights 1 and 10 should not be in action, since there are too many beams on the target and lights 1 and 10 are farthest away.

(2) Lights 2 and 3 should not have gone out of action, since light 1, which is more distant from the target, is still in action.

(3) Light 5 should be in action, even though there are too many beams on the target, since the plane is a legitimate target for this light.

(4) Lights 12 and 13 have gone into action too soon.

B. Correct Tactics Illustrated Above.

(1) Lights 4 and 6 are properly carrying the target.

(2) Lights 7 and 9, assuming they have just gone into action, have started their carry at the proper time. Their greater lateral displacement from the target permits them to go into action before light 8, even though the latter is closer to the target, since their beams project past the side of the target plane rather than to the rear.

(3) Light 8 is correctly staying out of action until the target gets a little closer in order to get a greater angle of elevation for the searchlight beam.

(4) Light 11 is correctly staying out of action until the target plane gets closer.

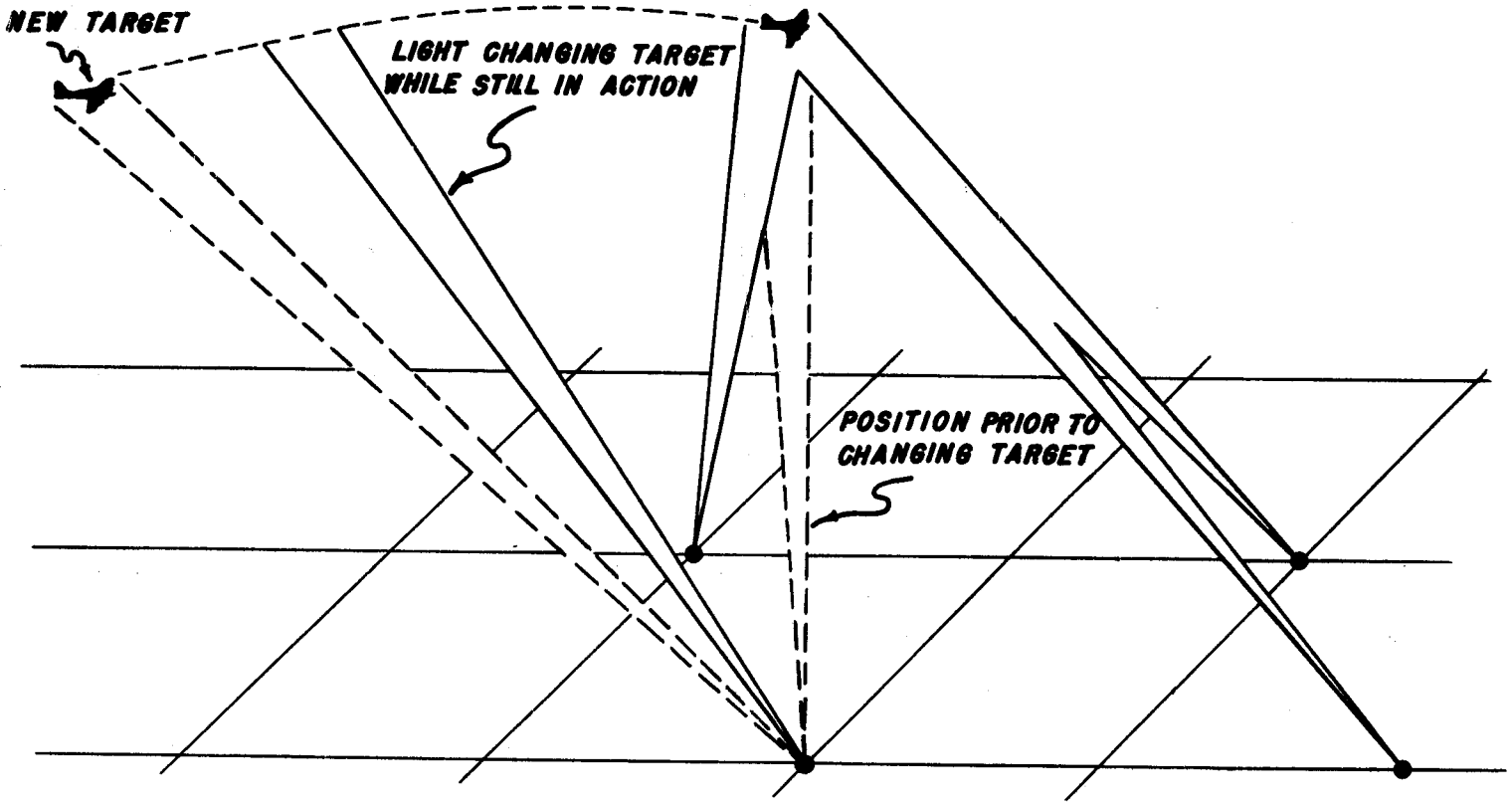


FIGURE-35.

SEARCHLIGHT BEAM CHANGING TARGET

i.e., after they understand what to do, they should begin night practice. The radio detectors should be grouped as closely together as mutual interference will permit, in order to simplify supervision. A plane flying at 4000-7000 feet, with running lights turned on, should be used as a target, and its course should be so laid out that it is always within range of the radio detectors. The control station operators should be instructed to keep the azimuth and elevation needles at zero at all times; no searching should be done at the control station. The target should not be tracked visually with the binoculars; to avoid the natural tendency of the chief controller to pick up and illuminate the target, which he can do easily since the plane carries riding lights, the binocular mount should by all means be left off the control station.

(2) Since the riding lights will show the position of the target plane, and the searchlight beams are following radio detector data, the progress of the azimuth and elevation oscilloscope operators can be determined by observing the errors of the searchlight beams, i.e., their divergence from the target. At first, these errors will be large, and few flicks of the target plane will be made, but, as the training progresses, the errors should become smaller and smaller, and the flicks more and more frequent. When the training has reached the point where the searchlight beams, still directed by radio detector data, are constantly on, or just a few beam widths from, the plane, with many flicks occurring, and the plane is illuminated at times for periods of several seconds, then, and not until then, the radio detector operators are ready for field training.

(3) For the benefit of battery commanders who might otherwise begin to despair over apparently inexplainable slumps, wherein their batteries show poor results after a few weeks of basic training, it is well to mention that any searchlight battery can lapse into a few nights' slump just as a first place baseball team can lose games to teams much their inferiors. Every searchlight organization has its "Monday night" drills, where everything seems to go wrong. These "Monday night" drills can be especially discouraging after the rapid progress which is usually evidenced during the early stages of basic training. However, if the battery commander knows that the basic training has been sound, he need not worry; the battery will suddenly snap into shape and show the inevitable results of good basic training.

(4) During the basic training of oscilloscope operators, there is one common fault which must be constantly watched for and corrected immediately whenever noticed -- the habit of lagging, which was discussed in Paragraph 75. This trait, which is almost universal among

untrained or poorly trained operators, can, if not corrected, result in a serious decrease in the effectiveness of the radio detector in directing the searchlight beam to targets.

86. SOUND LOCATOR BASIC TRAINING.--a. It is not anticipated that searchlight batteries will be issued radio detectors on the basis of one per searchlight for some time to come. For this reason, there is no doubt that M2 sound locators will have to continue to be used to furnish data on aerial targets for the direction of searchlights for a considerable length of time. The M2 sound locator is capable, with well trained crews, of detecting planes and furnishing accurate data thereon at altitudes up to about 15,000 feet. To realize fully the inherent capabilities of this instrument, however, requires the careful training of the listeners and acoustic corrector operator. The selection and training of these men are discussed in FM 4-111 and 4-115, along with the use of training aids such as the binaural trainer, but some additional information on training is included in the following paragraph.

b. (1) After the listeners have been selected and have received some training on the binaural trainer, they will be ready for actual practice with planes. They should get such practice for a few hours each day, but night training with searchlights will be the most beneficial part of their training, for the reason that supervision will be simplified and rendered more valuable by the fact that the results of the practice can be seen by watching the searchlight beam.

(2) The night training procedure should be carried out along the same lines as that for the radio detector operators, explained in Paragraph 85c. The same plane should not be used for both radio detector and sound locator training, however, as this increases the difficulty of supervision. As in the radio detector training, the target plane should carry riding lights, and should start at low altitudes, about 4000 feet in the initial stages of instruction, gradually increasing to 8000 to 10,000 feet as the training progresses. The control station operators must follow sound locator data at all times during this phase of the training; no searching should be permitted, nor should the chief controller ever be allowed to track the target visually during basic training. The nearness of the searchlight beams to the target will then be an accurate indication of the ability of the sound locator crew. As the training progresses, the observed errors should decrease, and the number of flicks increase, until the sound locator crews are able to provide data which will keep the searchlight beams constantly in the near vicinity of the target plane.

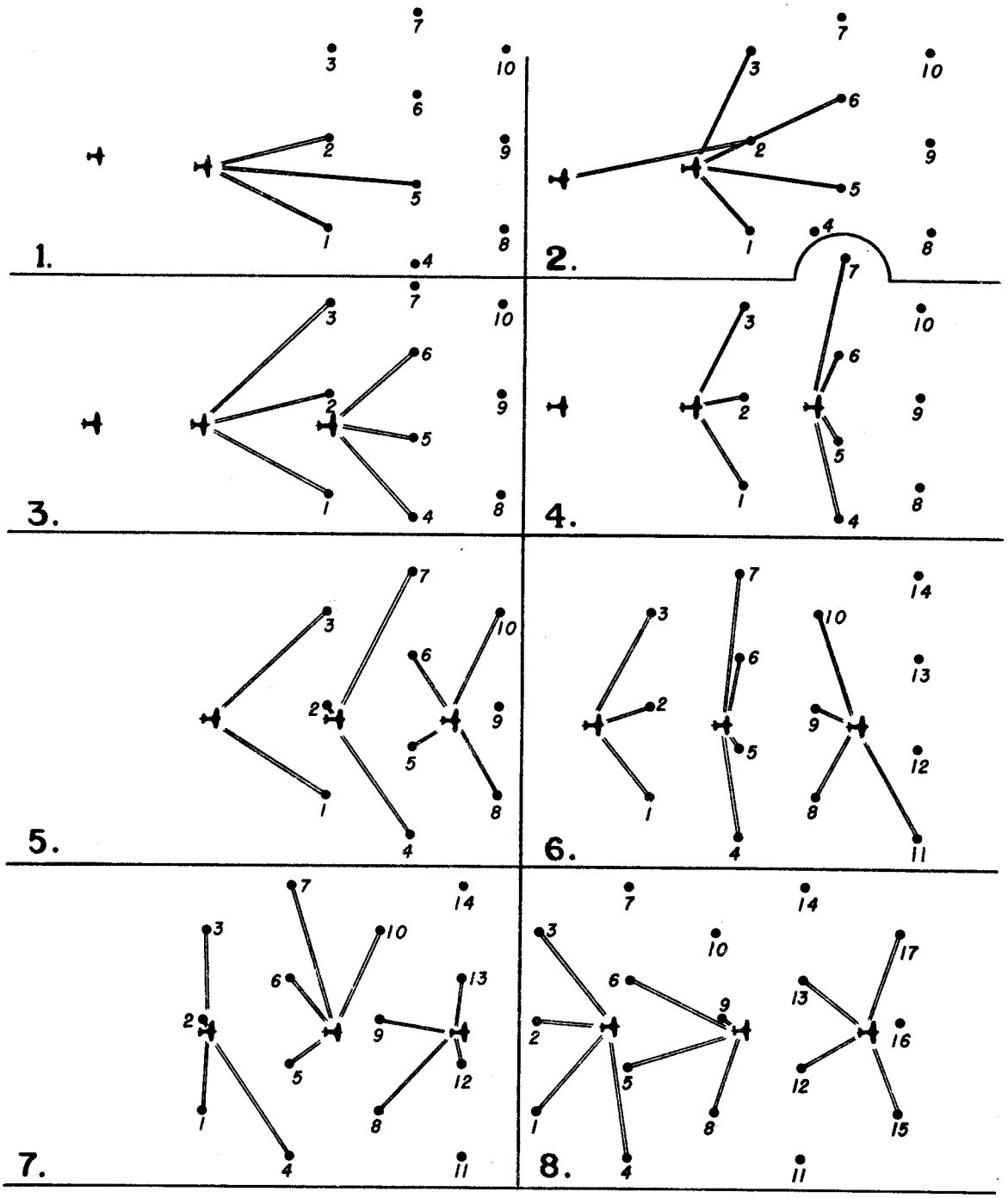


FIGURE-36.

ATTACK BY 3 PLANES IN COLUMN

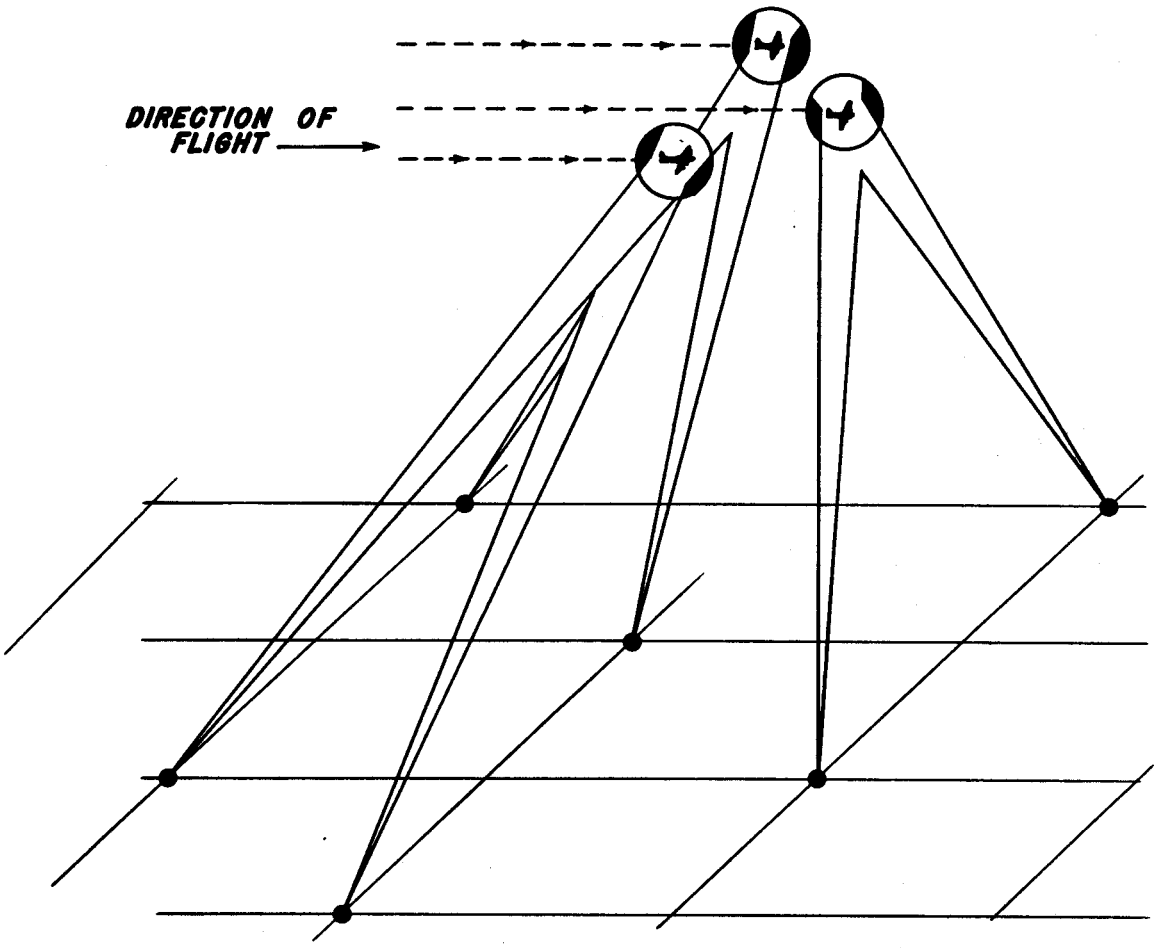


FIGURE-37.

ILLUMINATION OF LOOSE FORMATION

(1) At least two beams on each plane in formation, more if possible.
(2) Each searchlight illuminates plane which is nearest to it, to eliminate the crossing of beams below formation.

(3) Care should be taken in the selection of the acoustic corrector operator. He should be an intelligent man who will be able to understand the principles of acoustic correction when clearly explained to him, as the secret of success in acoustic corrector operation lies in the thorough understanding by the operator of what he is doing rather than in the uncomprehending following of instructions during constant practice. Of course, supervised practice is still a necessity, but in this case, it should be preceded by a very complete explanation of the purpose and method of acoustic correction. It should be made clear to the acoustic corrector operator that sound lag, and, consequently, the correction therefore, is not something which makes sudden, erratic changes in magnitude. On the contrary, the magnitude of the sound lag, and, consequently, the acoustic correction, is as steady and smooth as the flight of the plane itself. It can change magnitude or direction only with the same facility with which the plane can change speed or direction. The sudden, erratic movements of the pantograph pointer, therefore, do not correspond with the required acoustic correction, but are the result of erratic tracking on the part of the listeners. Consequently, the acoustic corrector operator should not attempt to follow the sudden movements of the pantograph pointer; his applied correction should be smooth, with only gradual changes and should follow the average position of the pantograph pointer. This fact is important for the efficient operation of the sound locator, and is the vital part of the training of acoustic corrector operators.

87. TACTICAL BASIC TRAINING.-- Tactical basic training should be conducted in daily classes for officers and NCO's. The use of model searchlights, locators, and airplanes is indispensable in the conduction of these classes. The basic principles of tactics covered in previous portions of this text should be explained, one at a time, by the instructor, and each explanation illustrated by the use of the models. After all the fundamental principles have been taught, the models should be set up to simulate an integrated searchlight defense, and the handling of single and multiple plane attacks demonstrated by moving the model airplane through the searchlight area. The students should be assigned as detector and light commanders at the model detectors and lights, and should conduct the exercises exactly as if they were commanding actual detectors and lights in a real night practice. They should give all the proper commands, and should manipulate the models to simulate operation. The instructor should supervise this work, and make any necessary corrections with accompanying explanations. This work with models should be continued daily throughout the basic training period, and should also be used during critiques after actual operations, to demonstrate tactical points under discussion.

88. BASIC TRAINING IN SEARCHING.—a. After the detector crews have reached a satisfactory stage in their basic training, some time should be devoted to the training of control station operators of sound locator sections only in the proper method of searching with the searchlight beam. It was pointed out in Paragraph 78a(3) that the controllers in a radio detector section do not conduct a search, that they keep the azimuth and elevation needles at zero. This is due to the fact that the radio detector, when properly synchronized, is extremely accurate for searchlight work, and, in addition, the slight variations in tracking by the oscilloscope operators, which are inevitable, provide a small degree of search. Sound locators, however, are somewhat less accurate, and even with well-trained crews errors of 2° to 3° may be expected. Therefore, control station operators in sound locator sections should conduct a search of about 3°, or approximately 3 needle widths, to take care of possible errors.

b. During the training of control station operators, emphasis must be placed upon training them to search SLOWLY. Flicks of an unilluminated plane will be observed only if the illumination thereof persists for an appreciable length of time. This length of time of illumination required for observation of flicks will vary with conditions of visibility, altitude of the plane, degree of camouflage, etc., but, in general, a flick which produces illumination of the target for less than 2 or 3 seconds is likely to be unobserved. Rapid searching, resulting in flicks which consist in the searchlight beam's rapidly whisking across the plane, will do no good. The search should be slowed down to a movement of about $\frac{1}{2}$° per second. In other words, the control station operator should take about 6 seconds to search 3° to the left of zero, another 6 seconds to get back to zero, and 12 seconds to go out to the right and return, making a total time for the entire search of somewhere between 20 and 30 seconds.

c. It is an excellent idea, during the training on searching, to allow the platoon commanders and NCO's to fly in the target plane, to observe the drill from the air. There is nothing that points out the necessity for a slow search quite as well as being in a plane which is being constantly flicked by rapidly moving searchlight beams, but never picked up and illuminated because the rapid flicks are not noticed by the chief controller.

d. The training of the control station operators can be combined with the training of the chief controller, by allowing him to pick up and carry the target visually after it is flicked. The target planes should still keep their riding lights on during this training, to permit observation by the instructors.

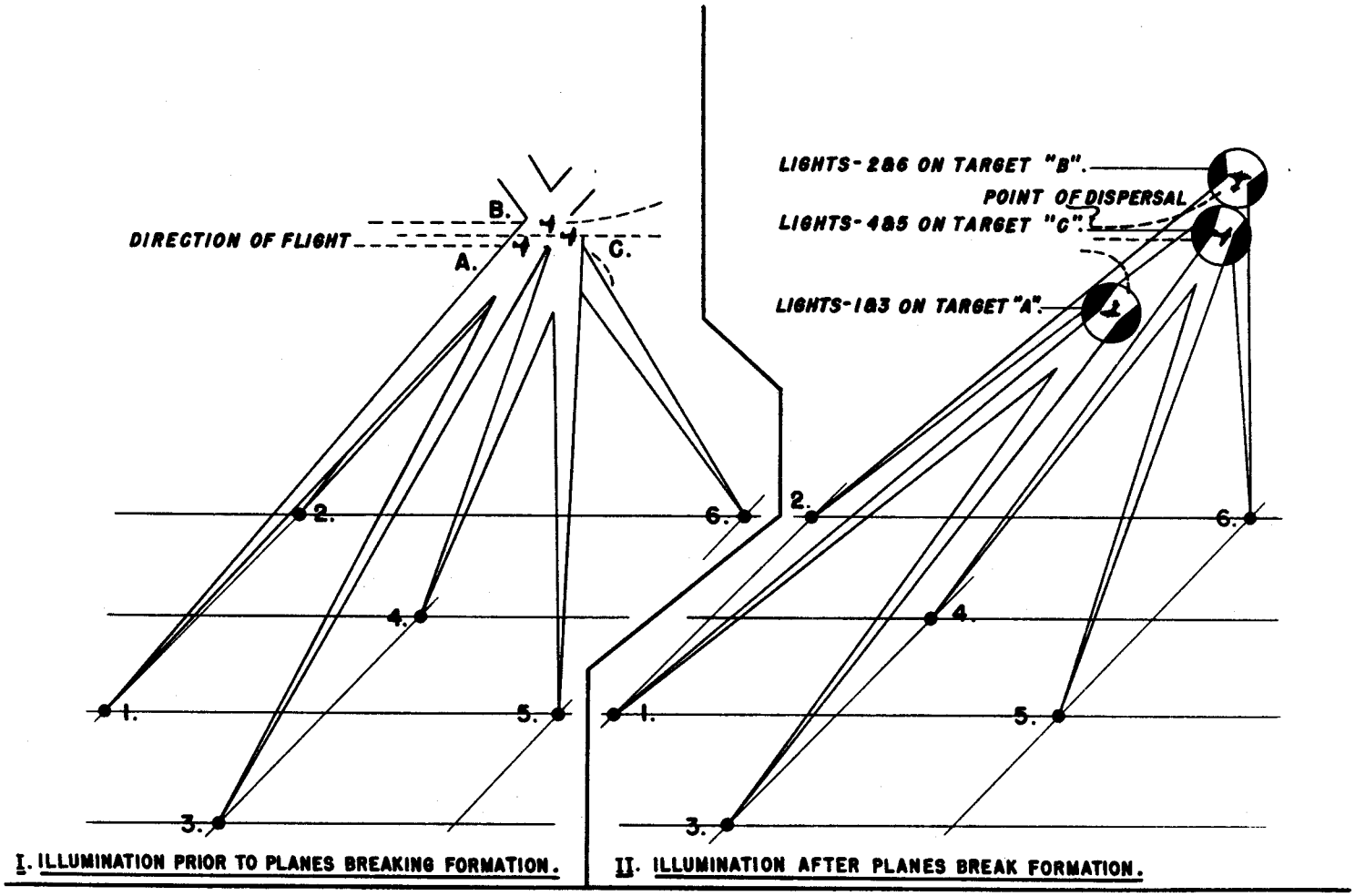


FIGURE-38.

ILLUMINATION OF A MULTI-PLANE FORMATION

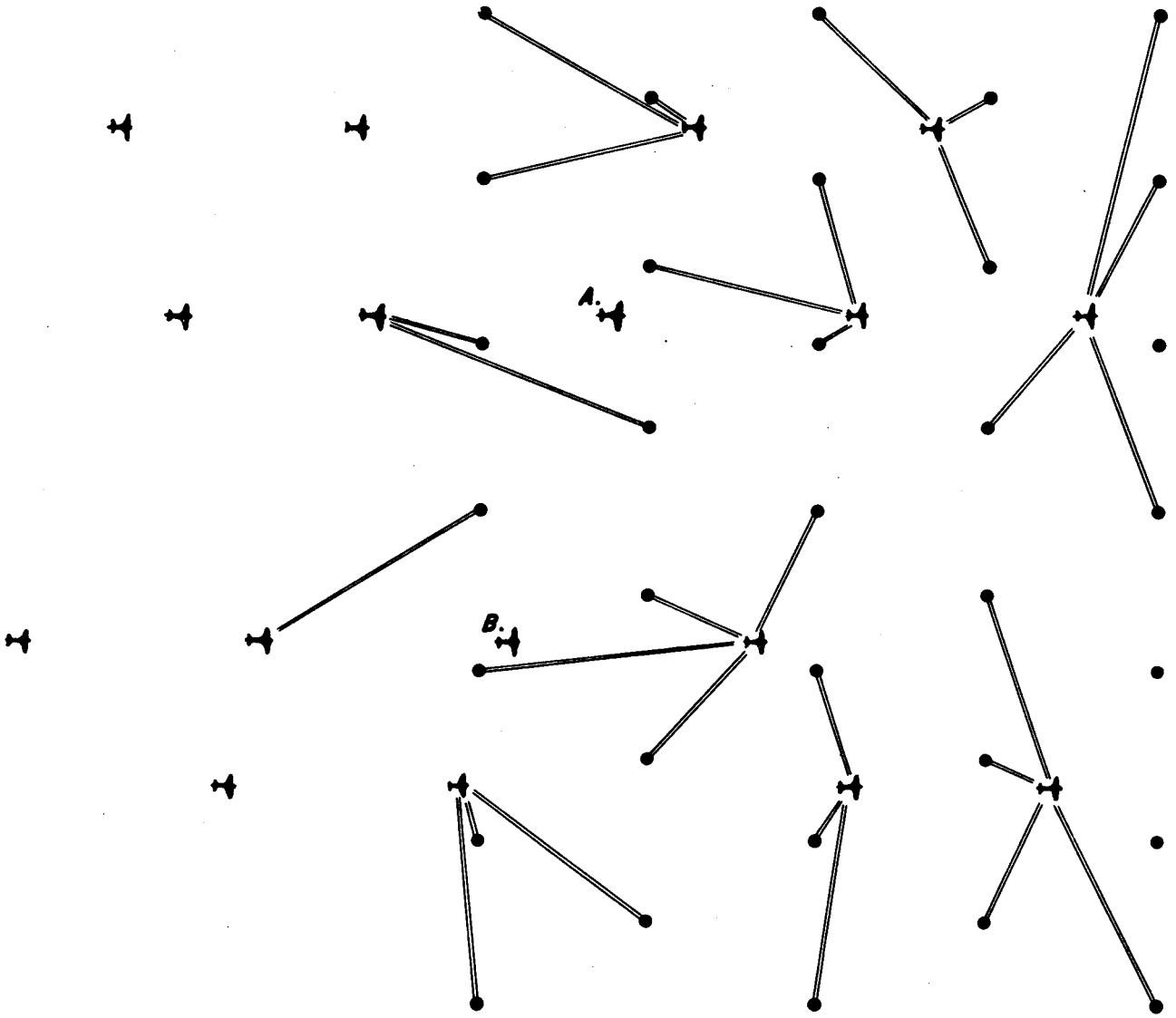


FIGURE-39.

ILLUMINATION OF MULTIPLE PLANE ATTACK

(1) At least 3 beams on each target, 4 whenever possible.
(2) Targets already picked up and illuminated are given priority over succeeding, unilluminated targets. Targets A and B are disregarded in order to maintain sufficient illumination on targets which preceded them.

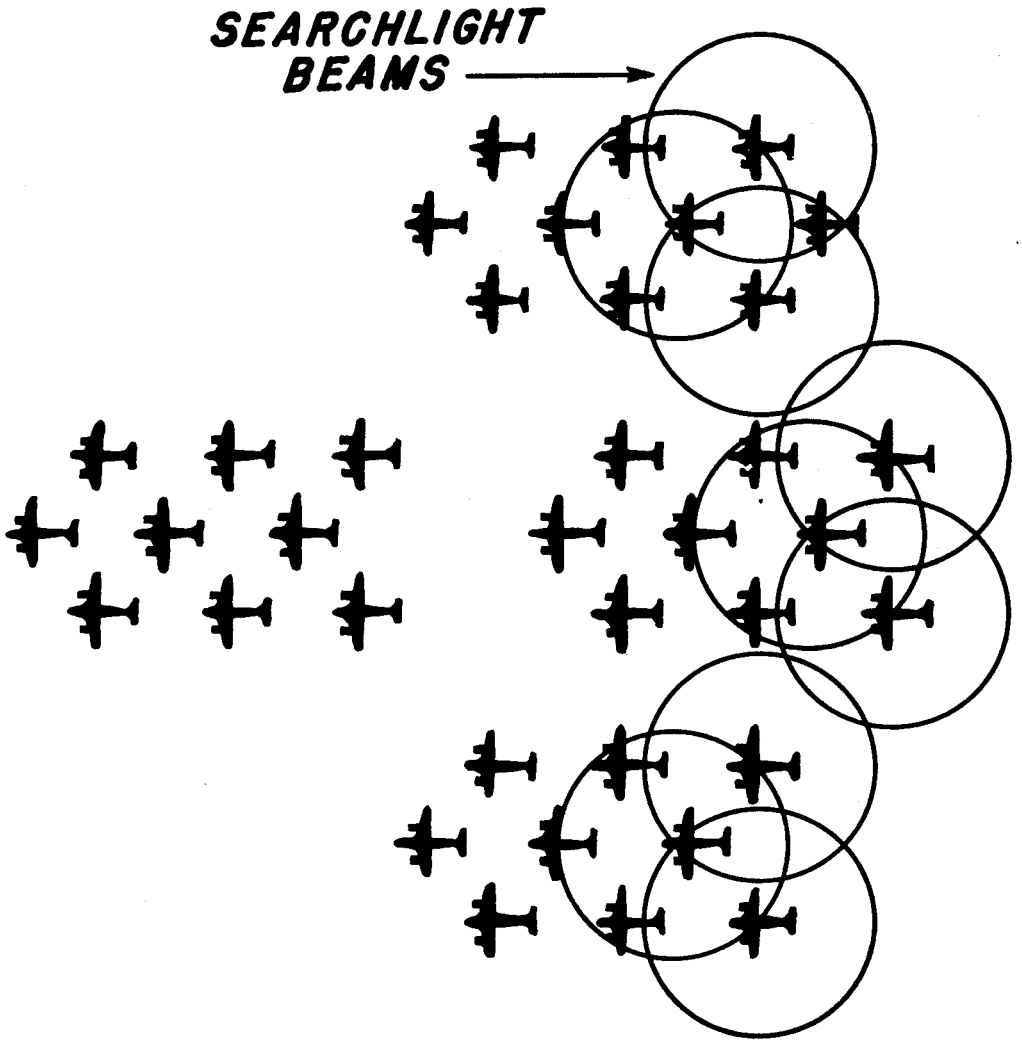


FIGURE-40.

ILLUMINATION OF LARGE FORMATION

1 — Base of formation illuminated so that fighters may attack from rear.
2 — As many elements of formation illuminated as available lights within range will allow.

89. TRAINING IN COMMUNICATIONS.—a. Every man in a searchlight section should be a communications man. There is only one way to install in a reasonable length of time the communication system required in a searchlight battery, and that is by having every searchlight section, in addition to the regular battery and platoon communications sections, assist in laying the wire. The communications officer should plan in advance, prior to a move into a new location, the work which is to be done by each section, and explain in detail to each section chief the part of the work his section will do, so that immediately upon arrival at new positions, all sections can start laying wire simultaneously.

b. This requires, of course, that all searchlight personnel be trained in communication work. This training can be carried out in the same manner as that for regular communication sections except that it should be confined principally to laying and picking up wire, and splicing. The section telephone operators should have additional training in trouble shooting, as this will be one of their duties, as mentioned in Paragraph 67d. The searchlight personnel should not be expected to put up overhead lines which require the use of climbing irons; their job is to get the wire in, on the ground if necessary, in such a manner that breaks are not likely to occur before the regular communications detail can get time to "dress up" the lines.

c. The training of the telephone operators must include, in addition to the above, the usual training in enunciation, telephone operation, etc., which is ordinarily given to telephone operators. Additional instruction must also be given in the use of commands and informative terms pertinent to searchlight work (see Paragraph 56), and in the special duty of telephone operators, described in Section III, Chapter Three, Part Two.

90. INTERMEDIATE TRAINING.—a. (1) When the basic training period has been completed, the completion being determined by the results obtained and not by calendar dates, the searchlight unit is ready to move into the field for intermediate training. During this period, and the final training period, the units occupy normal field positions. At the beginning of the intermediate training, the target planes should carry riding lights, to insure their being picked up, and thereby to minimize delay in getting all the radio detectors oriented and synchronized with the searchlights. The night drills should be supplemented by daytime alinement missions for the alinement of the radio detector open sights. The target planes for the night drills should continue to carry riding lights until all, or at least the major portion, of the radio detectors are properly synchronized.

(2) Throughout the intermediate phase of training, emphasis must be placed upon the correct tactical handling of searchlight beams -- number of beams on the plane, the pick-up and carry, going out of action at the proper time, etc.

b. After the radio detectors are properly synchronized, the target planes should begin to fly without lights, and should continue to fly without lights for the balance of the training period. The altitudes of the target planes should be gradually stepped up from about 6000 or 7000 feet to 25,000 feet, or higher. When attacks by single planes are being satisfactorily handled, multiple plane attacks should be scheduled -- attacks by planes in column 30 seconds to a minute apart, by planes spaced laterally, by planes stacked up in altitude, by close formations, by loose formations, and by combinations of any of these. The most important general feature of this training, as it was during basic training, is that no step of the program should be considered completed because the allotted time is over, but must be judged by results only, and prolonged, if necessary.

c. During this and the final phase of training, it is extremely advantageous to hold daily officers calls, to discuss the previous night's practice and following this, the platoon commanders should have a similar discussion with their NCO's. The use of models, as mentioned previously, will clarify these discussions.

91. TRAINING WITH FIGHTER PLANES.--a. Training with fighters is the final phase of the training program. Before the first practice with fighters, the platoon commanders should be given a lecture on the tactics used by fighters when operating with searchlights, and the platoon commanders must in turn explain these tactics to their NCO's, so that the work which is to follow will be clearly understood by all concerned. The only difference between this final phase of training and the previous phases is that the searchlights are permitted to illuminate only those planes which approach from outside the area -- they must stay off the fighters. This can only be done by a thorough understanding on the part of the NCO's of the fighter tactics which were explained in Paragraphs 47-52, and the correct application of searchlight tactics covered in the intermediate phase of training.

92. TRAINING PROGRAM.-- A typical training program for a searchlight battalion follows:

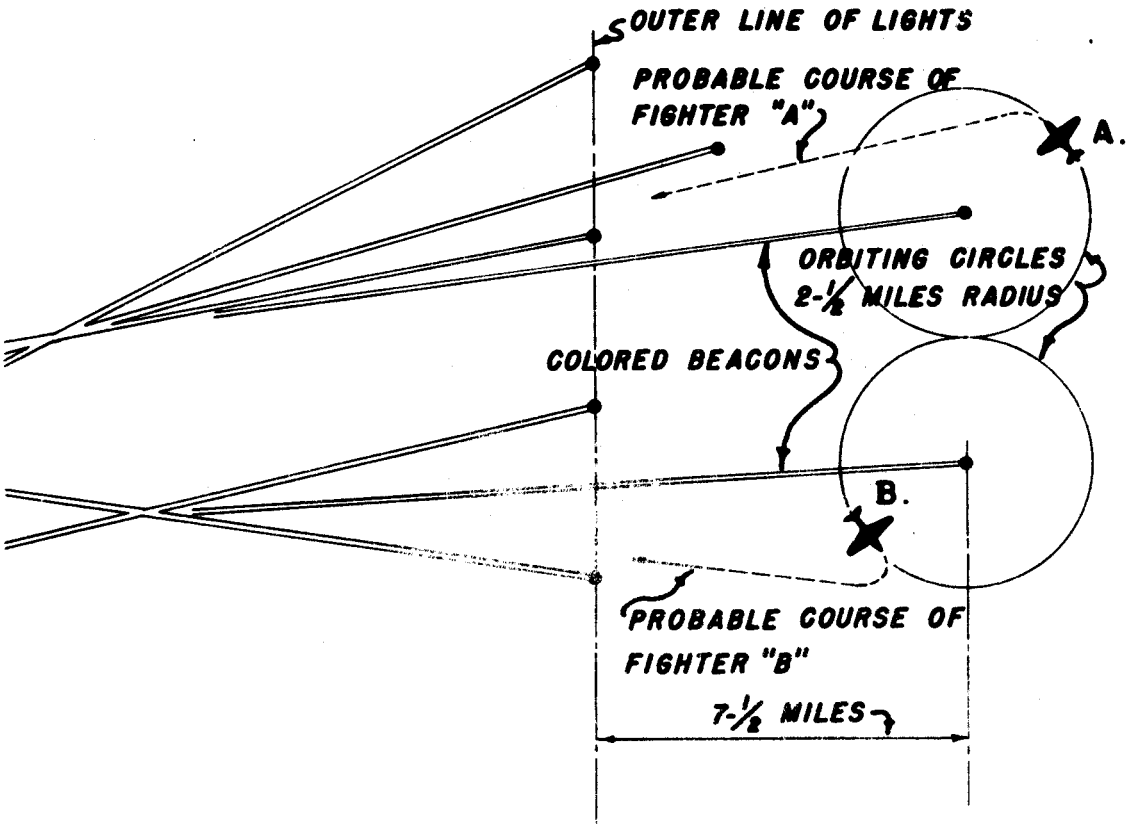


FIGURE-41.

USE OF ORBITING BEACON TO GUIDE FIGHTER PILOT TO PROPER INTERSECTION

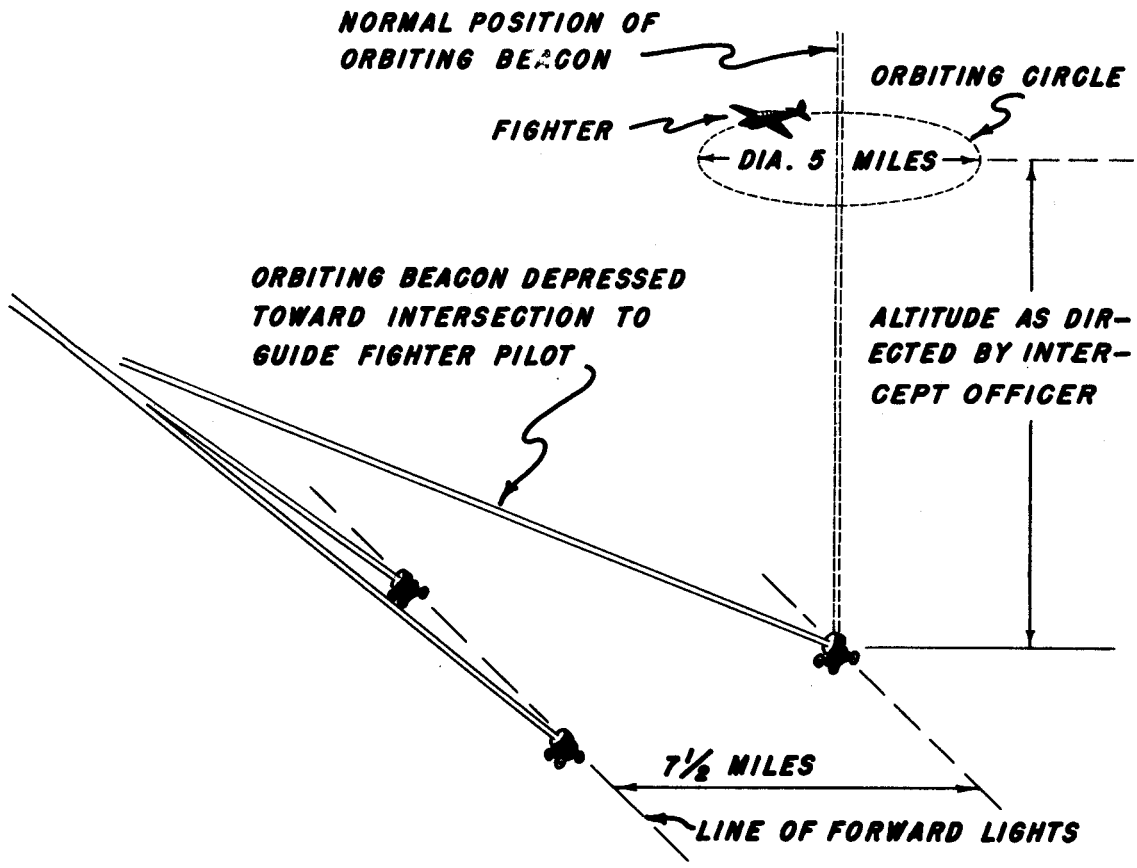


FIGURE-42.

USE OF ORBITING BEACON TO GUIDE FIGHTER PILOT TO PROPER INTERSECTION

(1) Fighter directed to sub-control point by intercept officer.
(2) Fighter orbits about colored beacon light at assigned altitude until he receives announcement "Intersection".
(3) Orbiting beacon is depressed and pointed at intersection on its normal front to guide pilot to proper intersection.
(4) Orbiting beacon resumes normal vertical position after approximately 15 seconds.

Phase I: Basic Training

NOTE: All basic training, both in operation and tactics, MUST be completed while the unit is undergoing Phase I. The unit must not move into the field until the state of training of its personnel has reached a sufficiently high level for the unit to derive real benefit from training in field positions. If at any time during training, some particular phase of training has not produced satisfactory results, then, that phase should be prolonged until satisfactorily completed.

Planes to fly with running lights at all times. Units occupying compressed positions within a few hundred yards of each other.

1st Week: Classroom work in theory of Fighter-Searchlight Team, AAAIS, Air Force Organization, and basic searchlight tactics to include model drill and emplacement of equipment in position in basic training area.

2nd Week: Daytime instruction in operation and tactics for platoon commanders and NCO's.
Night Drills - 4 drills of 3 hours each.
Planes required - 2.
Altitude - 4000 to 7000 feet.

3rd Week: Same except planes fly at altitude of 8000 to 10,000 feet.

4th Week: Same except planes fly at altitude of 10,000 to 15,000 feet.

Phase II: Intermediate Training

Units to occupy normal field positions.

5th Week: Daytime alinement flights - 4.
4 drills — 3 hours each.
Planes required — 1.
Plane to fly within sight of radio detectors.
Altitude 8000 feet.
Night drills — 4 drills of 4 hours each.
Planes required — 3.
Planes to fly parallel courses through area, laid out to give practice to all units.
Altitudes — left 10,000 feet; center 12,000 feet; right 11,000 feet.

All planes to carry riding lights to facilitate accomplishment of final precision alinement and synchronization of searchlight and radio detector.

6th Week: Night drills — 4 drills of 4 hours each.
Planes required -- 3.
Planes to fly same courses and altitudes as 5th week but without riding lights.

7th Week: Same as 6th week.

8th Week: Night drills — 4 drills of 4 hours each.
Planes required -- 9.
Planes to fly three parallel flight paths through area with 3 planes on each flight path at 1 minute intervals. (2 drills).
2 night drills with planes flying in formation, one 3 plane formation on each of 3 parallel flight paths.
Altitudes — 10,000 to 20,000 feet as arranged by air unit for safety.

Phase III: Advanced Training With Fighters

NOTE: During Advanced Training Phase, target planes will use evasive tactics whenever safety precautions permit. A minimum of one mission will be conducted with target planes using evasive tactics.

9th Week: Night drills — 4 drills of 4 hours each.
Planes required -- 9 target planes, 3-9 fighters.
Target planes to fly on 3 parallel courses through area, 3 target planes on each course at 2 minute intervals.
Fighters to carry riding lights for safety.
Altitudes -- 10,000 to 20,000 feet as arranged by air unit for safety.

10th Week: Same as 9th week.

11th Week: Same as 9th week except target planes to fly at 1 minute intervals on each course.

12th Week: Night drills — 4 drills of 4 hours each.
Planes required — 9 target planes, 3-9 fighters.
Period of free maneuver; at least one mission with target planes flying at 30,000 feet.
Target planes to fly any course over area at any altitude.
Searchlight units not to have advance information on courses or formations.

CHAPTER TWO

SPECIAL TRAINING OF A FIGHTER UNIT FOR OPERATION IN THE FIGHTER-SEARCHLIGHT TEAM

Section I

GENERAL

93. GENERAL.—a. Experience has shown that operation of fighters in night interception over searchlights is normally neither difficult nor dangerous. Provided the searchlight personnel have attained moderate proficiency of operation by the methods herein described, and provided inadvertent illumination of friendly fighters is guarded against by their remaining always inside the searchlight area, a fighter unit with only a moderate amount of previous night flying training will find night interception over searchlights a matter of ease and simplicity.

b. At the beginning of the 1941 Fighter-Searchlight Exercises, wherein the basic procedures herein described were originally tried and found sound, the participating fighter unit arrived at the location of the exercises with a material majority of pilots who had, at that time, never before flown a fighter plane at night. After one week of basic night flying practice, they entered the exercises and participated throughout without a single accident during, or in any way directly connected with, their operation over the searchlights.

Section II

TRAINING METHODS

94. GROUND.—a. Preliminary to entry upon operation over searchlights, all pilot personnel should become thoroughly familiar with the methods of operation covered herein. Particular emphasis should be placed upon thorough indoctrination on plans of operation, as follows:

1. Use of Control Points.
2. Staggered altitudes.
3. Formation methods.
4. Radio Procedure.
5. Interception procedure.
6. Coordinated attacks upon enemy formations.

b. Critiques should be held continuously throughout the training period and thereafter, for discussion of methods of operation, improvement of training, and determination of results.

95. TRAINING PROGRAM.—a. Day — Transition for Fighter Pilots — 25 hours.

b. Night.

(1) Local night flying.
Individual, 5 hours. (2 hrs., Airdrome; 3 hours, local area familiarization) ———— 5 hrs.
(2) Formation night flying including at least one (1) hour without navigation lights. Fly on Turbo Slow. Must be preceded by training in day formation flights. ———— 1 hr. (minimum)
(3) Use of control points and observing flight of illuminated targets without dispatching ———— 2 hrs.
(4) Individual approaches and attacks ———— 3 hrs.
(5) Formation approaches and attack by individuals ———— 2 hrs.

Total flying, night ———— 13 hrs.

NOTE: All attacks should be practiced first in daylight.

ABBREVIATIONS AND THEIR MEANINGS

AB	Air Base
AC	Air Corps
AD	Air Defense
ADGrid	Air Defense Grid
AF	Air Force
AFCC	Air Force Combat Command
S_a	Air Speed of Target
ASC	Air Support Command
ASV	Air to Surface Vessel
AI	Airborne Interception
A/C	Aircraft
AWS	Aircraft Warning Service
H	Altitude
E	Angular Height
AA	Anti-Aircraft
AAA	Anti-Aircraft Artillery
AAAIS	Anti-Aircraft Artillery Intelligence Service
AA (AW) GP.	Anti-Aircraft Automatic Weapons Group
App	Appendix
AAF	Army Air Forces
AW	Automatic Weapons
Az or A (orig)	Azimuth
BB	Balloon Barrage
Bn	Battalion
BRL	Bomb Release Line
BC	Bomber Command
Cal.	Caliber
CB	Center of Burst
CH	Chain, Home
CHL	Chain, Home, Low
CARW	Civil Air Raid Warning
CA Slt. Bn.	Coast Artillery Searchlight Battalion
CD/CHL	Coast Defense - Chain Home Low
CIO	Combat Intelligence Officer
CP	Command Post
D	Slant Range
DR	Dead Reckoning
D/F	Direction Finding
DEC	Distant Electric Control

E	Angular Height
FC	Fighter Command
FCA	Fighter Control Area
FCAOR	Fighter Control Area Operations Room
GCI	Ground Controlled Interception
GOC	Ground Observer Corps
GOFC	Ground Observer Filter Center
GP	Group
Guns	Term used to describe the general category of larger caliber Antiaircraft Weapons.
H	Altitude
R	Horizontal Range
IFF	Identification, Friend or Foe
IO	Identification Officer
IS	Identification Section
IC	Information Center
IB	Intercept Board
L	Liaison
MG	Machine Guns
mm.	Millimeter
m	Mils
OP	Observation Post
OPS	Operations
OB	Operations Board
PPI	Plan Position Indicator
T	Position of target
R	Horizontal Range
RFR	Radar Filter Room
RDF	Radio Direction Finding
r-f	Radio Frequency
R/T	Radio Telephone
S_a	Air Speed of Target
Slt.	Searchlight
S-L	Sound Locator

T	Position of Target
t	Time of Flight
t_d	Dead Time
UHF	Ultra High Frequency
VHF	Very High Frequency
WOR	Wing Operations Room
268	SCR-268

(Not all of these abbreviations are used herein.)

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