# TM 5-7045

# WAR DEPARTMENT

## OPERATING INSTRUCTIONS MANUAL

## Searchlight, 60-inch Model 1942 and Control Station

General Electric Co.
Schenectady, N. Y.

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TM 5-7045

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The Adjutant General

# OPERATOR'S MANUAL

## SEARCHLIGHT AND CONTROL STATION

for

## 60-INCH ANTIAIRCRAFT SEARCHLIGHT

Model 1942

UNIT SERIAL NUMBERS

C. OF E. 4447-4946, 6147-6879 INCLUSIVE

CORPS OF ENGINEERS U.S. ARMY

FOR OFFICIAL USE ONLY

GENERAL ELECTRIC
SCHENECTADY, N.Y.

GEJ-1517

# FOREWORD

This Operator's Manual has been prepared to aid in the operation of the Model 1942 General Electric 60-inch Antiaircraft Searchlight Equipment.

This Manual describes the construction and covers the operation of the searchlight and control station only. Maintenance and repair of these units are covered by a separate Maintenance Manual (TM 5-7047). The operation and maintenance of the associated power plant are covered respectively by a Power Plant Operator's Manual (TM 5-7049) and a Power Plant Maintenance Manual (TM 5-7051).

Illustrations in this Manual have been numbered consecutively beginning with Fig. 1, and are suitably titled. A list of these illustrations, with the page number on which they appear, will be found at the front.

The relation of the searchlight to the antiaircraft problem, as well as some of the principles underlying the design of the searchlight proper, are discussed in an addendum to this Manual.

With very few exceptions, the reference numbers of parts and assemblies coincide with the reference numbers of the same parts and assemblies in the Searchlight and Control Station Parts and Price Lists (TM 5-7046). The purpose of this is to facilitate the use of the two books in conjunction with each other.

In using this Manual, it is recommended that it be studied in sequence beginning at page 1. Skipping around, especially in the portion covering the detailed and technical description, will lead only to confusion and make it more difficult to understand the operation of the equipment.

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# INTRODUCTION

Before entering into a detailed description of the operation and functioning of the searchlight equipment, it is important that the reader be familiar with the relationship of this equipment to the rest of the antiaircraft battery.

The primary purpose of such a battery is to defend a position against aerial attack; and the antiaircraft guns are the nucleus of the battery. However, to properly direct the gunfire on a swiftly moving target, a fire-control director is employed. In the present directors, it is necessary to view the target in order to obtain the data necessary for computation of future target position. At night, therefore, some means of illuminating the target must be employed. This is the function of the searchlight equipment.

In order to determine the point in space to which the searchlight beam is to be directed, the position of the target is determined by a locator. The angular displacement of the searchlight may be controlled directly from the locator. However, for tactical reasons it is frequently desirable, especially after the target becomes visible, to control the searchlight beam from a control station. Due to emplacement requirements, the locator and control station may be located at points distant from the searchlight, and some means for controlling the searchlight from these remote points is necessary. This is the function of the distant-electric-control (D.E.C.) system. The necessary power for proper operation of these related units is supplied by the power plant or sometimes by the locator. A description of each unit of the searchlight equipment will be found in Section I. A general arrangement of the equipment is shown in Fig. 1. Actual emplacement procedure is described in detail in Section I.

## APPROXIMATE WEIGHTS AND DIMENSIONS

| Equipment | Weight in Pounds | Height in Inches | Width in Inches | Length in Inches |
|---|---|---|---|---|
| Searchlight | 2500 | 87 | 72 | 100 |
| Control Station | 314 | 68 | 31 | 29 |
| Power Plant (draw bar up) | 3400 | 74 | 66 | 102 |
| Spare-parts and Tool Box | 195 | 13 | 18 | 34 |
| Binocular-mount Box with Binoculars | 78 | 12 | 15 | 34 |
| Canvas (Searchlight) | 33 | .. | .. | .. |
| Canvas (Control Station) | 8 | .. | .. | .. |
| Extended Hand Controller | 19 | .. | .. | 120 |
| Control-cable Reel | 50 | 24 inches in diameter | | |
| Power-cable Reel | 76 | 24 inches in diameter | | |

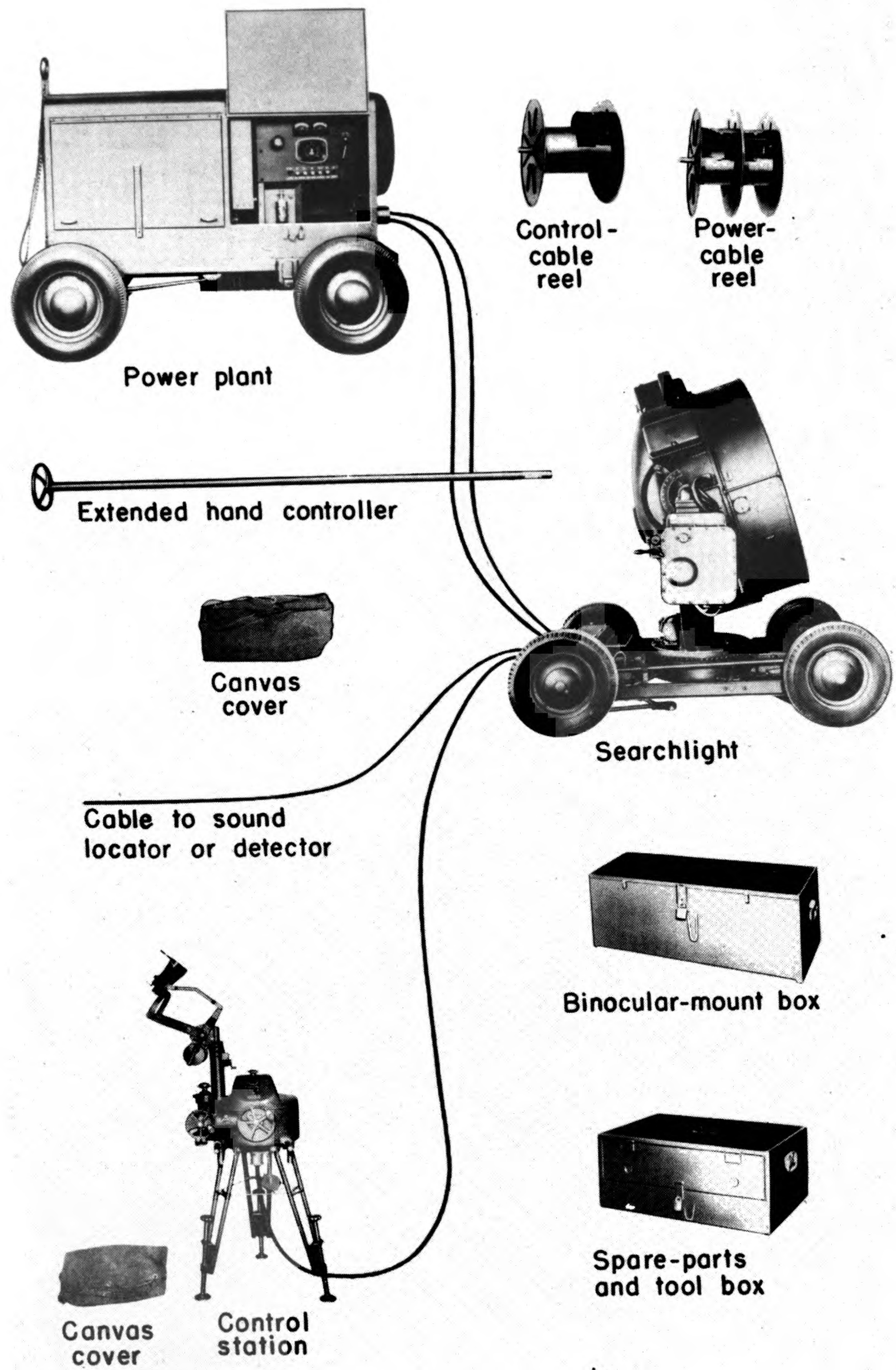



**Fig. 1. Antiaircraft searchlight equipment**

# SECTION I—OPERATING INSTRUCTIONS

## DESCRIPTION

### 1. General

This section, with its illustrations, associated references and text, provides a general description of the searchlight equipment sufficient only for operating instructions. The searchlight equipment consists of all the items shown in Fig. 1; the power plant, however, will not be discussed in this book, since there is an Operator's and Maintenance Manual provided separately for it. Descriptions of the various parts will be made in more detail in subsequent sections.

## SEARCHLIGHT

### 2. Major Assemblies

The major assembly subdivisions of the searchlight are shown in Fig. 2, which illustrates the searchlight arranged both for operation and for transportation. These subdivisions are designated by letter references, in order that the apparatus described and referred to throughout this instruction book may be readily identified.

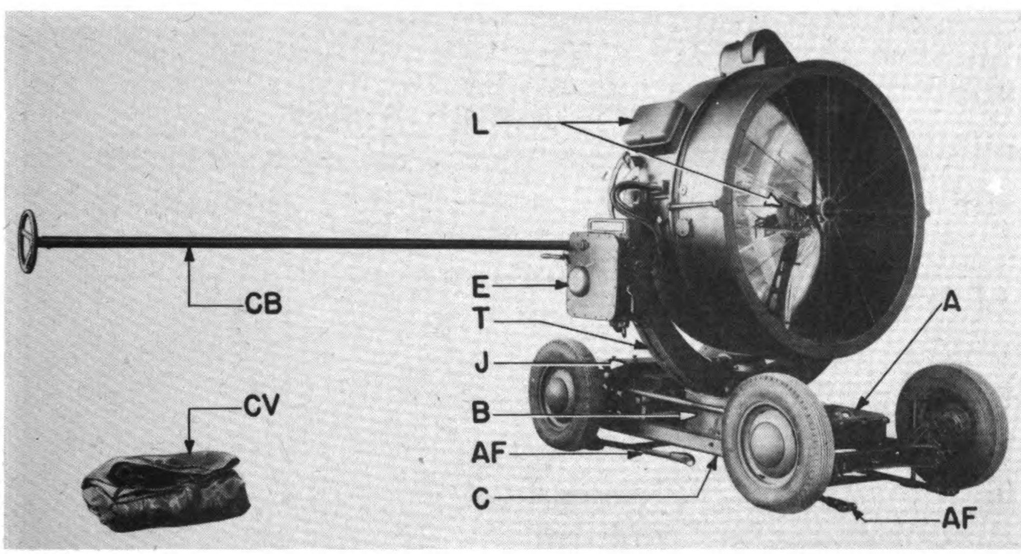



**Fig. 2a. Searchlight in operating position**

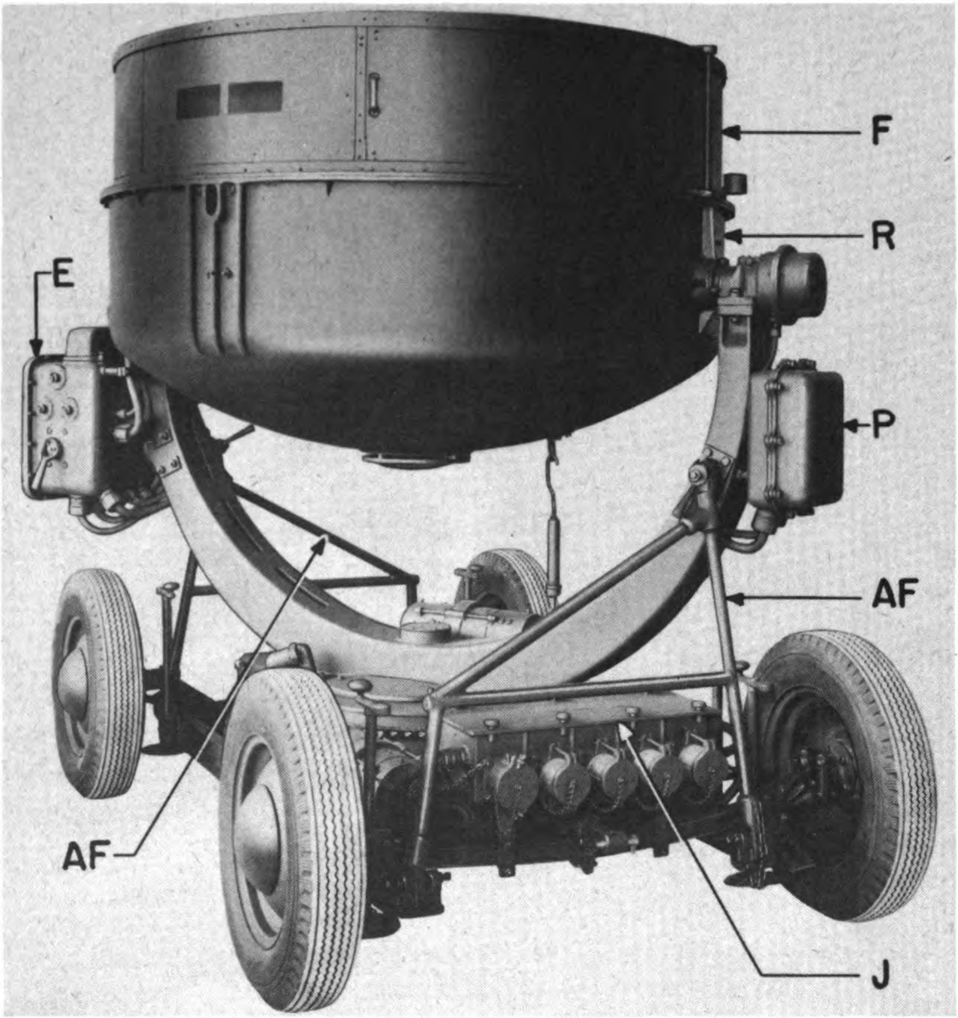



Fig. 2b. Searchlight in transportation position

| Ref. Letter | Designation | Paragraph Referring to Item |
|---|---|---|
| C | Chassis | 3 |
| J | Junction Box | 4 |
| B | Base | 5 |
| A | Azimuth Control Box | 6 |
| T | Turntable | 7 |
| E | Elevation Control Box | 8 |
| P | Elevation Amplifier Box | 9 |
| R | Rear Drum Section | 10 |
| F | Front Drum Section | 10 |
| L | Lamp and Lamp-mechanism Box | 11 |
| CB | Extended Hand Controller | 12 |
| CV | Canvas Cover | 13 |
| AF | "A" Frame | 13 |

# DESCRIPTION, CHASSIS EQUIPMENT

## 3. Chassis Equipment

The chassis equipment is shown in Fig. 3. The illustration in itself presents the obvious purpose of many of the details, and such items require no further description in this section. For operation, and for other details which may not be fully obvious, descriptive comments have been provided with the illustration.

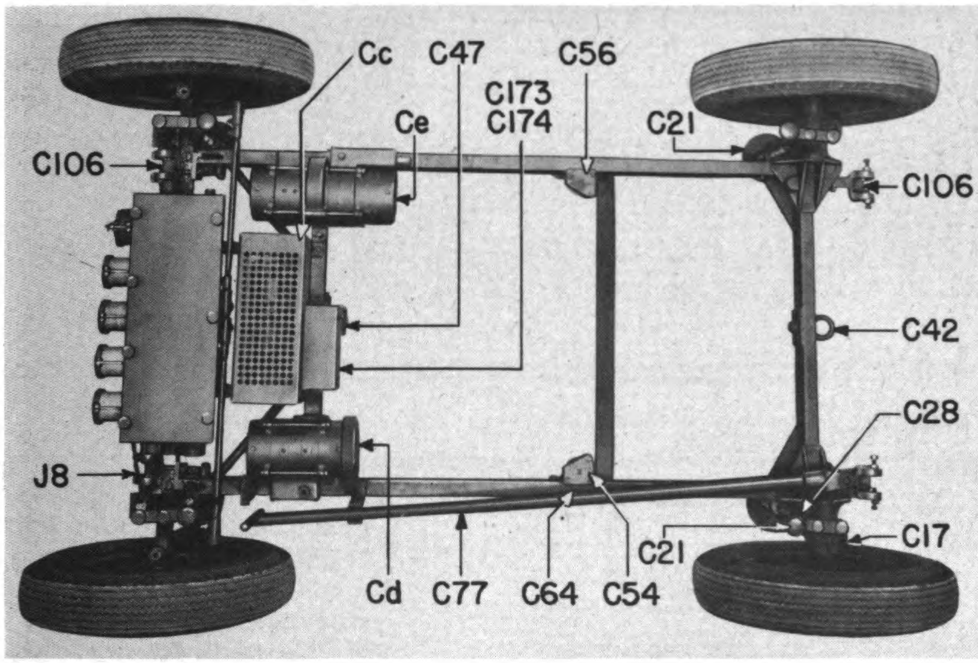



**Fig. 3. Chassis**

| Ref. No. | Designation | Purpose |
|---|---|---|
| Cc | Ballast-resistor Assembly | For compensation of various interconnecting power-cable lengths |
| C173, C174 | Ballas-resistor-tap Studs (200 ft, 400 ft, 600 ft) | |
| Cd | Dynamotor | For conversion of d-c to a-c |
| Ce | Azimuth Amplidyne Motor-generator | For supplying power to energize azimuth drive motor |
| C21 | Jackscrews | For leveling searchlights |
| J8, C28 | Jackscrew Chains | For securing jackscrews in their raised position |
| C42 | Eyebolt | For attachment of transporting-vehicle loading line |
| C47, C54, C56 | Mounting Blocks | For supporting base assembly |
| C77 | Towing Bar | For towing searchlight by hand |
| C64 | Towing-bar Spring | For securing towing bar to chassis support |
| C17, C70, C71 | Hold-down Fixtures | For securing searchlight in transporting vehicle |
| C106 | Joint Supports | For attaching "A" frame |

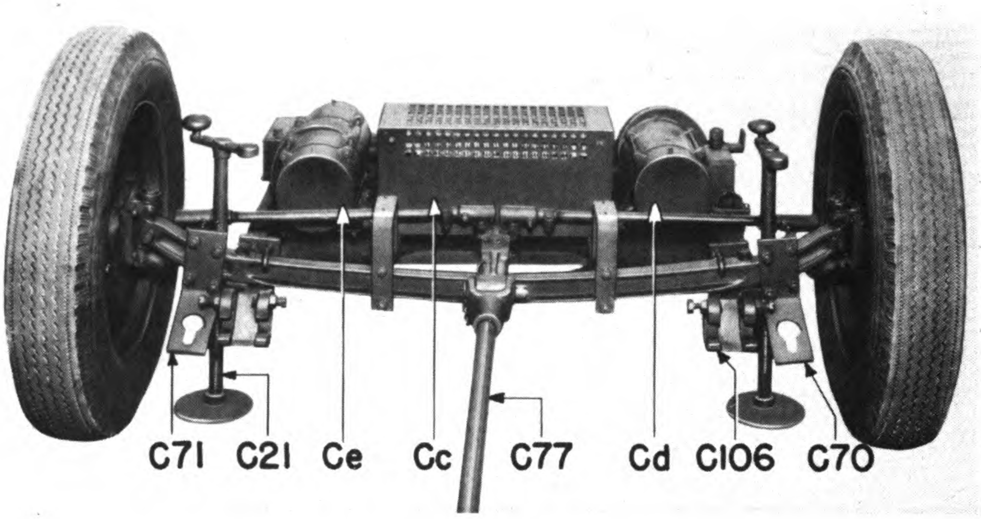



Fig. 3. Chassis (Cont'd)

| Ref. No. | Designation | Purpose |
|---|---|---|
| Cc | Ballast-resistor Assembly | For compensation of various interconnecting power-cable lengths |
| Cd | Dynamotor | For conversion of d-c to a-c for data indication and D.E.C. |
| Ce | Azimuth Amplidyne Motor-generator | For supplying power to energize azimuth drive motor |
| C21 | Jackscrews | For leveling searchlights |
| C77 | Towing Bar | For towing searchlight by hand |
| C70, C71 | Hold-down Fixtures | For securing searchlight in transporting vehicle |
| C106 | Joint Supports | For attaching "A" frame to chassis during transportation |

## 4. Junction Box

The junction box, Fig. 4, is located at the front of the chassis. It acts as the receiving box for all the cables to the searchlight, and also houses the searchlight signal buzzer, protecting fuses, voltage-adaptation equipment, and terminals for conductor interconnections.

# DESCRIPTION, JUNCTION BOX

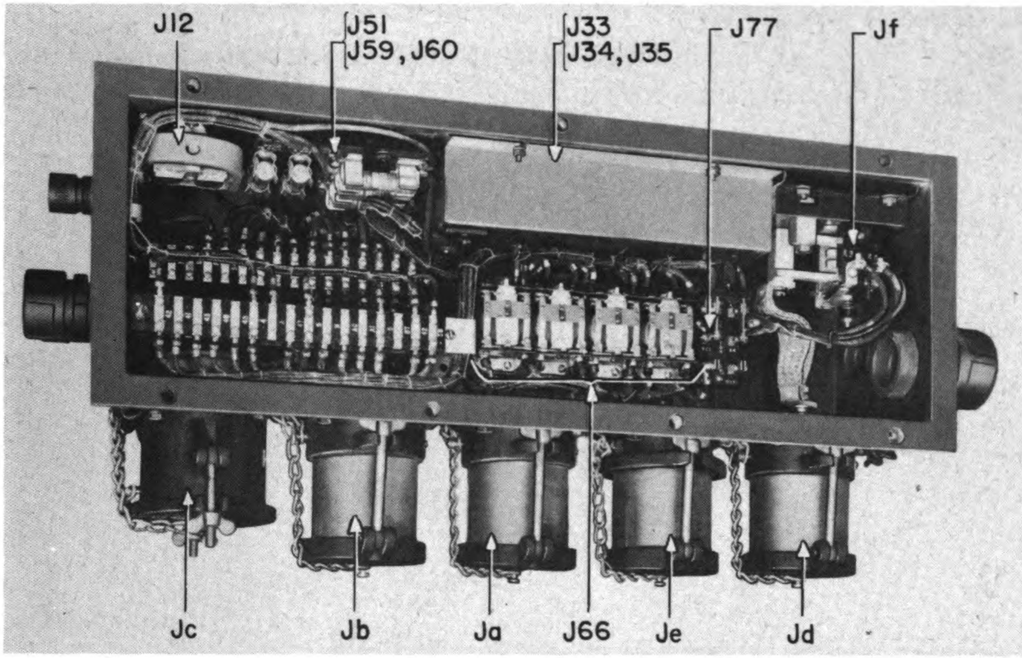



**Fig. 4. Junction box**

| Ref. No. | Designation | Purpose |
|---|---|---|
| Ja | Cable Receptacle | To receive 15-conductor cable from control station |
| Jb | Cable Receptacle | To receive 15-conductor cable from locator (1- and 33-speed) |
| Jc | Cable Receptacle | To receive 9-conductor cable from locator (1-speed only) |
| Jd, Je | Cable Receptacles | To receive positive and negative cables from power plant |
| Jf<br>J34, J35 | Voltage-adapter Relay<br>Voltage-adapter Resistors | To maintain substantially the same voltage at dynamotor for arc and control loads |
| J33 | Resistor Housing | To enclose voltage-adapter resistors |
| J12 | Signal Buzzer | To receive signals from locator or control station |
| J51 | Fuse-board Assembly | To hold fuses |
| J59 | 15-ampere Fuses | To protect dynamotor d-c input circuit, azimuth d-c power circuits; one spare |
| J60 | 5-ampere Fuses | To protect dynamotor a-c output circuit; one spare |
| J66 | D.E.C. Transfer Relays | For transfer between Automatic and Manual D.E.C. operation |
| J77 | A-c-supply Selector Switch | To transfer a-c supply source between DYNAMOTOR and EXTERNAL |

## 5. Base Assembly

Fig. 5 illustrates, and the associated references describe, the major components of the base assembly.

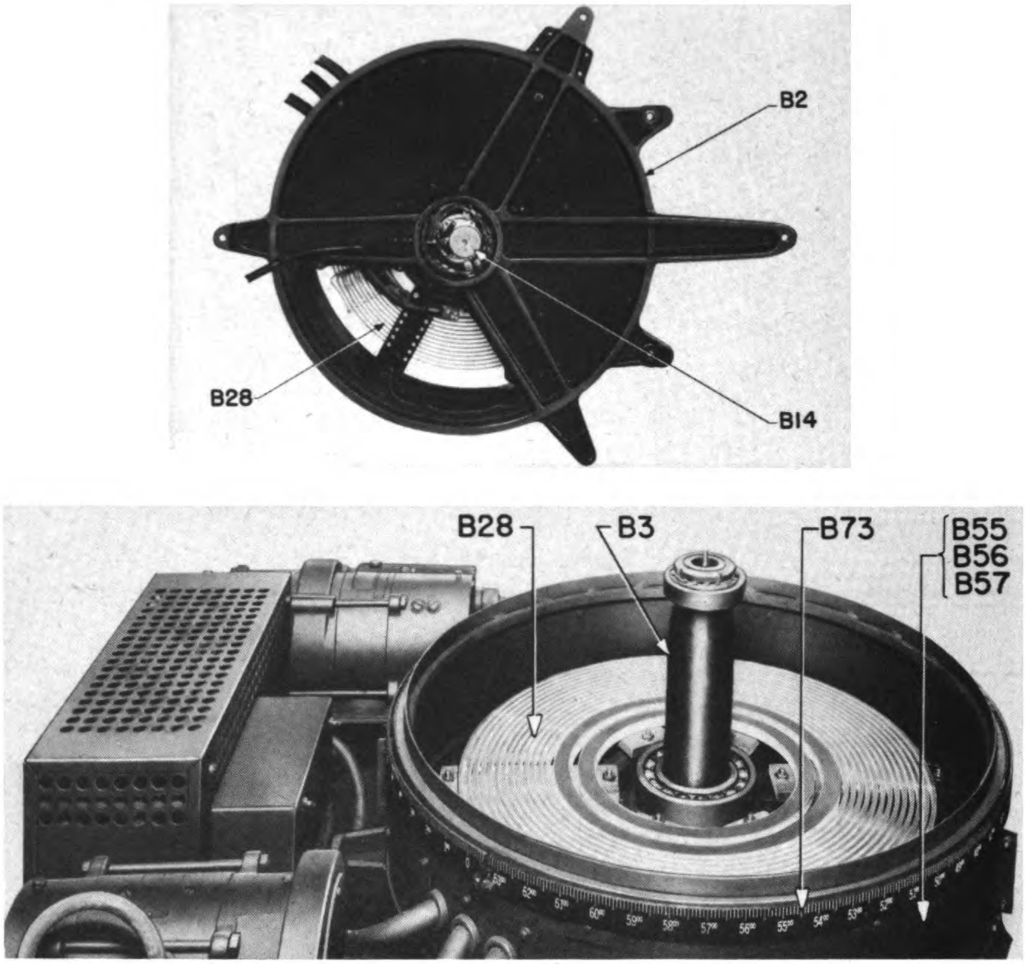



Fig. 5. Searchlight base

| Ref. No. | Designation | Purpose |
|---|---|---|
| B2 | Base Casting | For support of turntable |
| B55, B56, B57 | Base-housing Plates | To protect collector rings |
| B28 | Collector-ring Assembly | To transmit arc and control voltages from base to turntable |
| B73 | Azimuth Scale | To indicate searchlight position in azimuth (mils or degrees) |
| B14 | Azimuth 1-speed Control Transformer | To supply voltage to azimuth 1-speed zero-reader indicator and to azimuth amplifier when searchlight is not synchronous with locator or control station |
| B3 | Spindle | To house control-transformer assembly |

# DESCRIPTION, AZIMUTH CONTROL BOX

## 6. Azimuth Control Box

The azimuth control box with its mechanical and electrical elements are illustrated in Fig. 6.

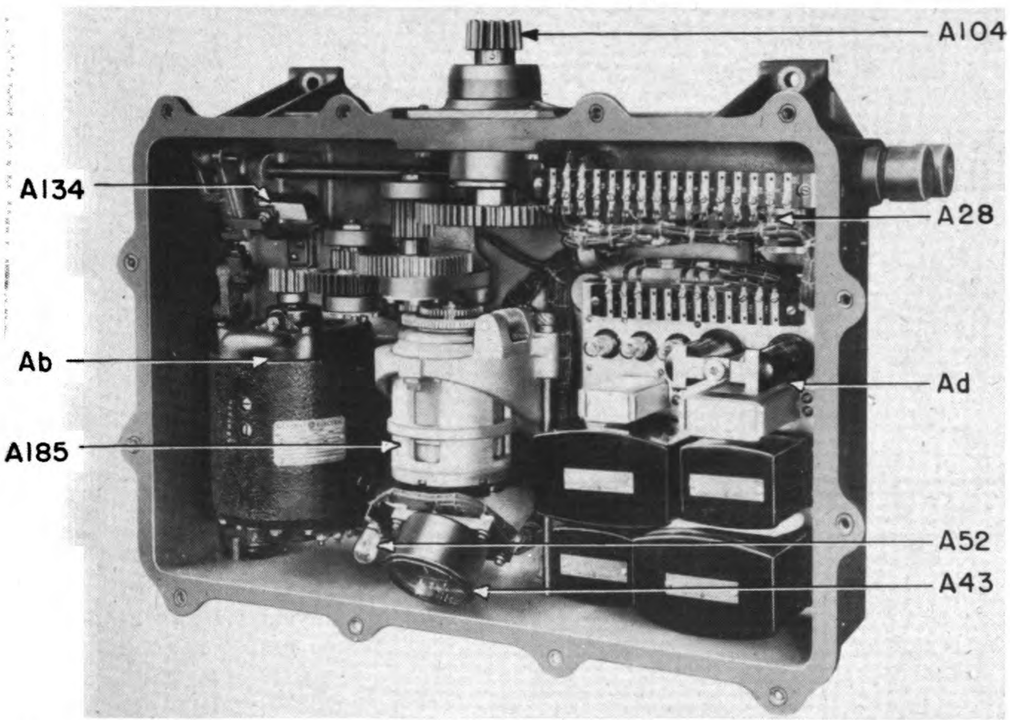



Fig. 6. Azimuth control box

| Ref. No. | Designation | Purpose |
|---|---|---|
| Ab | Azimuth Drive Motor | To rotate searchlight in azimuth |
| Ad | Azimuth Amplifier | To convert signal voltage from azimuth control transformers into control-field voltage for azimuth amplidyne motor-generator |
| A134 | Clutch Switch | To de-energize control circuit during HAND operation |
| A104 | Pinion | To rotate turntable in azimuth |
| A28 | Control Contactor | To de-energize azimuth drive motor |
| A43 | Azimuth 33-speed Zero Indicator | To indicate adjustment of 33-speed azimuth D.E.C. system |
| A52 | Instrument Lamp | To illuminate zero indicator |
| A185 | Azimuth 33-speed Control Transformer | To supply voltage to azimuth 33-speed zero-reader indicator and to azimuth amplifier when searchlight is not synchronous with locator |

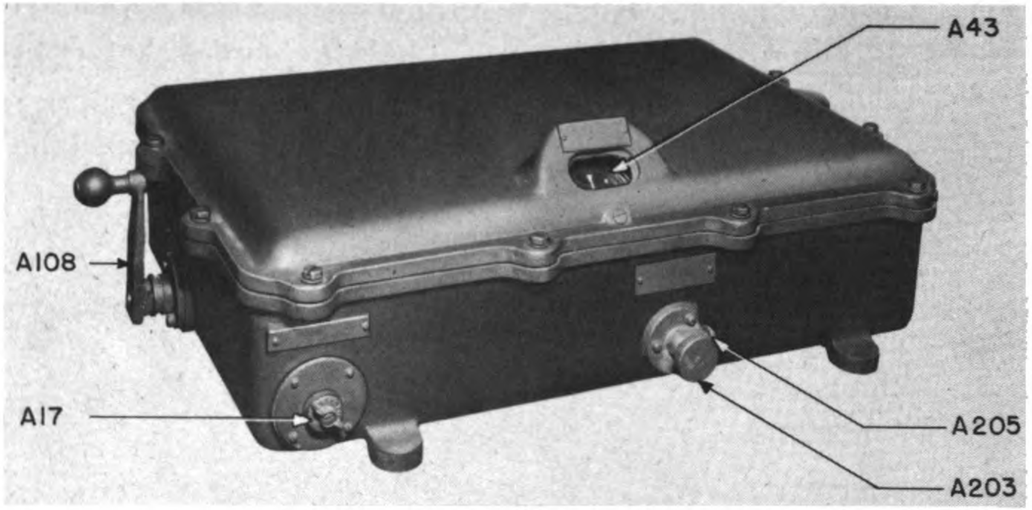



**Fig. 6. Azimuth control box (Cont'd)**

| Ref No. | Designation | Purpose |
|---|---|---|
| A17 | Azimuth Amplidyne Switch | To start and stop azimuth amplidyne motor-generator and azimuth drive motor |
| A43 | Azimuth 33-speed Zero Indicator | To indicate adjustment of 33-speed azimuth D.E.C. system |
| A203 | Azimuth 33-speed Corrector | To adjust 33-speed azimuth D.E.C. system |
| A205 | Thumbscrew | (To adjust 33-speed azimuth D.E.C. system) |
| A108 | Azimuth Clutch-lever Assembly | To make and break electrical and mechanical connections in switching from HAND to D.E.C. operation |

## 7. Turntable

Fig. 7 shows the main parts constituting the turntable assembly.

| Ref. No. | Designation | Purpose |
|---|---|---|
| Tf | Elevation-scale Lamp | To illuminate elevation pointer and scale |
| T78 | Elevation Pointer | To indicate position of drum in elevation |
| T50 | Levels | To indicate whether searchlight is level |
| Th | Elevation Stowing Spring | To secure drum in elevation during transportation |
| T90 | Stowing-spring Storage Hook | To support stowing spring while searchlight is in operation |
| Tk | "A"-frame Clamp Assembly | To attach "A" frames to turntable arms during transportation |

# DESCRIPTION, TURNTABLE

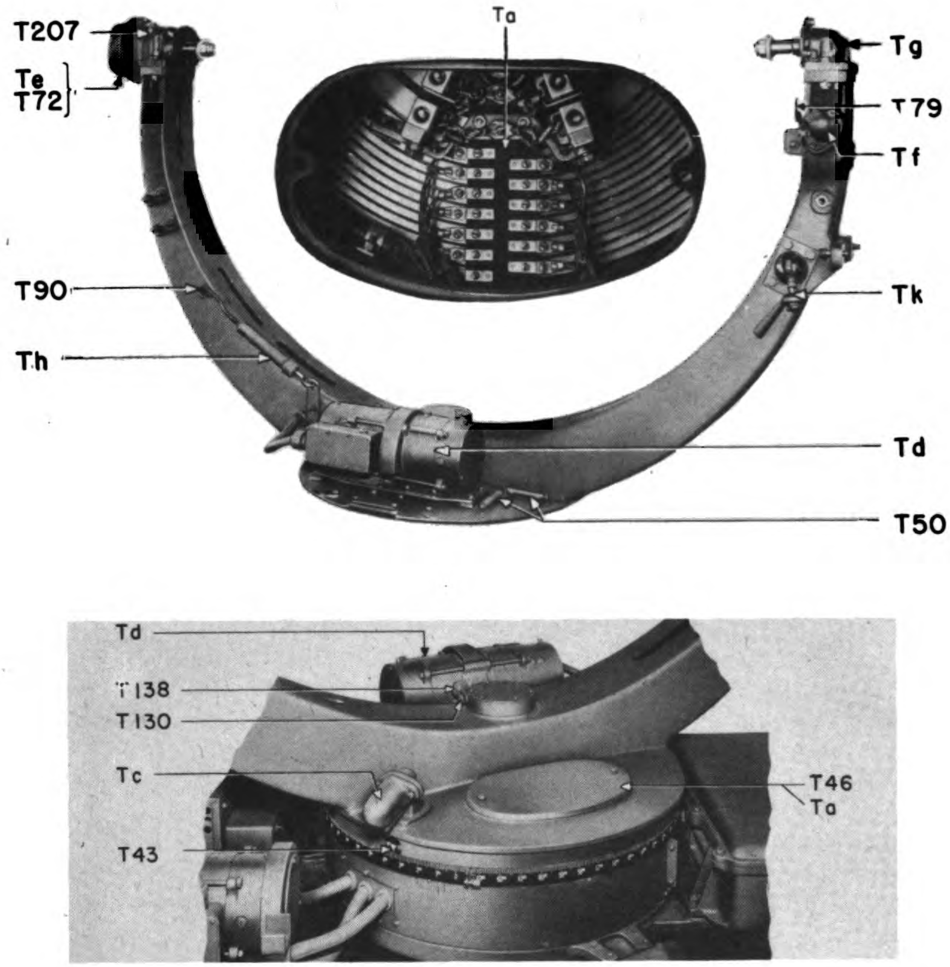



**Fig. 7. Searchlight turntable**

| Ref. No. | Designation | Purpose |
|---|---|---|
| Ta | Collector-ring Brush Assembly | For transmitting arc and control voltages from collector rings to turntable |
| T46 | Inspection Plate | To provide access to brush and collector-ring assemblies |
| Tc | Azimuth-scale Lamp | To illuminate azimuth scale |
| T43 | Azimuth Pointer | To indicate azimuth position of turntable |
| T138 | Azimuth 1-speed Corrector | To adjust and clamp azimuth 1-speed control transformer |
| T130 | Corrector Clamp | |
| Te, T72 | Control Transformer and Trunnion-bearing Housing | To support drum on turntable and to house elevation 1-speed control transformer |
| Tg | Trunnion Bearing and Housing | To support drum on turntable |
| Td | Elevation Amplidyne Motor-generator | To supply energizing power to elevation drive motor |
| T207 | Elevation 1-speed Corrector | To adjust elevation 1-speed control transformer |

## 8. Elevation Control Box

The elevation control box and its principal mechanical and electrical elements are illustrated by Fig. 8.

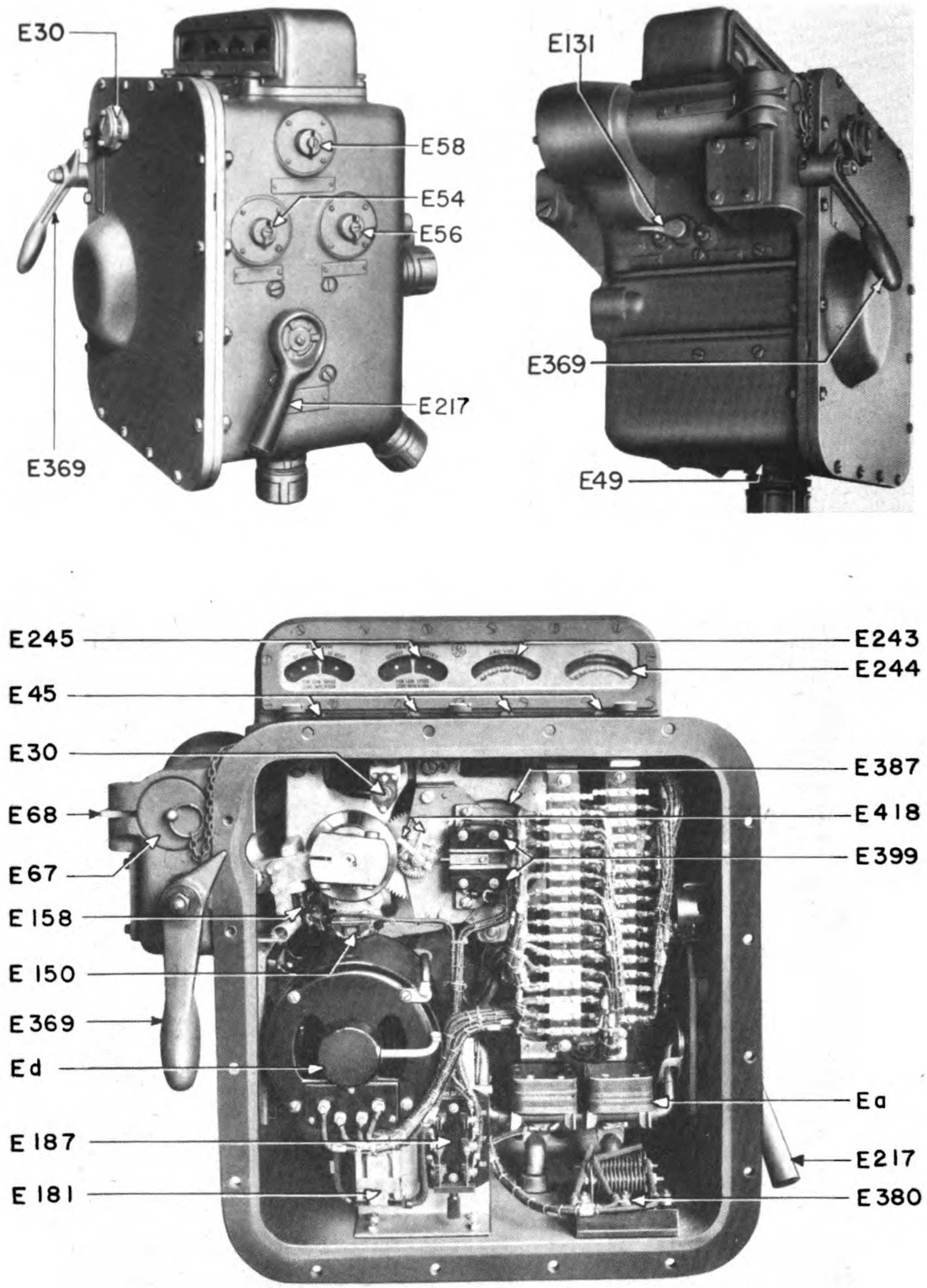



**Fig. 8. Elevation control box**

# DESCRIPTION, ELEVATION CONTROL BOX

| Ref. No. | Designation | Purpose |
|---|---|---|
| E217 | Arc-switch Handle | To operate arc switch |
| Ea | Arc Switch | To turn arc and arc-control circuits ON and OFF |
| E54 | Recarboning-lamp Switch | To operate recarboning lamp |
| E56 | Instrument-lamp Switch | To turn indicator and instrument lamps ON and OFF |
| E58 | Elevation Amplidyne Switch | To start and stop elevation amplidyne motor-generator |
| E131 | Elevation Clutch Lever | To make and break electrical and mechanical connections required in transfer between HAND and D.E.C. operation |
| E150 | Elevation Clutch Switch | To de-energize control circuit when clutch is disengaged |
| E369 | Elevation Brake Handle | To hold drum in any desired position in elevation |
| E158 | Elevation Brake Switch | To de-energize control circuit when brake is set |
| E418 | Elevation Electrical-limit Arms | To operate upper and lower limit switches |
| E399 | Upper- and Lower-limit Switches | To electrically stop drum travel before the mechanical stops |
| E68 | Extended-hand-controller Socket Latch | To secure extended hand controller into socket |
| E67 | Socket Cover | To close socket when extended hand controller is not in use |
| Ed | Elevation Drive Motor | To rotate drum in elevation |
| E387 | Elevation 33-speed Control Transformer | To supply voltage to elevation zero indicator and elevation amplifier when searchlight is not synchronous with locator |
| E243 | Voltmeter | To indicate supply voltage |
| E244 | Ammeter | To indicate arc, lamp-mechanism, and ventilating-motor current |
| E245 | Zero-indicator Instruments | To indicate zero adjustment for searchlight in elevation and in azimuth (1-speed) |
| E187 | Elevation Zero-indicator Selector Switch | To enable elevation zero indicator to read either 33 or 1 speed |
| E45 | Instrument Adjusting Screws | To allow adjustment of instrument pointers without removing housing cover |
| E30 | A-c Indicating Lamp | To indicate when a-c power is available |
| E181 | Control-contactor Relay | To de-energize elevation drive motor |
| E380 | Dry-disk Rectifiers | To rectify current through limit switches |
| E49 | D-c Receptacle | To supply voltage for portable trouble lamp |

## 9. Elevation Amplifier

The elevation electronic amplifier and fuse board are illustrated in Fig. 9.

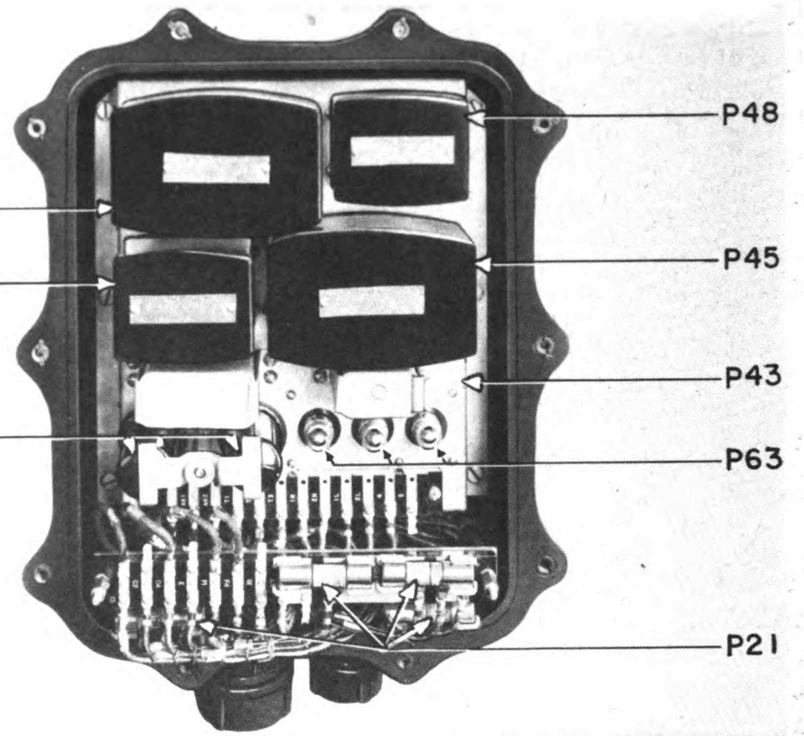


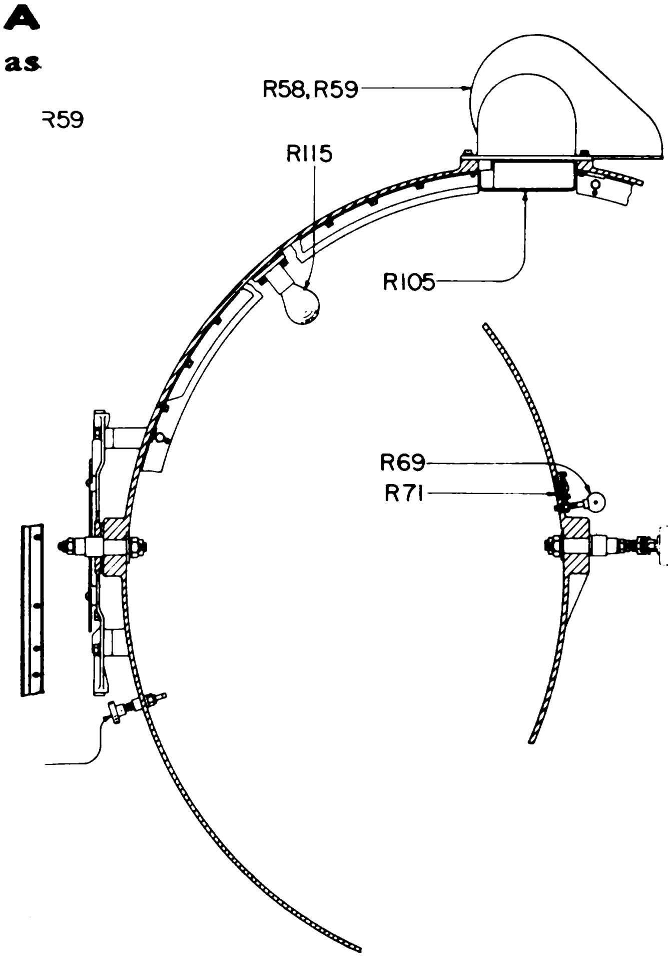

Fig. 9. Elevation amplifier

| Ref. No. | Designation | Purpose |
|---|---|---|
| P43 | Elevation Amplifier | To convert voltage from elevation control transformers into control-field voltage for elevation amplidyne motor-generator |
| P47 | 1-speed Input Transformer | To introduce signal from 1-speed control transformer |
| P48 | 33-speed Input Transformer | To introduce signal from 33-speed control transformer |
| P45 | Power Transformer | To bring a-c power to the amplifier |
| P46 | Reactor | Part of circuit which prevents hunting |
| P58 | 6L6 Vacuum Tubes | To rectify and amplify signal voltage |
| P63 | Neon Glow Lamps | To limit and switch input signal voltage |
| P21 | 15-ampere Fuses | To protect elevation d-c power circuits and auxiliary d-c circuits (two spares) |

## '42 SEARCHLIGHT AND CONTROL STATION

### 10. Drum A

The drum as

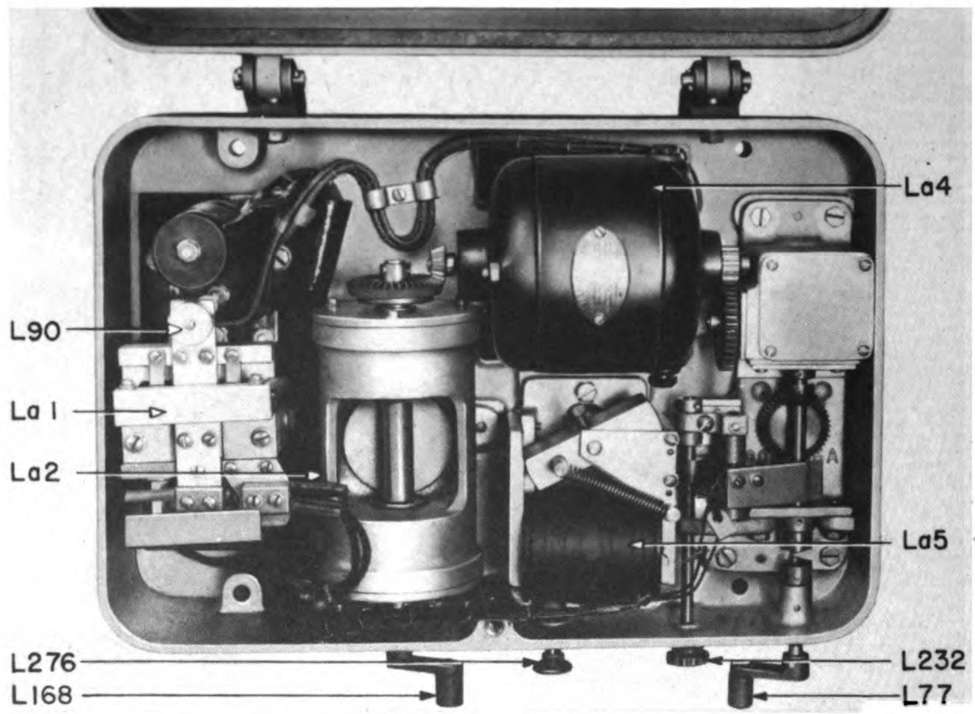



· Drum Section

| Ref. No. | | No. | Designation | Purpose |
|---|---|---|---|---|
| F | F | 23 | Elevation Rack | To move drum in elevation |
| | | 50 | Focusing Knob | To move lamp along mirror focal axis |
| F1a | D | R59 | Ventilating Fan and Housing | To obtain suitable ventilation and cooling of drum interior |
| F29 | G | F23 | Orientation Sight | To assist in orienting searchlight with the associated equipment |
| F56 | I | 97 | Mirror | To reflect searchlight arc into a beam |
| F57 | V | R105 | Ventilating Ducts | To properly direct ventilation |
| | | 115 | Recarboning Lamp | To provide illumination for recarboning at night |
| F70 | F | | | |

## 11. Lamp and Lamp-mechanism Assembly

Fig. 11 illustrates the searchlight arc lamp and the lamp-mechanism box, and the tabulation refers to the principal mechanical and electrical subassemblies. Drive shafts, universal joints, and the insulated couplings which connect the lamp mechanism to the lamp are not illustrated here; nor is the lamp column which supports the lamp inside the drum. Their purpose, however, is obvious and they will be discussed in later portions of this manual.



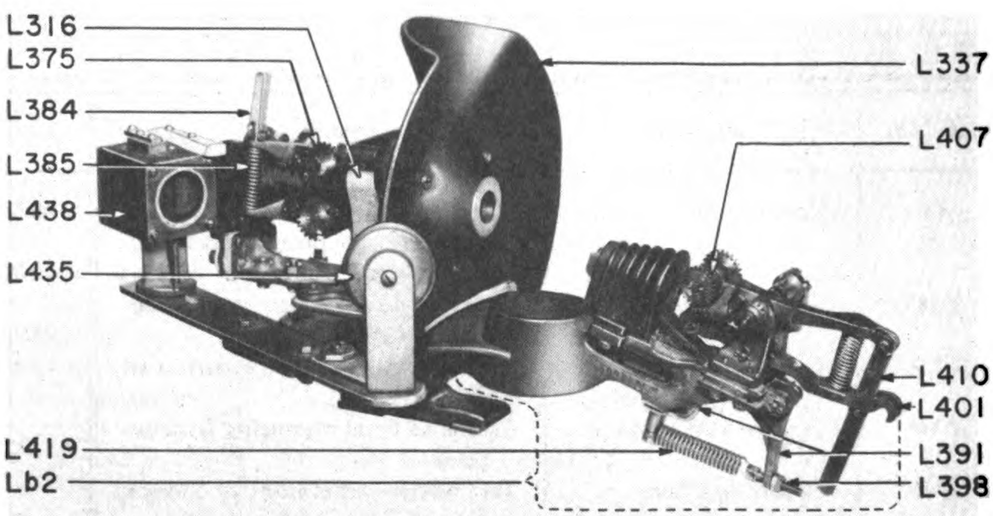




Fig. 11. Lamp and lamp-mechanism box

# DESCRIPTION, EXTENDED HAND CONTROLLER

## 12. Extended Hand Controller

The extended-hand-controller assembly is adequately shown in Fig. 2. This controller is provided for manual directional control in the event of failure of the distant-electric-control system. The primary purpose of such a device is to place the operating observer at the maximum practical distance from the light source in order that the target may be more easily viewed.

## 13. Canvas Cover and "A" Frame

A canvas cover, as shown in Fig. 2, is provided to afford protection for the searchlight during a prolonged emplacement in the field. The canvas cover is so made that it can be placed over the drum and lashed to the chassis. The "A" frames are also shown in stowage and in transportation position in Fig. 2.

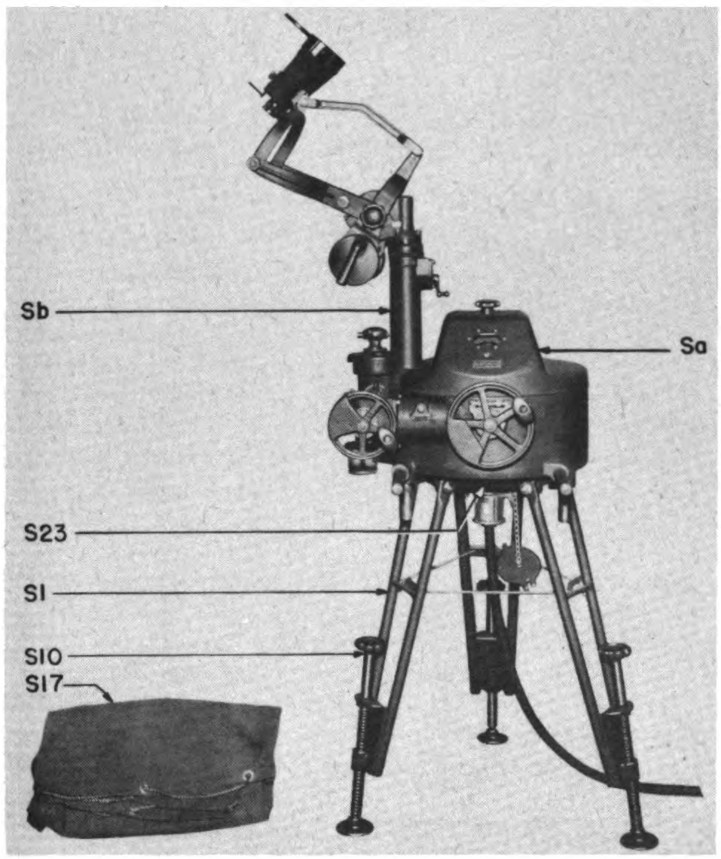



Fig. 12. Control-station assembly

| Ref. No. | Designation | Paragraph Referring to Item |
|---|---|---|
| S1, S10 | Tripod with Jackscrews | 15 |
| Sa | Controller | 15 |
| S23 | Controller Base | 15 |
| Sb | Binocular Mount | 16 |
| S17 | Canvas Cover | 17 |

# CONTROL STATION

## 14. General Assembly

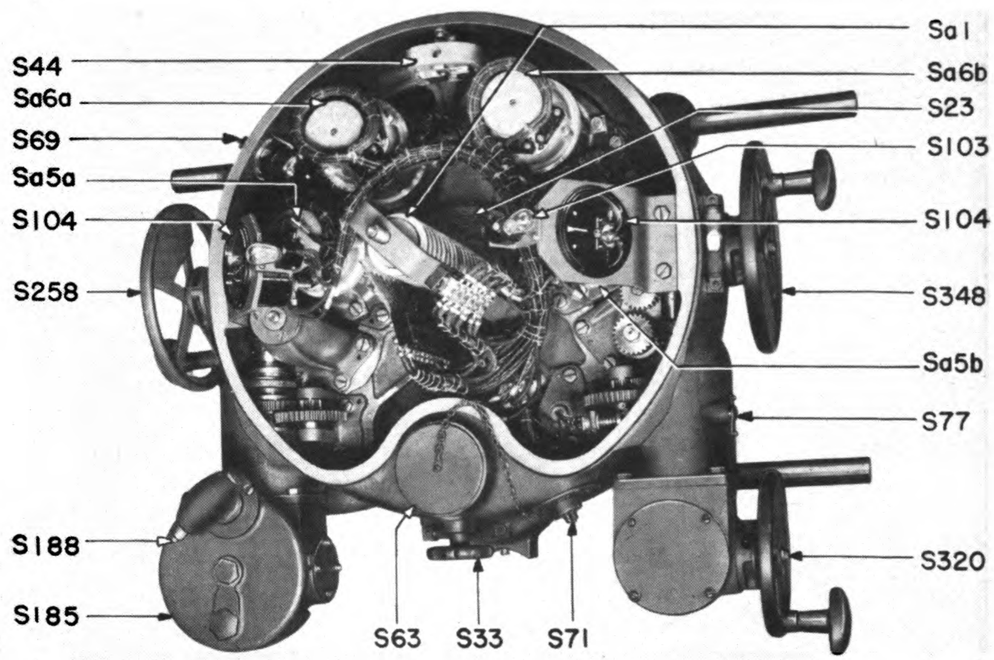
The control station is identified in this book by the reference letter "S." General assembly of this item is shown in Fig. 12, and references to its various parts are given in the associated tabulation.

## 15. Controller Assembly

Fig. 13 shows the essential mechanical and electrical operational elements of the controller. The tripod is sufficiently illustrated in Fig. 12. The controller base rests on, and remains in fixed relation to, the tripod during operation.

| Ref. No. | Designation | Purpose |
|---|---|---|
| S118 | Contact Plugs | To connect control-cable plug |
| S31 | Controller Feet | To support unmounted controller |
| S32 | Carrying Bars | To manually handle controller |
| S66 | Levels | To indicate proper control-station level |
| S23 | Controller Base | To support controller on tripod |
| Sa4 | Controller Cover | To cover and protect controller mechanism |
| S22 | Controller Housing | To enclose controller mechanism |
| Sa1 | Contact-cylinder Assembly | To transmit current from receptacle to controller |
| S33 | Binocular-mount Clamp | To lock binocular mount in place |
| S77 | Buzzer Switch | To signal searchlight operator |
| S44 | Signal Buzzer | To receive signals from locator |
| S71 | D.E.C. Transfer Switch | To change from AUTOMATIC D.E.C. to MANUAL D.E.C. operation |
| S258, S348 | Zero-reader-operators' Handwheels | To direct searchlight beam and binocular field on observed target |
| S104 | Zero-reader Instruments | To provide visual means for checking synchronism between locator and control station |
| S158 | Instrument Adjustment Caps | To permit pointer adjustment without removing cover |
| S103 | Indicator Lamps | To illuminate zero-reader instruments |
| S69 | Indicator Lamp Switch | To control indicator lamps |
| S105, S320 | Observer's Handwheels | To direct searchlight beam and binocular field on observed target |
| Sa5a | Azimuth Transmitter | To supply control voltage for searchlight D.E.C. |
| Sa5b | Elevation Transmitter | |
| S63 | Binocular-mount-socket Cover | To cover and protect binocular mount socket when not in use |

# DESCRIPTION, CONTROL STATION



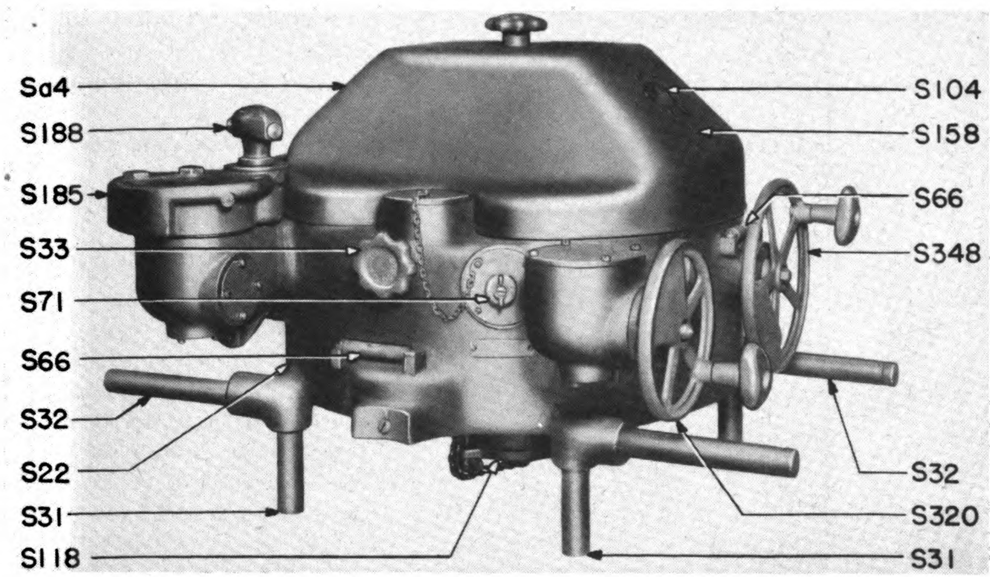




Fig. 13. Controller

| Ref. No. | Designation | Purpose |
|---|---|---|
| Sa6a<br>Sa6b | Azimuth Control Transformer<br>Elevation Control Transformer | To supply voltage to zero-reader instruments when control station is not in directional synchronism with locator |
| S188 | Ratio Shifter | To change azimuth observer's handwheel from 1-speed to 33-speed drive |

## 16. Binocular-mount Assembly

The principal operating mechanisms of the binocular-mount assembly are shown in Fig. 14.

## 17. Canvas Cover

A canvas cover, illustrated in Fig. 12, is provided to afford protection for the control station during any prolonged emplacement in the field.

| Ref. No. | Designation | Purpose |
|---|---|---|
| S457<br>S496 | Gear Box<br>Zero-elevation Index | To enclose gears and indicate zero-elevation position of binoculars |
| S429 | Height-adjustment Crank | To raise or lower binocular-mount linkage |
| S438 | Elevating Coupling | To elevate binoculars and open sight |
| S479 | Linkage Clamp | To adjust friction in linkage of elevation drive |
| S474, S476, S488, S489 | Linkage | To align binoculars in elevation with searchlight beam |
| S498 | Linkage Pin | To lock linkage in either operating or stowing position |
| S483 | Adjusting Handles | To position binoculars in relation to the elevation drive |
| S16 | Open Sight | To provide an indication for direct observation of field illuminated by searchlight beam |
| ........ | Binoculars | To aid observer in viewing illuminated field. (They are not supplied by searchlight manufacturer, and are shown here for information only.) |
| ........ | Clamp Screw | To clamp open sight and binoculars to linkage |
| S494 | Binocular-mounting-support Block | To hold the binoculars and open sight in position on the binocular mount |

## DESCRIPTION, BINOCULAR MOUNT

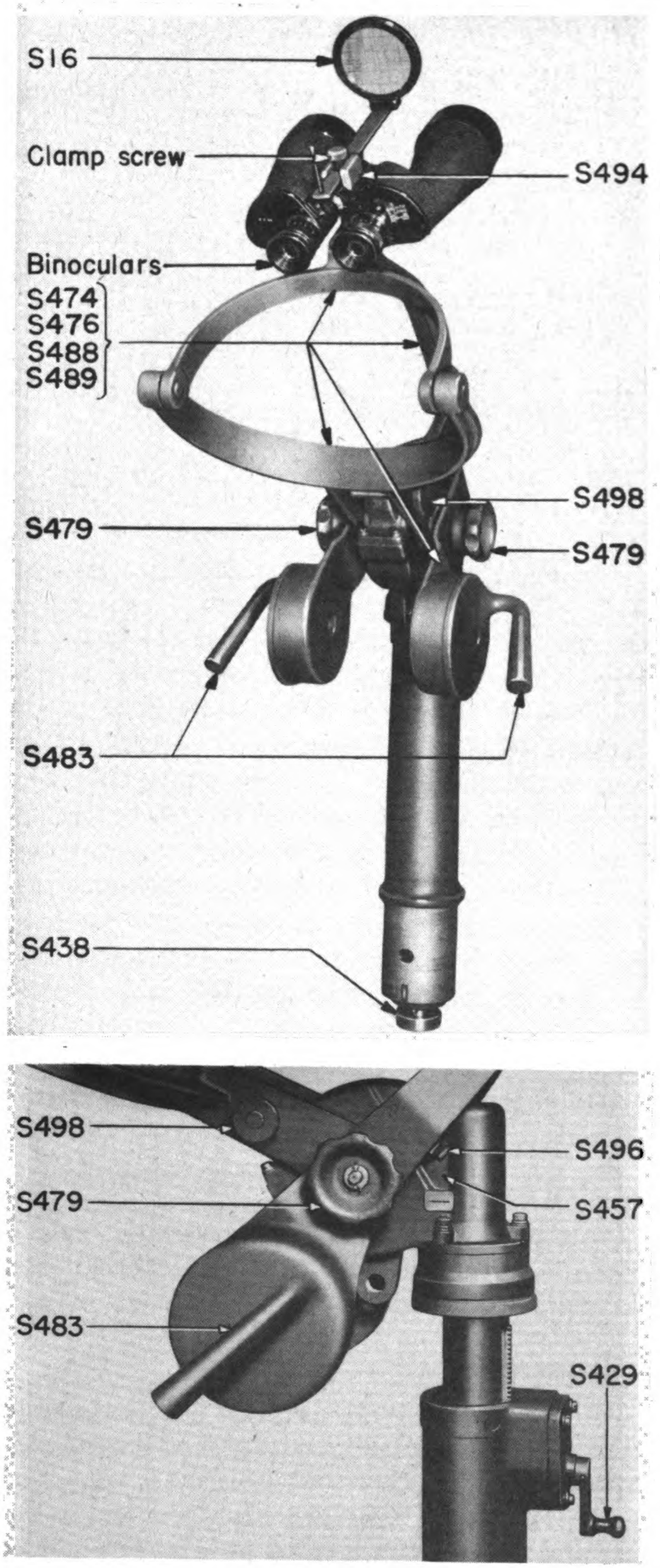



Fig. 14. Binocular mount

# INTERCONNECTING CABLES AND MISCELLANEOUS EQUIPMENT

## 18. Cables

Interconnecting-cable assemblies for use with this searchlight equipment consist of the following:

| Type | Ref. No. | Nominal Length in Feet | Number of Conductors |
|---|---|---|---|
| Power-Positive | CP2 | 200 | 1 |
| Power-Negative | CP3 | 200 | 1 |
| Control | CP4 | 300 | 15 |

In addition, a nine-conductor cable or a fifteen-conductor cable, furnished with the locator equipment, is required for connection between the locator and the searchlight. This fifteen-conductor cable is keyed differently from the fifteen-conductor cable used between the searchlight and the control station, so that interchange of these cables is impossible. The plugs are so arranged that their insertion in, or withdrawal from, their proper sockets must be done by grasping the plug bodies. An attempt to withdraw a plug by pulling on the cable may result in broken conductors. All plugs must be securely locked in place by means of their associated wing nuts. Male plugs for all cables are provided with protective caps which must be firmly attached in place over the plug skirts as soon as the cable is disconnected. This will prevent damage such as the skirt being forced out of round. A tough, flexible sheath has been applied to both power and control cables; care, however, should be exercised to prevent damage to the sheath and to avoid sharp bends or kinks in the cable.

## 19. Miscellaneous Equipment

Spare parts, tools, protective boxes, cable reels and replacement carbons are supplied with the searchlight equipment. A general description of each of these subassemblies is provided by the directly following paragraphs.

## 20. Spare Parts and Tools

Searchlight and control-station spare parts and tools, together with the associated tool box and transporting case, form a separate single item of the equipment as shown in Fig. 1. Parts and tools are listed upon the inner side of the tool-box cover, and, for reference, are also listed in the Maintenance Manual. The purpose of each item is either apparent or will be described in this text or in the Maintenance Manual.

## DESCRIPTION, MISCELLANEOUS EQUIPMENT

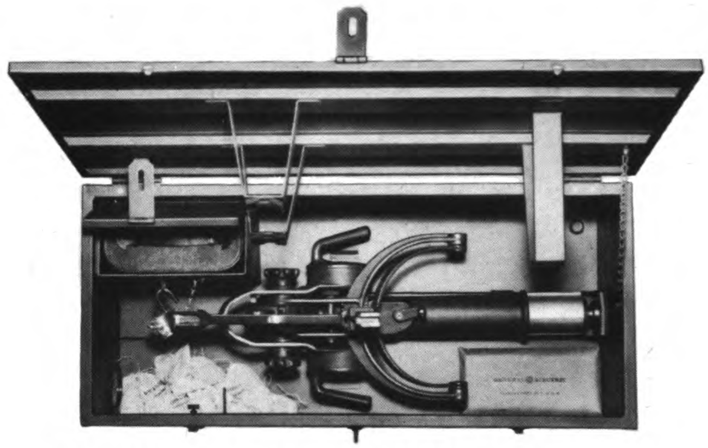


Fig. 15. Binocular-mount box

### 21. Binocular-mount Stowage Box

The binocular-mount stowage box, with the binocular mount, open sight, envelope of connection prints, free-issue bags of extra screws, etc., and the binoculars, all in their proper places, is shown in Fig. 15.

### 22. Cable Reels

Cable reels are provided for each class of interconnecting cables. (Refer to Fig. 1.) Those for the locator cables are supplied with the locator equipment and are, therefore, not subject to further comment in these instructions. The other reels are provided with wooden shipping ends, bolted to the reel flanges. The shipping-end assembly may be retained with searchlight equipment not provided with transportation auxiliary reel racks. Shipping ends provide ample ground clearance for rolling or moving the cable and reel assembly. For equipment with reel racks, the shipping ends serve for the initial cable shipment only, and should be removed upon receipt of the cable by the using organization.

### 23. Replacement Carbons

A metal container holding 25 pairs of replacement carbons is supplied with each searchlight unit. Description of these high-intensity carbons is as follows:

| Classification | Diameter Inches | Length Inches | Nominal Burning Rate per Hour, Inches |
|---|---|---|---|
| Positive | 0.633 | 22 | 10.1 |
| Negative | 0.433 | 12 | 4.4 |

# TRANSPORTATION

## 24. General Loading and Stowing

The searchlight equipment, with the exception of the power plant which is towed, is transported on certain vehicles which are not furnished directly with the searchlight proper. The proper sequence for loading the searchlight and locator items depends upon the equipment involved, and separate instructions will apply in this respect. The following instructions are for transportation arrangement of the searchlight equipment. For emphasis certain precautionary measures are printed in capital letters. Reference to transportation of the power plant will also be made, for the sake of simplicity, in this part of the instructions.

### a. Cables

Disconnect all interconnecting-cable plugs from their associated receptacles. Clamp the plug caps and receptacle caps in place as directed in Paragraph 18, and assemble each cable upon its respective transporting reel. Exercise care in placing the cable upon the reel and avoid, as far as practicable, dragging the cable over the ground.

### b. Searchlight

(1) Remove the carbon stubs from the lamp. BE SURE THAT THE VARIOUS LAMP-MECHANISM DRIVE RODS AND THE FOCUSING-DRIVE-ROD COUPLINGS ARE SECURELY IN PLACE, SO THAT THE RODS CANNOT DROP UPON THE MIRROR AND DAMAGE ITS REFLECTING SURFACE. CLOSE THE DRUM ACCESS DOOR.

(2) RELEASE ELEVATION BRAKE E369, SET ELEVATION CLUTCH LEVER E131 TO "HAND" POSITION, AND SET AZIMUTH CLUTCH LEVER A109 TO "HAND" POSITION. FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN DAMAGE TO THE ELEVATION-RACK OR RING-GEAR TEETH.

(3) Place the drum at approximately 1600 mils (90 degrees) in elevation, and engage elevation stowing spring Th with the stowing-spring lug on the rear of the drum. Rotate the turntable until the elevation control box is over the right side of the chassis and the turntable arms are approximately parallel to the front axle. (The junction-box end of the chassis is assumed to be the front end, and the dynamotor side of the chassis the left side.) Make certain that the searchlight chassis is level as indicated by the levels T50, and make any necessary adjustments by the jackscrews C21 to provide this level position before securing the "A" frames to the turntable arms. Engage the "A" frames with the chassis joint supports C106. Swing the "A" frames up and tightly secure them to the turntable arms with their respective "A"-frame clamps, moving the searchlight in azimuth as necessary.

(*a*) It may be found that even though the turntable levels indicate that the turntable is level, the socket on the upper end of each "A" frame may not be on the same level as the corresponding clamp assembly on the turntable arm, and as a result the "A" frame cannot be secured to the turntable arm. If the sockets on both "A" frames are higher than their corresponding clamp assemblies on the turntable arms, turn either the right-rear jackscrew or the left-front jackscrew in a counterclockwise direction to lower the chassis or turn either the left-rear jackscrew or the right-front jackscrew clockwise to raise the chassis until the sockets engage their respective clamp assemblies. If the sockets are lower than the clamp assemblies, turn one of the jackscrews in the opposite direction to that given above until the sockets engage their respective clamp assemblies. After both "A" frames have been secured to the turntable, raise all of the jackscrews and secure them with their locking chains.

(4) Place the searchlight in position for loading, and attach the loading line to the chassis eyebolt. The towing bar should be used to assist in guiding the searchlight during the loading procedure.

(5) Load the searchlight and secure it in place on the transporting vehicle by FIRM attachment of the vehicle turnbuckles to the chassis hold-down fixtures. Lock the turnbuckles by means of their locking nuts. Remove the loading line from the chassis eyebolt.

(6) Stow and secure the towing bar on the searchlight chassis rack.

(7) Stow and secure the extended hand controller in the proper fixtures provided on the transporting vehicle.

(8) Fold the searchlight canvas cover and stow it at a suitable location on the transporting vehicle.

### c. Control Station

(1) Remove the binoculars and open sight from the binocular mount. Remove linkage pin S498 from the binocular mount. Collapse the linkage into its stowage position, and lock it in place by the linkage pin. Rotate the binocular mount until the yoke is over height-adjustment crank S429, raising the mount by means of the crank if necessary. Now lower the binocular mount until the yoke straddles the crank housing. Release binocular-mount clamp S33 at the controller, and remove the binocular mount from the controller socket. Place and clamp socket cover S63 in the socket opening. Carefully stow the binoculars, open sight, and binocular mount in the binocular-mount box shown in Fig. 15. Lock and stow this box in its proper place on the transporting vehicle.

(2) Release the three knurled thumbscrews on the underside of the tripod top. These screws are so arranged that release of the controller can be attained with the screws remaining attached to the tripod proper. The controller should be carried by the handles S32. Stow the controller in its proper place in the transporting vehicle.

(3) Unlatch the tripod leg braces, collapse the legs, and stow the tripod in its prescribed place on the transporting vehicle. Proper stowage may require certain adjustment of the tripod jackscrews.

(4) Fold the control-station canvas cover, and place it at a suitable location on the transporting vehicle.

### d. Miscellaneous

Completely assemble the spare parts and tools in the spare-parts and tool transporting case. Lock and stow the transporting case at its predetermined location in the transporting vehicle. Place the spare carbons in their container and place that in its rack.

### e. Power Plant

(1) Make sure that all the panel switches and the main power switch are in their OFF positions and that all the ventilating openings are closed and the hood doors locked.

(2) After the drawbar has been attached to the towing vehicle, the safety-brake chain should be attached to the eye on the safety-brake cable at the right front end of the power-plant chassis frame. The other end of the chain should be looped around the bumper or some other strong part of the towing vehicle, and the snap fastened in the chain.

(3) MAKE SURE THAT THE BRAKE HANDLE ON THE POWER PLANT IS IN ITS EXTREME FORWARD POSITION, FULLY RELEASED.

(4) Connect the power-plant lighting plug to the receptacle on the towing vehicle.

## 25. Unloading

Unloading the searchlight equipment is, of course, essentially the reverse of the procedure outlined above.

# EMPLACEMENT AND EQUIPMENT SETUP

## 26. Emplacement Location

Emplace the searchlight equipment as shown by Fig. 16. The locator or detector should be emplaced in accordance with the instructions contained in the Operator's Manual for that equipment. If a sound locator is used, care should be taken in selecting a site for the power plant, so that the ambient noise at the sound locator is minimized.

## 27. Equipment Setup

After the equipment is properly emplaced, the various components should be set up in the following order:

### a. Searchlight

(1) Place the towing bar on the chassis supports and secure it in place.

(2) Temporarily set elevation brake E369.

# EQUIPMENT SETUP, SEARCHLIGHT

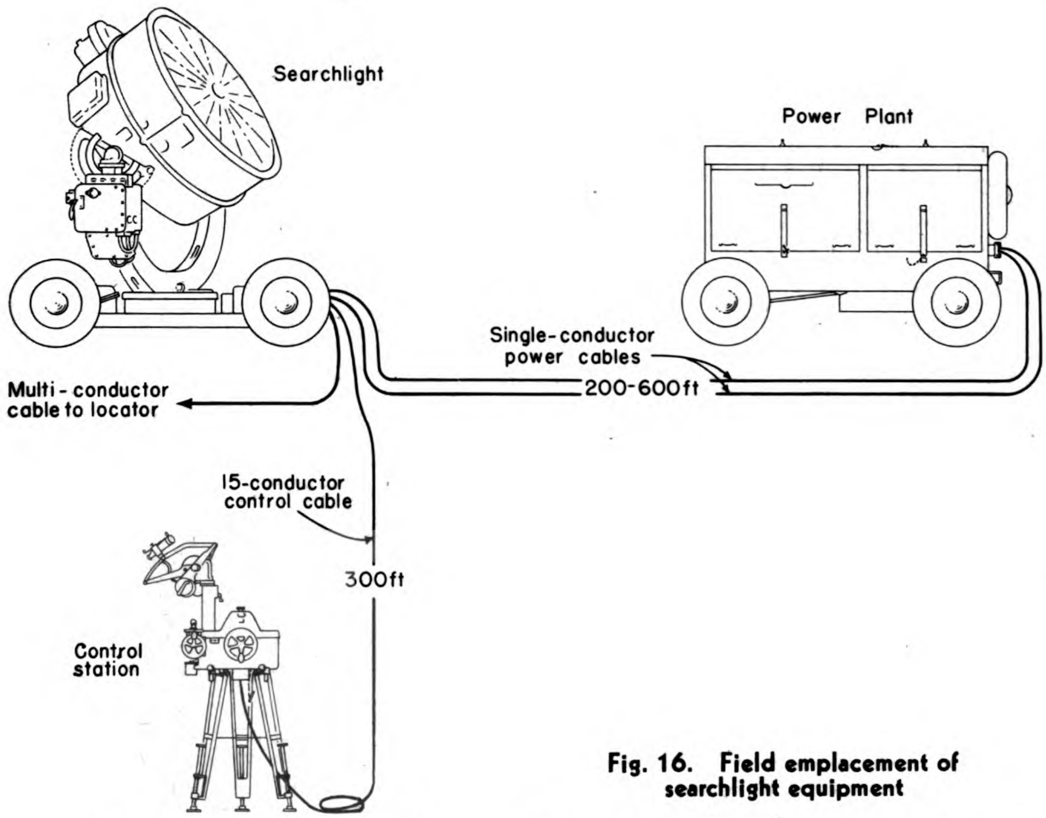



**Fig. 16. Field emplacement of searchlight equipment**

(3) Release the elevation stowing spring from the lug on the rear of the drum, and secure it to its storage hook T90 on the turntable arm.

(4) Release both "A" frames by loosening the clamps on the turntable arms. If the searchlight is standing on sloping or uneven ground, it may be necessary to remove the jackscrew locking chains and partially jack up the searchlight, following a procedure similar to that outlined in Paragraph 24b (3), before the "A"-frame sockets can be disengaged from their clamps. Swing the "A" frames downward to an approximately horizontal position and disengage the frames from the joint supports on the chassis. Store them on the ground under the chassis.

(5) Release the elevation brake, lower the drum to its approximate zero-elevation position, and reset the brake.

(6) Make sure that a firm support, such as solid ground, or rock or board reinforcement, exists at the jack-feet locations. Turn the searchlight drum in azimuth until it is pointed over the junction-box end of the chassis. Release the jackscrews by removing their chains. Level the chassis by screwing down the released jackscrews. The jackscrews must be lowered to such an extent that support of the searchlight will be removed from each of the wheel tires. Leveling of the searchlight with the drum in the preceding position will provide the most accurate leveling for all azimuth positions, although it will be noted that the level bubbles will not remain central at all azimuth positions with any leveling procedure.

**b. Control Station**

(1) Latch the leg braces in their retaining holes on the tripod, and make sure that the tripod is set firmly, and approximately level, in place.

(2) Place the controller in position on the tripod. Exercise care in this operation to see that the receptacle and the centering flange pass through the hole in the tripod top. Rotate the controller until the shoulders on the tripod top fit into the holes of the controller base. Should the controller base fail to turn with the controller, due to slippage of the azimuth clutch, lift the controller just enough to take its weight off the tripod while rotating it on top of the tripod, until the shoulders engage the holes. Secure the controller to the tripod with the three knurled thumbscrews on the tripod top.

(3) Remove the binocular-mount socket cover and attach it to its mount at the side of the controller.

(4) Check binocular-mount coupling S438 at the lower end of the column and see that it is free of sand or dirt.

(5) Note the position of the hole in the side of the binocular-mount column, and CAREFULLY insert the bottom of the column into the mount socket of the controller until the aligning slot engages the aligning key. Lower the binocular mount slowly, using a slight oscillatory motion of elevation handwheel S320 to find when the couplings engage. Turn binocular-mount clamp knob S33 while pushing in on it until the clamp engages the column, thus securing the binocular-mount column in place. Raise the binocular mount about one inch with the crank.

(6) Remove the binocular-linkage pin and set the linkage in its operating position. Replace the pin to lock the linkage in this position.

(7) Shift the linkage with the adjusting handles until elevation index S496 is at its mark.

(8) Spread the binoculars for the maximum distance between the eyepieces, and place the bincocular hinge in the slot of binocular mounting block S494 with the eyepieces at a lower position toward the open yoke of the linkage.

(9) Unscrew the clamp screw on open sight S16 as far as possible, and shift the clamp block fastened to the bottom of the screw until it is parallel with the open-sight bar. Insert the index end of the sight bar into the front of the mounting-block slot, and slide the bar into the slot until the clamp block is at the midpoint of the binocular hinge. Tighten the clamp screw until the clamp block applies moderate pressure on the binocular hinge and secures the binoculars in place.

(10) Carefully level the assembled control station by adjustment of the tripod jackscrews.

(11) Set the binocular eyepieces to a suitable separation for the observer, and adjust the binocular-mount height with the adjusting crank.

**c. Power Plant**

Make sure that the power plant contains the necessary fuel, oil and water, and that the main breaker is in the OFF position. Comply with instructions contained in the Power-plant Operator's Manual.

### d. Interconnecting Cables

(1) Connect the power cables to the junction-box receptacles at the searchlight and to the associated receptacles at the power plant. The power receptacles and plugs are identified by plus and minus marks and by polarizing keys and keyways. It is impossible to seat unassociated power plugs and receptacles completely. Lock the plugs securely in place in their receptacles with the wing-nut clamps provided.

(*a*) The length of the power cables used affects the resistance of the circuit and, therefore, the voltage at the searchlight. Ballast resistor C170 in ballast unit Ce is provided so that fixed resistances may be put in series with this circuit. Thus, taps on this resistor can be utilized to compensate for the changes in resistance. Proper adjustment can be made by removing the cover from the ballast unit and attaching the cable to the proper terminal stud marked "FOR 200 FEET," "FOR 400 FEET" or "FOR 600 FEET," whichever length cable is used. IRRESPECTIVE OF THE LENGTHS OF THE POWER CABLES, ALWAYS BE SURE THAT THE TERMINAL OF THE CABLE WHICH ENTERS THE TURNTABLE BASE IS CONNECTED TO THE TERMINAL STUD MARKED "FOR 600 FEET," and check that the cable from the junction box is connected to its proper stud as explained above.

(2) Connect the control-cable plugs and receptacles at both the searchlight and control station in the same manner as previously indicated for power-cable connections. These receptacles and plugs are also provided with polarizing keys and keyways to prevent incorrect connections.

(3) Connect and secure the locator-cable plugs and receptacles at both the searchlight and locator.

# OPERATION

## 28. Orientation

To use D.E.C. operation, it is required that the locator, searchlight, and control station be properly oriented to a common base line, and synchronized in azimuth and elevation. Under this instruction it is assumed that the above three units have been set up; that no parallax correction is being provided for the locator; that all electric interconnections have been made; that arc switch E217 is OFF; that searchlight azimuth and elevation clutches A109 and E131 are in their HAND positions; that a-c selector switch J77 is in its DYNAMOTOR position (unless a locator supplying a-c power is used, in which case it should be in its EXTERNAL position); that D.E.C. transfer switch S71 at the control station is in its AUTOMATIC position; that the drum access doors are closed; and that the amplidyne switches (A17 and E58) and the miscellaneous lighting switches are in their OFF positions. It is also assumed that the power plant has been placed in operation in accordance with the Power-plant Operator's Manual, and that supply power is available at the power receptacles on the searchlight junction box.

### a. Orientation Upon a Distant Point

There are two methods by which the equipment can be readily oriented. The first method accomplishes orientation by directing all the pertinent items of equipment toward a distant point, such as a star or a fixed light, which can be readily observed. Since the influence of parallax will vary inversely with the distance to the point used (orientation point), choose as remote a point as possible.

(1) Set the locator on the orientation point in accordance with instructions contained in the Operator's Manual for that equipment.

(2) Make sure that a-c indicating lamp E30 at the elevation control box is lighted.

(3) Release the elevation brake at the elevation control box.

(4) Manually move the searchlight drum in azimuth and elevation until the orientation point is sighted at the cross-wire intersection, F23, of orientation sight R69.

(5) Turn scale-lamp switch E56 at the elevation control box to its ON position. Loosen all the azimuth-scale clamping screws and rotate azimuth scale B74 until its zero point is directly beneath the azimuth pointer. Tighten the azimuth-scale screws. Do not move the searchlight from the position established.

(6) Loosen 1-speed azimuth-corrector clamp T130 at the lower part of the turntable and, upon being assured that the locator is directed toward the orientation point, observe the position of the searchlight 1-speed azimuth zero-indicator pointer on the elevation control box. The zero-indicator scales and pointers are marked with luminous paint and can, therefore, be readily observed in the dark. With care taken not to move the searchlight from its zero-azimuth position, observe whether the 1-speed zero-indicator pointer is in the GO RIGHT or the GO LEFT sector.

Turn 1-speed azimuth-corrector knob T138 in the direction indicated on the corrector nameplate (clockwise for GO RIGHT or counterclockwise for GO LEFT) until the zero-indicator pointer is aligned with its center index. [In some instances, the pointer will first move away from the center index, or zero point, and then return to the zero point after the azimuth-corrector knob is turned farther in the same direction. The corrector knob MUST be turned in the direction indicated by the zero-indicator-pointer deflection, and that movement must be continued until the zero pointer is centered. It is possible, but extremely unlikely, that upon first noting the position of the 1-speed zero-indicator pointer, it will be at its zero position. If such is the case, turn the corrector knob in either direction to deflect the indicator pointer, and then proceed as instructed above.] Tighten the 1-speed azimuth-corrector clamp.

## OPERATION, ORIENTATION

(7) Turn the searchlight azimuth clutch lever A109 to its D.E.C. position.

(8) The following additional operation must be performed only when the associated detector is equipped with both 1- and 33-speed (low-speed and high-speed) transmitters: loosen 33-speed azimuth-corrector clamp A205 on the azimuth control box. With care taken not to move the searchlight from its zero-azimuth position, observe whether the pointer of 33-speed azimuth zero indicator A43 is in the GO RIGHT or the GO LEFT sector of the scale. Turn 33-speed azimuth-corrector knob A203 in the direction indicated on the corrector nameplate until the zero-indicator pointer is aligned with its center index. [If the pointer is initially at zero, or if it moves in what appears to be the wrong direction, follow the instructions given above in Paragraph 28a(6) in connection with the 1-speed azimuth corrector.] Tighten the corrector clamp. After this adjustment is made, the azimuth clutch lever should be left in its D.E.C. position, since turning it to its HAND position disengages the gearing between the searchlight turntable and the azimuth control box, thus breaking the mechanical coupling between the azimuth 33- and 1-speed control transformers. This would destroy the correspondence between these two control transformers. If this were done, it would be necessary to set the searchlight at its zero position as indicated by the 1-speed zero indicator, and then to rezero the 33-speed control transformers.

(9) The first time a particular locator is used with a searchlight, check the relative settings of the elevation transmitters in the locator and the elevation control transformers in the searchlight as follows: accurately set the locator at zero-mils elevation.

(*a*) If the locator has only a 1-speed transmitter, place elevation zero-indicator selector switch E187 in its LOW SPEED (1-speed) position. Turn the searchlight drum in the direction indicated until the elevation zero indicator reads zero. The drum should now be at zero-mils elevation.

(*b*) If the locator has both 33- and 1-speed transmitters, set the drum at approximately zero-mils elevation. Place the selector switch in its HIGH-SPEED (33-speed) position, and turn the drum in the direction indicated until the zero indicator reads zero. The drum should now be at zero-mils elevation. Then, without moving the drum, throw the selector switch to its LOW-SPEED position. The zero indicator should still read zero. If these conditions are not met, refer to Paragraph 64 of these instructions.

(10) Turn the searchlight elevation clutch lever to its D.E.C. position.

(11) Turn the scale-lamp switch at the control station to its ON position, and turn the azimuth and elevation zero-reader operators' handwheels (S258 and S348) until the control-station zero-reader indicators are at their zero positions.

(12) Holding the operating wheels at these settings, and pointing

the binoculars approximately in the same direction as the controller housing, move the controller housing in azimuth with respect to its base and adjust the binoculars in elevation by adjusting handles S483 until the orientation point is sighted at the center of the binocular field. After aligning the binoculars on the orientation point, reposition them in elevation to the zero index by matching the zero index mark on gear box S457 with indicator S496 on the linkage arm. If the binoculars are not available, the open sight may be used to secure approximately the proper setting of the binocular mount.

(13) Turn control-station D.E.C. transfer switch S71 to the MANUAL position.

(14) Turn both the azimuth and elevation amplidyne switches on the searchlight to their ON positions, standing clear in case the searchlight suddenly moves. However, the searchlight will not move if the foregoing steps have been carefully and accurately followed.

### b. Orientation by Interdirection of Units

In the event that a distant orientation point is not discernible, the equipment can be oriented by the interdirection of units. Under such a procedure, it will be necessary to provide suitable illumination. Orientation can be made in all respects as indicated by the preceding distant-point method, with the following detailed exceptions:

(1) Modify the procedure indicated by Paragraphs 28a (1) and 28a (4) to train the locator directly at the center of the searchlight drum; and the searchlight, through the orientation sight, at a point approximately 2½ feet to the left of the center of the locator.

(2) Modify the instructions contained in Paragraph 28a (5) to set and clamp the searchlight azimuth scale at 3200 mils (or 180 degrees), then turn the searchlight 3200 mils (180 degrees) in azimuth to read zero, thus aligning it with the locator.

(3) Instead of the steps called for in Paragraph 28a (13) and (14), this step should be followed. With the elevation and azimuth clutch levers in their D.E.C. positions, both amplidyne switches ON, and the control-station D.E.C. transfer switch in its MANUAL position, turn the searchlight by rotating the control-station handwheels so that it points directly away from the control station. Holding the operating handwheels, sight the binoculars on the manufacturer's monogram at the rear of the drum through azimuth movement of the controller housing and elevation movement of the binocular-mount linkage. Return the searchlight to its original position by a handwheel rotation opposite to that initially employed. This method will probably require a slight adjustment of the binoculars when the searchlight beam is available for comparison.

## 29. Operation Check

Directly after emplacement, setup and orientation, a check of the equip-

## OPERATION, OPERATION CHECK

ment must be made to determine that it is in satisfactory operating condition. Items subject to this check procedure are as follows:

### a. General

With the control-station D.E.C. transfer switch in its AUTOMATIC position, move the locator through several revolutions clockwise and counterclockwise in azimuth, also up and down the elevation range, and observe that apparent synchronism of locator and searchlight can be maintained under D.E.C. operation. With the control-station D.E.C. transfer switch in its MANUAL position, determine whether the searchlight can be moved in synchronism with movement of the control-station zero-reader operators' handwheels. Make sure that the buzzer-signal circuits from the control station to the searchlight, from the locator to the control station, and from the locator to the searchlight are operable.

WARNING: When controlling the searchlight by either automatic or manual D.E.C., DO NOT LEAVE THE DRUM, FOR MORE THAN ABOUT TEN MINUTES, ELEVATED OR DEPRESSED TO SUCH A POSITION THAT A LIMIT SWITCH IS ACTUATED. These positions are approximately indicated by the elevation scale. The elevated position limit switch is actuated at 2200 mils and the depressed position limit switch is actuated at −175 mils.

### b. Searchlight

Reference has been made to the desirability of transporting the searchlight without carbons installed in the lamp, and it is therefore assumed that, at this stage of operation, carbons are not installed. Prior to installation of carbons, the arc switch at the elevation control box should be placed in its ON position, and observation made concerning the apparent satisfactory operation of the searchlight ventilating motor and electrically driven lamp feed mechanisms. Turn OFF the arc switch after checking for the above.

Turn both amplidyne switches to their OFF positions, but LEAVE THE AZIMUTH AND ELEVATION CLUTCH HANDLES IN THEIR "D.E.C." POSITIONS. Set the drum at its zero-elevation position. Operate the elevation brake to the engaged position. Light the recarboning lamp (Switch E54). Open the left drum door for access to the drum interior. Carbon the lamp as here outlined and illustrated by Fig. 17. CARBON IN ALL INSTANCES WITH A PAIR OF CARBONS.

(1) Release positive lever L384 on the lamp. Insert a positive carbon through the center opening of the front glass door and the hole in the lamp positive-head mechanism until it projects from ¾ to ⅞ inch beyond the mirror end of the positive nose cap. Rotate the carbon to facilitate entry between the positive brushes. Operate the positive lever to engage the carbon with the positive-feed rollers.

(2) Latch the negative rollers in open position by pushing forward

# MODEL 1942 SEARCHLIGHT AND CONTROL STATION

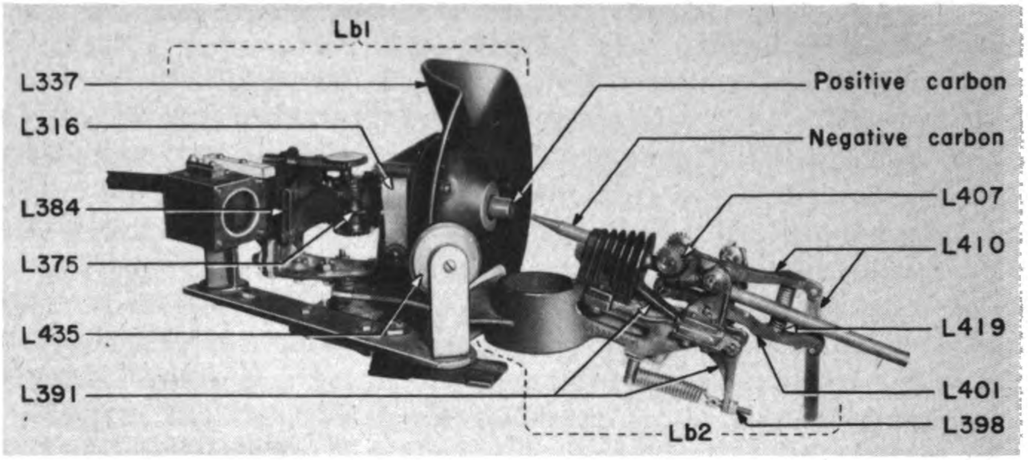



**Fig. 17. Carbon installation**

| Ref. No. | Designation | Ref. No. | Designation |
|---|---|---|---|
| Lb1 | Positive-head Assembly | L410 | Negative Lever and Roller Arm |
| L316 | Positive-brush Assembly | | |
| L337 | Positive Nose Cap | L419 | Negative-feed-roller Spring |
| L375 | Positive Feed Rollers | | |
| L384 | Positive Lever | L398 | Negative-brush-pressure-spring Nuts |
| Lb2 | Negative-head Assembly | | |
| L391 | Negative-brush Assembly | L435 | Thermostat Mirror |
| L407 | Negative Feed Rollers | ...... | Positive Carbon |
| L401 | Lower Negative Roller Arm | ...... | Negative Carbon |

the lever arm of negative-lever assembly L410 to the position shown in Fig. 11. Insert the pointed end of a negative carbon through the negative head until its tip is about ¼ inch from the tip of the positive carbon. Operate the negative lever to engage the carbon with the negative-feed rollers. Close the drum door. Turn OFF the recarboning-lamp switch.

(3) Release the elevation brake, and position the searchlight in both azimuth and elevation so that the zero-indicator pointers are approximately in the center. Turn both amplidyne switches to their ON positions.

CAUTION: WATCH OUT FOR SUDDEN MOVEMENT OF THE SEARCHLIGHT WHEN THESE SWITCHES ARE OPERATED.

(4) Make sure that the searchlight voltmeter indicates approximately 100 volts, and that the ammeter is at its zero point. Any required voltage adjustment should be made at the power plant in accordance with instructions contained in the Power-plant Operator's Manual. Failure of the ammeter to indicate zero will require adjustment of the ammeter pointer.

(5) Open the metal covers of ground-glass finder F29 and peep sights F82 and R72.

(6) Be sure that negative-drive crank L168 and positive-feed button

L276 at the lamp-mechanism box are in their lower, or out, positions. Also be sure that positive-feed rate-adjustment knob L232 on the lamp-mechanism box has been set for minimum feed.

## 30. Replacement of Carbons

Always use a pair of full-length carbons when recarboning. Entrance to the drum should be made through the left drum access door in order to avoid striking the feed rods. On entering the drum, take care not to drop carbons on the mirror; avoid burns when removing hot carbon stubs; and handle new carbons carefully to avoid breakage. Only special high-intensity carbons should be used in this lamp.

**a.** Disengage the negative lever by pushing its lower end toward the positive head. The stub should be removed by means of tongs. Caution should be used in removing the stub, to avoid the possibility of the stub sliding out of the negative head and dropping on the mirror. Spread the positive-feed-roller arms apart by raising the positive-carbon clamping lever. Withdraw the hot carbon with a pair of recarboning tongs. To facilitate the withdrawal of the carbon, it is suggested that the end of the new carbon be inserted in the feed end of the positive head, and be pushed through to force out the used stub. The new carbon should be pushed through until the end of the carbon projects beyond the positive nose cap between ¾ inch and ⅞ inch. In the initial position, the new carbon will extend through the opening at the center of the front door. Re-engage the carbon by lowering the positive-carbon clamping lever. Insert the pointed end of the new negative carbon into the rear of the negative head, and push the carbon forward until it is within ¼ inch of touching the positive carbon. Be sure that both drum doors are fully closed.

## 31. Distant Electric Control

The D.E.C. equipment provided furnishes two methods for remote directional control: AUTOMATIC DISTANT ELECTRIC CONTROL and MANUAL DISTANT ELECTRIC CONTROL. That is, the searchlight may be controlled either automatically from the locator or manually from the control station, depending upon the setting of the transfer switch at the control station.

NOTE: The power-plant main switch should be ON while preparing for tracking and during tracking. This is necessary to provide power for the D.E.C. and the indicating systems so that the searchlight may be kept in alignment with the locator.

For ready reference, Figs. 18 and 19 indicate the locations of the various operating controls which shall be referred to. In case of failure of the D.E.C. system, the searchlight may be operated by hand by use of the extended hand controller.

### a. Automatic Distant Electric Control

The equipment setup requires that: a-c selector switch J77 be in its

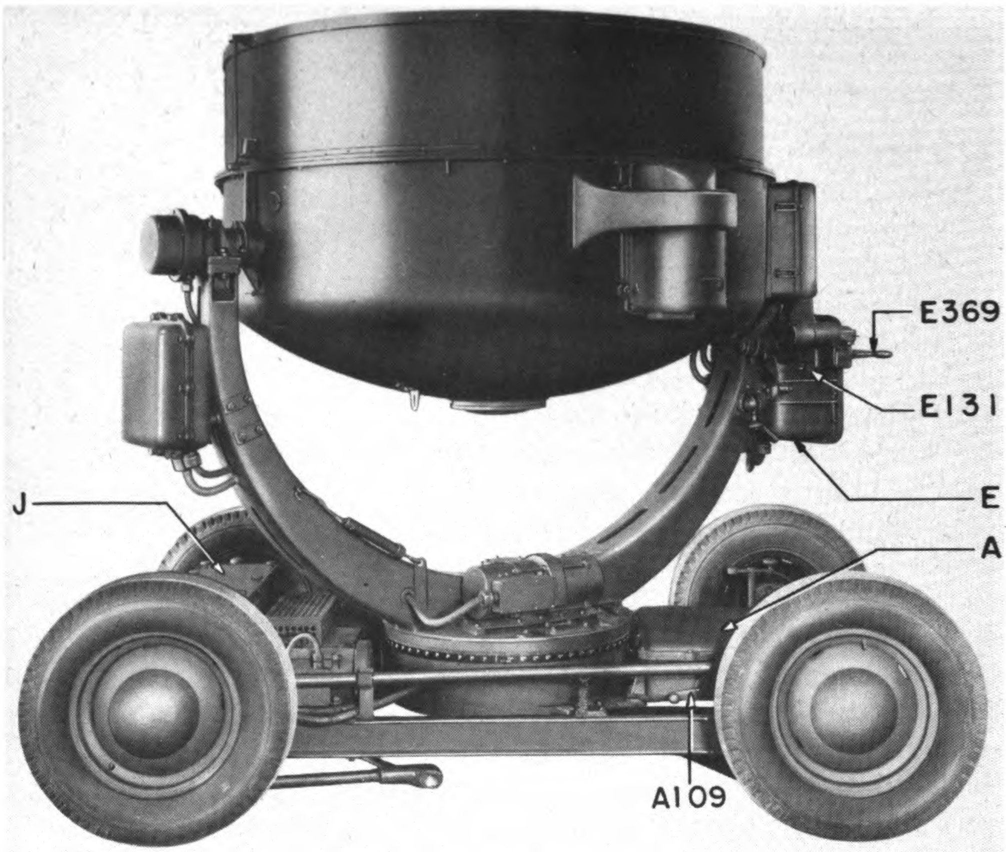



Fig. 18. Assembled searchlight

| Ref. No. | Designation | Ref. No. | Designation |
|---|---|---|---|
| A109 | Azimuth Clutch Lever | E | Elevation Control Box (containing elevation amplidyne switch) |
| E131 | Elevation Clutch Lever | | |
| A | Azimuth Control Box (carrying azimuth amplidyne switch) | J | Junction Box (containing a-c selector switch) |
| E369 | Elevation Brake Handle | | |

DYNAMOTOR position (unless a detector supplying a-c power is used, in which case it should be in its EXTERNAL position), and both amplidyne switches A17 and E58 be in their ON positions; azimuth clutch lever A109 and elevation clutch lever E131 be in their D.E.C. positions; D.E.C. transfer switch S71 at the control station be in its AUTOMATIC position; the drum access doors be closed; and elevation brake handle E369 be in its OFF position. It should be noted that if the searchlight is out of correspondence with the locator, alignment will automatically be accomplished when the amplidyne switches are turned ON. With the Automatic D.E.C. method of operation, the searchlight follows the locator without requiring the services of a control-station operator.

# OPERATION, DISTANT ELECTRIC CONTROL

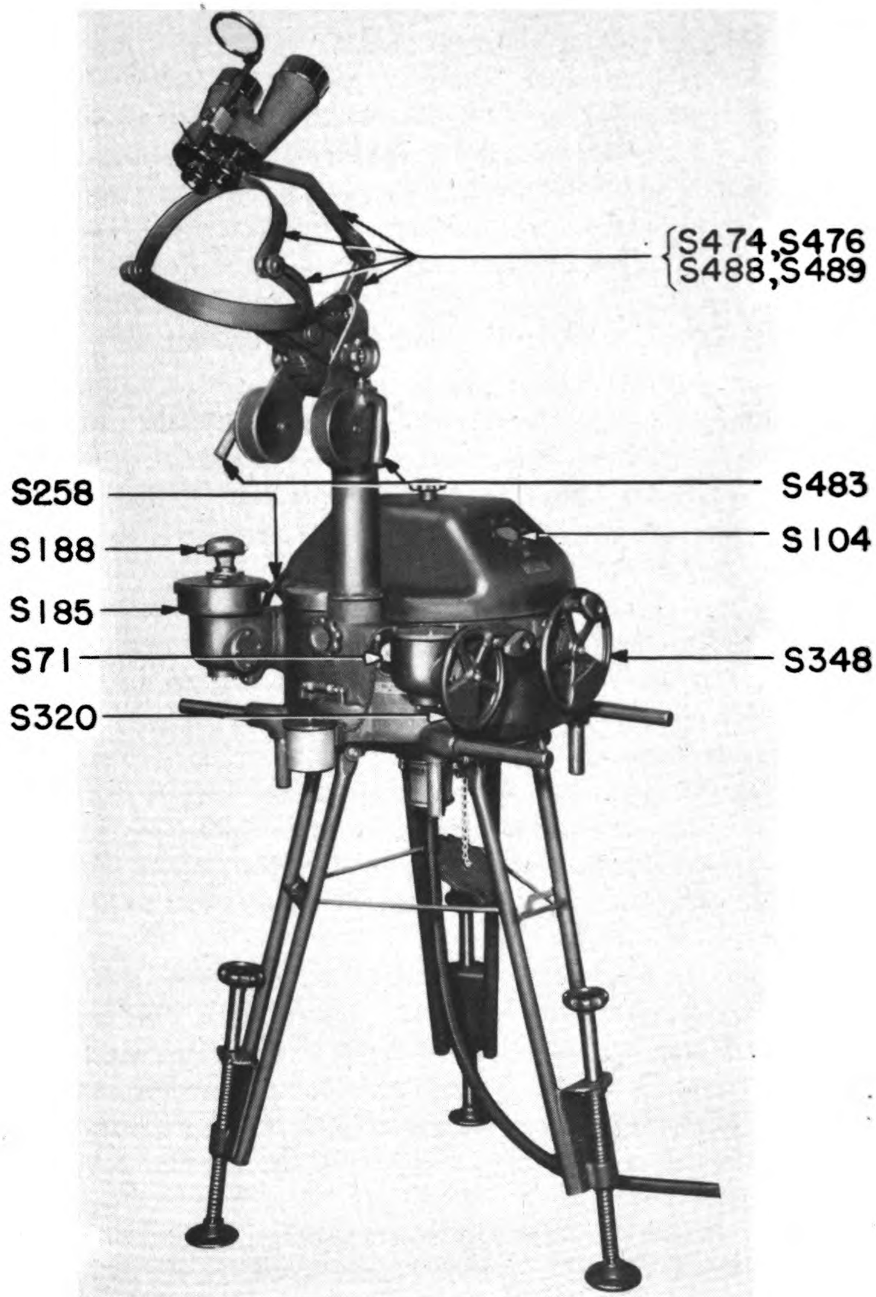



**Fig. 19. Assembled control station**

| Ref. No. | Designation | Ref. No. | Designation |
|---|---|---|---|
| S71 | D.E.C. Transfer Switch | S474, S476, S488, S489 | Binocular-mount Linkage |
| S258, S348 | Zero-reader-operators' Handwheels | S185, S320 | Observer's Handwheels |
| S104 | Zero-reader Instrument | S188 | Ratio Shifter |
| S483 | Adjusting Handles | | |

## b. Manual Distant Electric Control

This method employs the control station for tracking the target and eliminates the use of the locator. The same equipment setup as above exists for Manual D.E.C. except that the D.E.C. transfer switch should be in its MANUAL position. The zero-reader instruments at the control station will then indicate synchronism between the locator and the control station; and the zero-reader instruments at the searchlight (on the elevation control box) will indicate synchronism between the control station and the searchlight. The following is the proper procedure for Manual D.E.C. operation: Do not confuse Manual D.E.C. with hand-control operation.

(1) When a target is being tracked by the locator, the azimuth and elevation zero-reader operators at the control station shall observe movements of the zero-reader-instrument pointers. Maintenance of synchronism between the locator and control station is indicated by the centering, or zeroing, of the zero-reader-instrument pointers, and is secured by moving the zero-reader-operators' handwheels. For proper synchronization, movement of the handwheels must be in the direction indicated by the instruction plate at each zero-reader-instrument window. That is, to move the zero-reader's pointer to the right, its respective handwheel must be rotated clockwise, and counterclockwise for a left-hand movement of the pointer. Should the pointer move in an opposite direction it indicates that the transmitter at the locator and the control transformer at the control station are 180 degrees out of phase. Correction for this condition is obtained by rotating the handwheel continuously in one direction, which will cause first a maximum pointer deflection and then an ultimate return to the zero position.

(2) Rotate the zero-reader-operators' handwheels as smoothly and slowly as possible in order to facilitate the target pickup. This is particularly important at the instant of arc strike in order to minimize the jump which may occur due to the d-c supply voltage momentarily decreasing.

(3) The observing operator should stand by his station at the binoculars, in order that he may readily observe the illuminated field when the searchlight arc is struck.

(4) After the searchlight arc is struck, the observer must carefully watch the illuminated field through the binoculars, in order to ascertain the target flick or pickup. Instructions for striking the arc and operating the lamp are given in Paragraph 32 which follows.

(5) If the observer does not see the target immediately, the zero-reader operators should explore the field around the position indicated by the locator, by rotating their handwheels S258 and S348, so that the instrument pointers oscillate slowly from one side to the other of the zero index.

(6) When the target has been picked up by the observer, he should take control and follow the target with the observer's handwheels S185 and S320. The observer's azimuth handwheel is provided with a two-speed shift which is actuated by plunger S188 passing through the knob

on the wheel. The high-speed drive, which is engaged by pressing the end of the plunger containing a screw head, is particularly useful in following a low-flying, rapidly moving target.

(7) As a target is being followed, the binoculars may move from the illuminated field, due to parallax between the searchlight and the control station. They can be brought onto the illuminated field again by moving the binocular-mount linkage by adjusting handles S483. These handles may be used for positioning the binoculars both in azimuth and elevation. Such movement in azimuth will slightly affect the alignment in elevation between the searchlight and the control station.

### c. Transfer between Methods of D.E.C.

Under various tactical operations it will be essential that transfer be made between the two methods of control. This transfer must be accomplished with a minimum movement, or jump, of the searchlight beam to avoid losing the target. Procedure for the D.E.C. transfer is outlined by the following subparagraphs:

(1) Assuming that the equipment is operated from the locator with Automatic D.E.C. and that a target has been picked up by the locator and is being tracked by the searchlight, it may be desirable to release the locator to detect other targets while the searchlight and control station continue to track the original target. This transfer is obtained by turning control-station D.E.C. transfer switch S71 to the MANUAL position. Detrimental movement, or jump, of the beam can be prevented if the zero-reader operators maintain zero position on the azimuth and elevation zero-reader instruments before and during this transfer. The above procedure is followed whether the searchlight lamp is lighted or is not.

(2) When control is being maintained under Manual D.E.C. and it is desired to transfer to Automatic D.E.C., it is essential that the control station and searchlight are so directed that the zero-reader instruments at the control station point to zero or that the locator is brought back into correspondence with the control station. Such readings will show that the control station, the searchlight and the locator are in synchronism, and that the minimum movement will occur at the time of transfer. After these pointers are brought to zero, turn the D.E.C. transfer switch to AUTOMATIC.

## 32. Hand Directional Control

In case of D.E.C. failure, hand directional control of the searchlight can be accomplished in the following manner:

**a.** Place the elevation and azimuth clutch levers in their HAND positions. Turn OFF both the azimuth and elevation amplidyne switches. Remove socket cover E67 and insert the extended hand controller in its socket at the elevation control box. Apply a slight pressure toward the searchlight and rotate the handwheel until the couplings mate and the latch falls into its notch. When the coupling is properly engaged, the searchlight will turn freely in elevation with rotation of the handwheel.

(1) Azimuth and elevation control of the searchlight may follow the locator data by movement of the extended hand controller keeping the searchlight 1-speed zero-reader-instrument pointers on their zero positions.

(2) After the arc has been struck and the target picked up, manual directional control of the searchlight should be continued by direct observation of the target, instead of by instrument indications.

## 33. Lamp Control

The searchlight provides for three methods of lamp control, designated as automatic, semiautomatic, and manual. The automatic control is intended to be used normally. The semiautomatic and manual controls provide means for continuing operation of the lamp in the event of failure of certain features of the normal control. For reference, Fig. 20 indicates the location of the various items essential to lamp operation. Under any condition, make sure that the lamp is properly carboned. (Refer back to carboning instructions under Paragraphs 29 b and 30.) Never start an operation unless the positive carbon is of such length as to protrude at least two inches from the feed end of the lamp and to protrude from ¾ to ⅞ inch beyond the nose cap. The lamp should operate at nominal values of 150 amperes and 78 volts as read at the searchlight instruments. The method of setting the above current is indicated under each of the following lamp-operation methods; and the voltage adjustment is described for the power plant by the Power-plant Operator's Manual.

Efficient lamp operation depends upon proper positioning of the positive carbon. For an unspread beam the operator should frequently check that the image of the positive crater tip is maintained close to the black or focal line on the ground-glass finder. THE POSITIVE CARBON SHOULD NEVER BE PERMITTED TO BURN BACK BEYOND THE RED OR DANGER LINE.

Efficient lamp operation is also dependent upon maintenance of proper carbon alignment, and this should be checked frequently. The adjustment is described by Paragraph 70 of these instructions. CARE MUST BE EXERCISED AT ALL TIMES THAT THE POSITIVE CARBON REMAINS OF SUFFICIENT LENGTH. FAILURE TO OBSERVE THIS PRECAUTION MAY RESULT IN THE POSITIVE CARBON BEING FED TO THE LIMIT AND THE LAMP BEING QUICKLY BURNED TO SUCH AN EXTENT THAT THE SEARCHLIGHT WILL BE COMPLETELY OUT OF OPERATION.

### a. Automatic Lamp Control

The equipment setup requires that positive-drive crank L77, positive-feed button L276, and negative-drive crank L168 be in their out, or lower, positions; that positive-feed rate-adjustment knob L232 be at its minimum-

## OPERATION, LAMP CONTROL

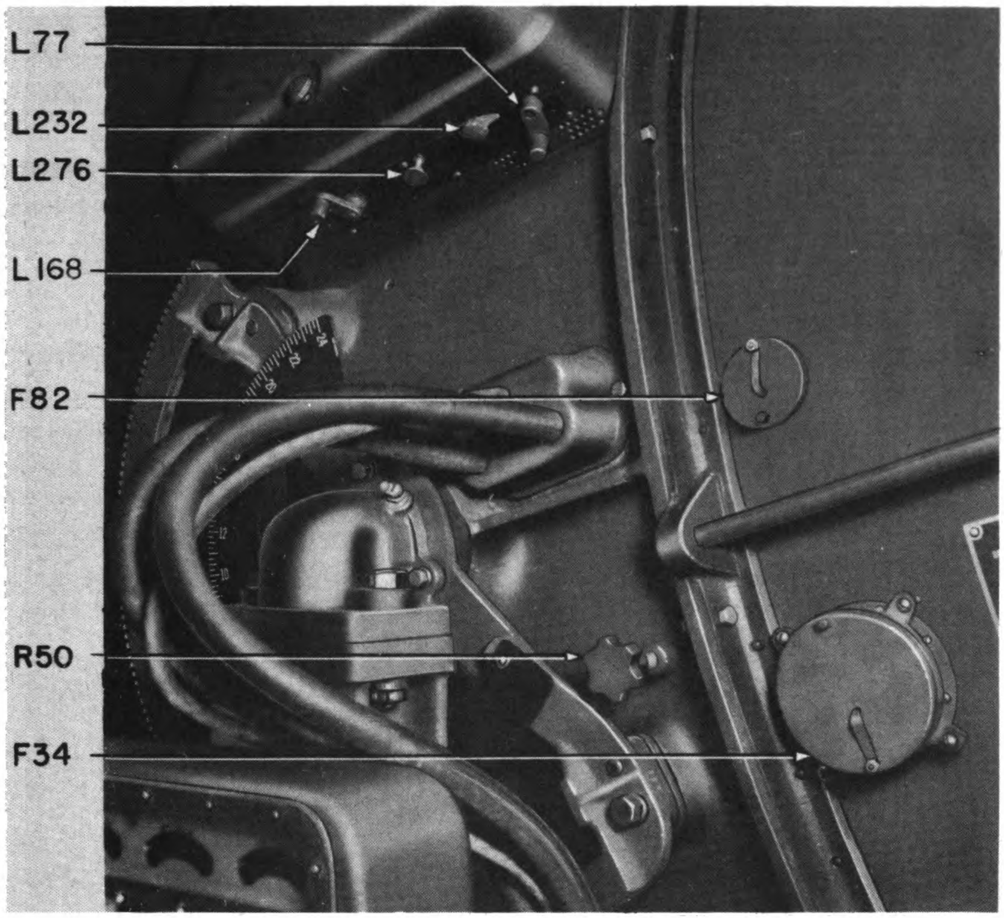



**Fig. 20. Partial view of drum**

| Ref. No. | Designation | Ref. No. | Designation |
|---|---|---|---|
| R50 | Focusing Knob | L168 | Negative Drive Crank |
| F34 | Ground-glass-finder Cover | L77 | Positive Drive Crank |
| | | L232 | Positive-feed-rate Knob |
| F82 | Peep-sight Cover | L276 | Positive Feed Button |

feed position; that ground-glass finder cover F34 and peep-sight cover F82 be open; and that the drum access doors be closed. Operation procedure is as follows:

(1) Close arc switch (handle E217). The ventilating motor and the lamp-mechanism motor will start rotating. The lamp mechanism will automatically feed the negative carbon to strike the positive carbon, and then immediately retract the negative carbon to obtain a lamp current in accordance with a preset value. Adjustment of this setting, which should be for 150 amperes at the searchlight ammeter, is made at the lamp control box, and is described in detail in Paragraph 68 and in the Maintenance Manual.

(2) Immediately after the arc strike, observe through the peep sight that the protrusion of the positive carbon has remained approximately at its original setting, and that it is not broken badly enough to endanger the positive nose cap. In the case of a bad break, the positive-feed rate knob should be turned clockwise to its maximum-feed position, and the positive-drive crank set in its upper position and rotated rapidly to bring the positive crater about ¾ inch beyond the positive nose cap. When the positive crater reaches this position, the positive-feed rate knob should be set back to minimum, and the positive-drive crank released.

(3) If the negative carbon does not automatically pull away from the positive carbon after they touch, the negative carbon should be retracted by pushing in on the negative-drive crank and turning it counterclockwise until the current is about 150 amperes. Then the negative-drive crank may be pulled out to return to automatic control. If the carbon cannot be retracted, turn the arc switch to OFF, enter the drum, disengage the negative carbon, rotate it 45 degrees, and reengage the negative carbon. Close the arc switch.

CAUTION: The action of the thermostat prevents underfeeding of the positive carbon, but does not prevent overfeeding. If the protrusion of the positive carbon increases beyond the usual ¾ to ⅞ inch, decrease the positive-feed rate by turning the positive-feed rate knob toward its minimum-feed position.

(4) If, after several-minutes' operation, the image of the positive carbon on the ground-glass finder does not terminate at the black, or focal, line look through the peep sight and observe whether the protrusion of the positive carbon is still approximately ¾ inch. If the protrusion is correct, adjust the lamp with focusing knob R50 to bring the end of the image on the line. If the image should change from this setting during operation, immediately check for sufficient positive-carbon length by observing whether it is still rotating in the lamp head. If the positive carbon is long enough to rotate and the image is still off the focal line, resort to semiautomatic operation, as described in the following subparagrah.

(5) If a spread beam for illuminating a greater field at shorter ranges is desired, it may be obtained by turning the focusing knob in a counterclockwise direction, thus moving the lamp closer to the mirror. After this change is made, the black and red lines on the ground-glass finder no longer have any significance. The operation of the arc, therefore, must be checked by observations through the peep sight.

## b. Semiautomatic Lamp Control

If the thermostat control should fail, the lamp strike is unaffected and can be obtained in the same manner as for automatic lamp control; the protrusion of the positive carbon, however, must be regulated by turning the positive-feed rate knob clockwise toward its maximum-feed position. Turn the knob sufficiently to cause the positive carbon to feed at such a rate as to maintain the positive crater at the focal line. Operation of the negative carbon is not affected by this change.

CAUTION: Since there is no automatic control of the positive carbon, its position must be watched carefully to prevent it from burning back to the nose cap, or overfeeding and damaging the negative-head assembly.

## c. Manual Lamp Control

Upon complete failure of the proper operation of the automatic lamp control, control of the lamp can be obtained in the following manner:

(1) The lamp strike can be obtained by closing the arc switch and pushing in and turning the negative-drive crank in a clockwise direction until an arc is struck with the positive carbon, and then immediately reversing the negative-drive-crank rotation to place the negative carbon for the prescribed 150-ampere setting.

(2) The positive carbon should be continuously rotated by pushing in and rotating positive-drive crank L77.

(3) Maintain the positive-carbon tip at the focal position by pushing in positive-feed button L276, while the positive-drive crank is being rotated.

(4) Maintain the arc current at 150 amperes, as read on the ammeter, by pushing in and turning negative-drive crank L168 in the proper direction.

# SECTION II

# DETAILED AND TECHNICAL DESCRIPTION

# SECTION II—DETAILED AND TECHNICAL DESCRIPTION

The detailed and technical description provided by this section relates to the various operating systems of the general searchlight equipment. It is intended to thoroughly acquaint the reader with all essential features of operation and control. The general searchlight equipment is divided into three primary systems; they are the General Arc System, the Zero-reader System, and the Distant-electric-control System. Each of these primary systems is subject to a further breakdown into its subsystems and assemblies.

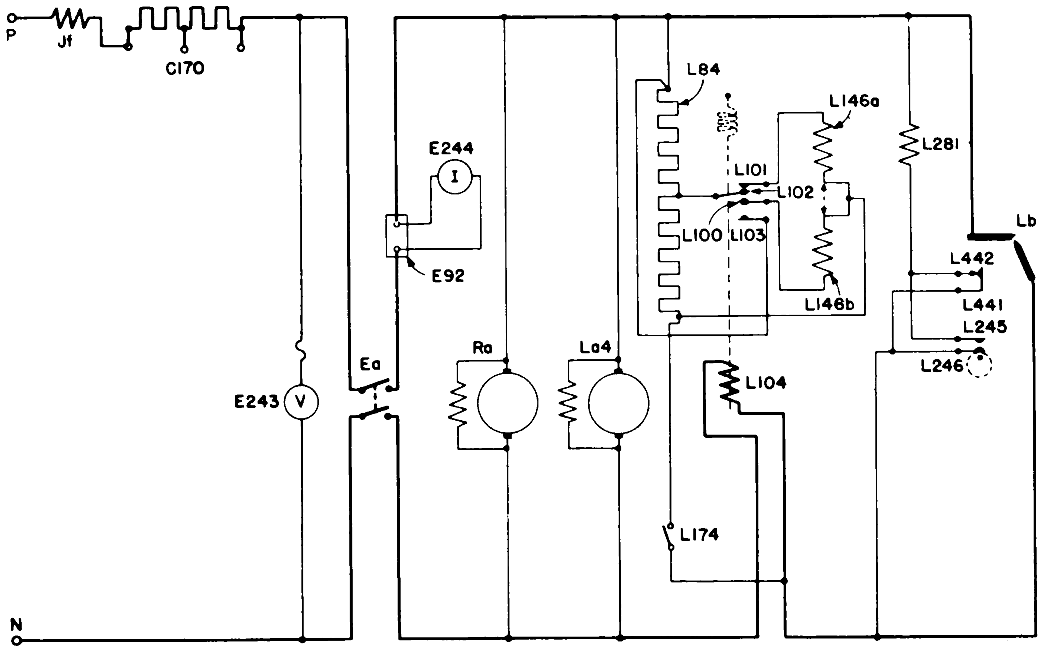



**Fig. 21. Schematic diagram of general arc system**

| Ref. No. | Designation | Ref. No. | Designation |
|---|---|---|---|
| Jf | Voltage-adapter Relay | L146b | Negative-drive-clutch Retract Coil |
| C170 | Ballast Resistor | | |
| Ra | Ventilating Motor | L174 | Negative-drive-crank Switch (silvered washer) |
| Ea | Arc Switch | | |
| E244 | Ammeter | | |
| E92 | Ammeter Shunt | L245, L246 | Semiautomatic-feed Contacts |
| E243 | Arc Voltmeter | | |
| L84 | Arc-current-regulator Resistor | L281 | Positive-feed Magnet Coil |
| | | Lb | Lamp Head Assembly |
| L100, L101, L102, L103 | Arc-current-regulator Finger Contacts | L441, L442 | Thermostat Contacts (bi-metallic strips) |
| L104 | Arc-current-regulator Coil | La4 | Lamp-mechanism Drive Motor |
| L146a | Negative-drive-clutch Feed Coil | | |

# GENERAL ARC SYSTEM

## 34. Components of Arc System

The General Arc System includes: the searchlight lamp and lamp-control mechanisms; the arc switch; searchlight power instruments; the ventilating system; drum details pertaining to the lamp and its control; and miscellaneous devices required in the general-arc-system circuit. Fig. 21 illustrates in schematic the above-mentioned items. Reference to this figure and to its identification symbols will be made throughout this subsection. Fig. 71 and 72 are the complete connection diagram and schematic wiring diagram for the entire searchlight equipment.

The lamp mechanism for positive-carbon rotation and for positive- and negative-carbon feed is described in the following text. Note that the method of transmitting current to the positive and negative carbons employs contact brushes located in both lamp heads. Feed rollers, gearing, gearing-support brackets, and the positive nose are insulated from the current-carrying parts of the lamp head. This insulation prevents arc current from being

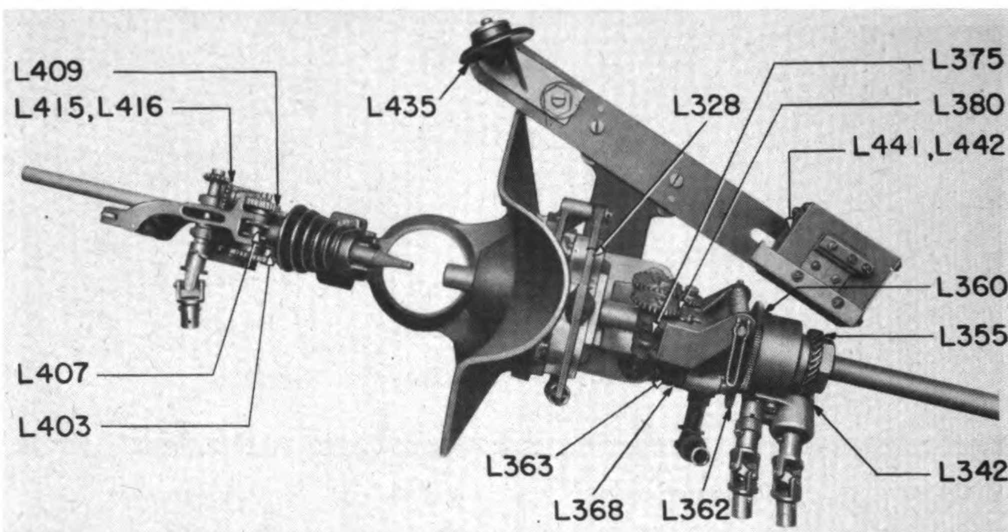



Fig. 22. Searchlight lamp

| Ref. No. | Designation | Ref. No. | Designation |
|---|---|---|---|
| L328 | Positive-brush-spring Lever | L380 | Gear |
| L342 | Helical Gear with Shaft | L407 | Negative-feed Rollers |
| L355 | Helical Gear | L409 | Worm Gear |
| L360 | Detent Wheel and Planetary Gear | L403 | Gears |
| | | L415, L416 | Bevel Gears |
| L362 | Positive-drive Gear | L435 | Thermostat Mirror |
| L363 | Worm | L441, L442 | Thermostat Contact (bimetallic) Strips (located within housing) |
| L368 | Worm Gear | | |
| L375 | Positive-feed Rollers | | |

# GENERAL ARC SYSTEM, LAMP ASSEMBLY

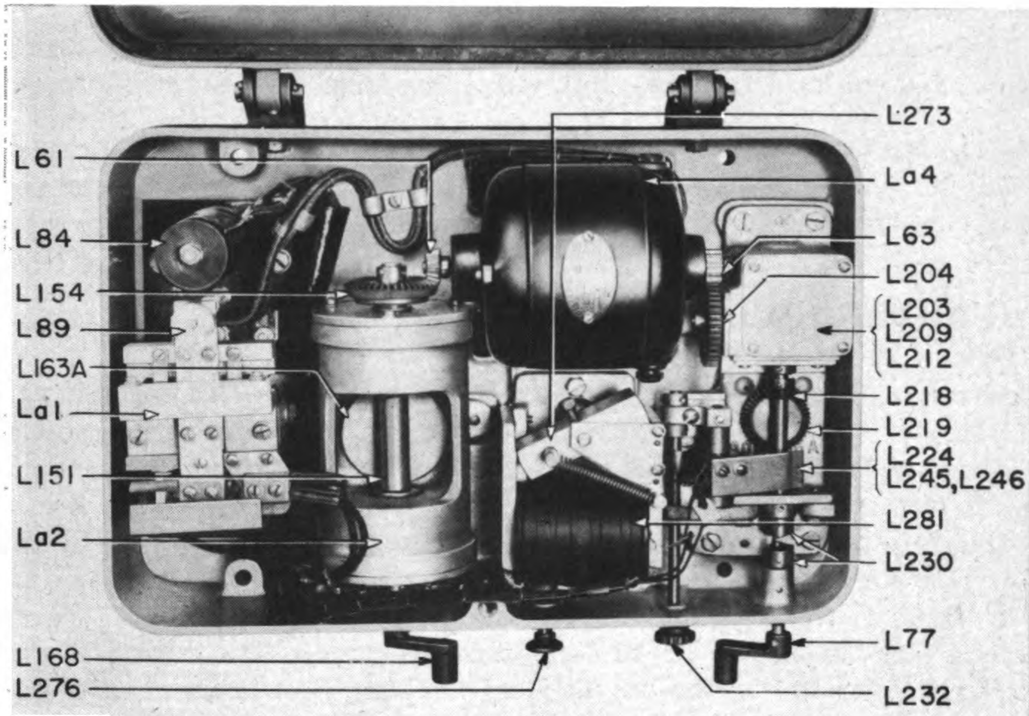



**Fig. 23. Lamp mechanism**

| Ref. No. | Designation | Ref. No. | Designation |
|---|---|---|---|
| La1 | Arc-current Regulator | L218, L219 | Bevel Gears |
| L84 | Arc-current-regulator Resistor | L224 | Positive-semiautomatic-feed Cam |
| L89 | Arc-current Adjustment Nut | L245, L246 | Positive-semiautomatic-feed Contacts |
| La2 | Negative-drive-clutch Assembly | L230 | Positive-drive Clutch (Manual) |
| L151 | Negative-drive-clutch Armature | L77 | Positive-drive Crank (Manual) |
| L154 | Bevel Gear | L232 | Positive-feed-rate-adjustment Knob |
| L163a | Negative-drive Disk | | |
| L168 | Negative-drive Crank (Manual) | L273 | Positive-feed-magnet Armature |
| La4 | Lamp-mechanism Motor | L276 | Positive-feed Button (Manual) |
| L61 | Bevel Gear | | |
| L203 | Worm | L281 | Positive-feed Magnet Coil |
| L212, L209 | Worm Gear and Overrunning Clutch | L63 | Spur Gear |
| | | L204 | Spur Gear |

transmitted to the carbons by the feed rollers and the positive nose; HENCE, MAKE SURE THAT THE POSITIVE CARBON DOES NOT MAKE CONTACT WITH THE POSITIVE NOSE CAP AT ANY TIME.

# MODEL 1942 SEARCHLIGHT AND CONTROL STATION

## 35. Lamp Assembly

The searchlight lamp is contained in the drum and holds the carbons in proper relation to the mirror. This unit is illustrated by Fig. 22.

## 36. Lamp Mechanism

The searchlight lamp mechanism, illustrated by Fig. 23, is located at the outside of the drum just above the right trunnion arm. Its function is to feed the carbons and maintain them in their proper relative positions.

## 37. Detailed Description of Lamp Operation

Fig. 24 shows the relationship between the lamp itself and the lamp mechanism. (Identical cross-reference numbers are provided for Fig. 21, 22, 23 and 24.) The lamp mechanism and the lamp-control mechanism perform a mechanical function in rotating and feeding the positive carbon, and in feeding or retracting the negative carbon. These carbons are fed to positions of proper relationship between themselves and a point which has been preset with respect to the positive nose cap. This mechanical function is controlled electrically under both automatic and semiautomatic operation. Means are also provided for manual operation. Description of the parts and operational details of the lamp and lamp control are given in the following subparagraphs:

### a. Positive-carbon Rotation

(1) The positive-carbon rotating mechanism is driven under automatic and semiautomatic operation by lamp motor La4 through spur gears L63 and L204, worm L203, worm gear and overrunning clutch L212 and L207, bevel gears L218 and L219, positive drive rod L5, helical gears L342 and L355, and tube L350. The feed-roller mechanism supporting the positive carbon is directly attached to the tube, and transmits the tube rotation to the carbon.

(2) The positive-carbon rotating mechanism is driven under manual operation by pushing in and rotating positive-drive crank L77. The train of operation, under this condition, is through clutch L230 (the overrunning-clutch gear remaining stationary) and then as outlined above for the automatic and semiautomatic rotation.

### b. Positive-carbon Feed

(1) The positive-carbon automatic feed receives its driving power through the same drive rod L5, the helical gears L342 and L355 and tube L350. In this case, detent wheel and gear L360 which fits loosely over the tube is held in a fixed, nonrotating position. Thus, gear L362 is forced to rotate about the now stationary planetary gear L360b, driving worm L363, worm gear L368, gear train L370, L374, L373 and L380, and feed rollers L375. Detent wheel L360a is held in its fixed position by detent L344. Operation of the detent is automatically controlled by the thermostat through positive-feed-magnet armature L273 and rod L4.

# GENERAL ARC SYSTEM, LAMP OPERATION

(2) Semiautomatic control is obtained by proper setting of the positive-feed rate-adjustment knob L232 which, through an eccentric wheel, positions the semiautomatic-feed contacts L245 and L246. These contacts are thus given a greater or less relative time of contact against feed cam L224 energizing the positive-feed magnet for a corresponding period of time. The semiautomatic-feed contacts L245 and L246 are in parallel, electrically, with thermostat contacts L441 and L442 (Fig. 21) so that either or both may operate the armature L273.

(3) The positive-carbon manual feed is as shown for the automatic feed, with the exception that positive-feed-magnet armature L273 is manually actuated by pushing feed button L276.

## c. Negative-carbon Feed

(1) The negative-carbon automatic-feed and retraction drive is actuated by the same lamp motor La4. The lamp-motor drive is through bevel gears L61 and L154 to negative-clutch armature L151. The negative-clutch armature is free to slide on the drive shaft which carries bevel gear L154, but is keyed to the shaft so that it rotates with it. In its normal position, the armature does not contact negative-drive disk L163a. However, when either the retract coil or the feed coil is excited, the armature is pulled toward that coil and makes contact with disk L163a driving it in either a clockwise or a counterclockwise direction depending on which coil is excited. The clockwise or counterclockwise rotation of the negative-drive disk is transmitted to drive rod L6, bevel gears L415 and L416, worm L417, worm gear L409, the negative-feed-roller gears L403, and finally to negative feed rollers L407 engaged with the negative carbon. The negative carbon is then retracted from, or fed toward, the positive carbon.

(2) The negative-carbon manual feed or retraction is as described above for the negative-carbon automatic feed, except that the initial drive is provided through manual rotation of negative-drive crank L168 and bevel gears L156 and L163b, which are engaged by pushing in the negative-drive crank.

## d. Maintenance of Arc Position

It is necessary to keep the luminous ball of vapor, which is formed in the crater of the positive carbon, at a preset point in relation to the positive nose cap.

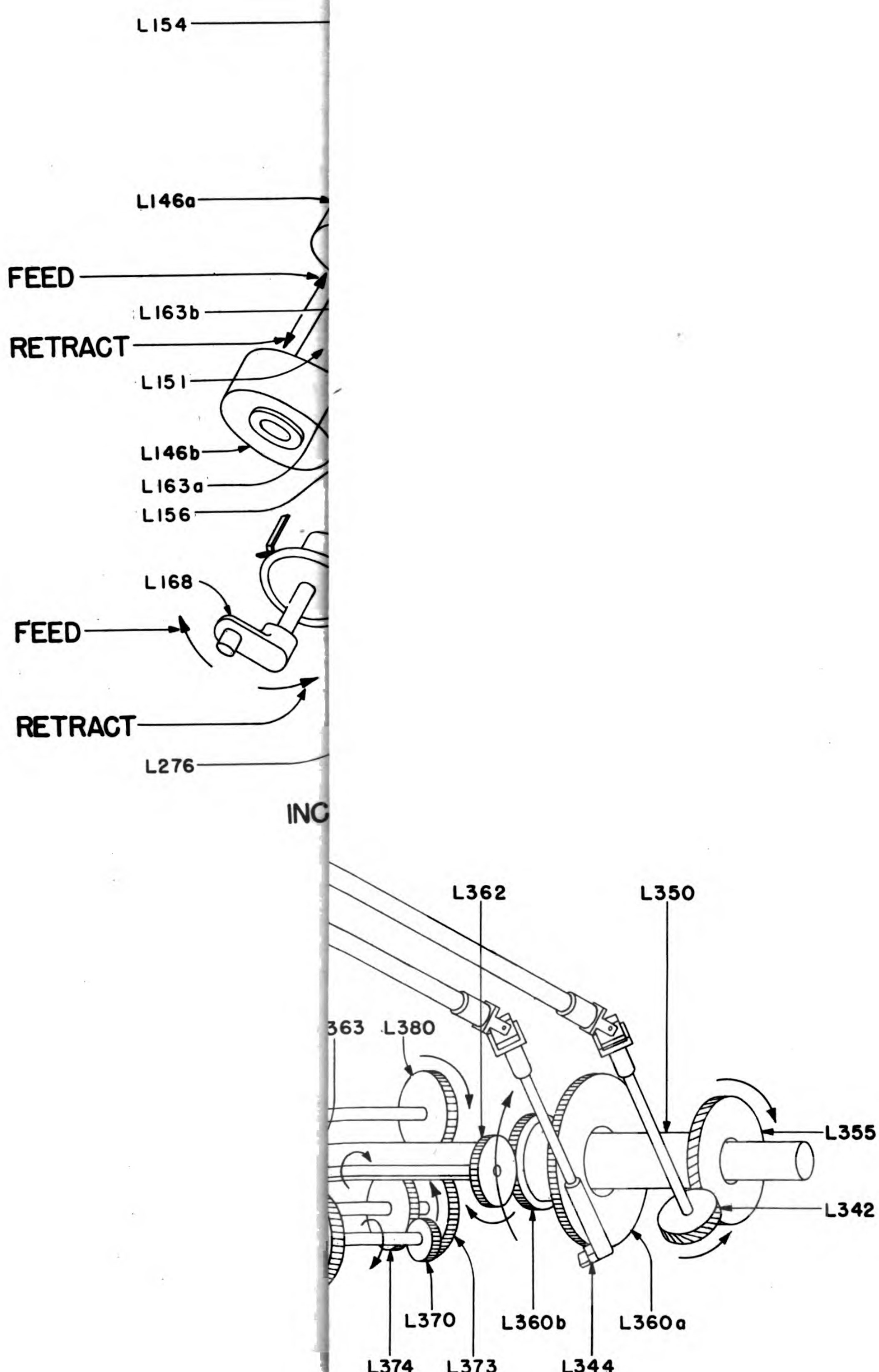
(1) Under automatic control, this is performed by utilizing the heat rays from the positive carbon to control positive-feed-magnet armature L273. The heat rays are focused by means of thermostat mirror L435 (refer to Fig. 22 and 23), so that they are properly directed on thermostat bimetallic strips L441 and L442. These strips bend with heat and are so assembled that, for changes in ambient temperature, the bending is the same in both strips. The free end of each strip carries a contact; these contacts act as a switch in the positive-feed-magnet circuit. The mirror and thermostat are

# MODEL 1942 SEARCHLIGHT AND CONTROL STATION

so adjusted with respect to the positive carbon that, when the positive-carbon tip is at its preset point, the heat rays are equally distributed on the two bimetallic strips, heating each strip an equal amount and bending both of them to the same degree. Under this condition, the thermostat contacts do not close, keeping the circuit to the positive-feed magnet open. The detent is not then in its engaged position. As the edge of the crater burns back, the heat rays shift so that they are more on the right bimetallic strip (looking through the glass window in the thermostat housing) than on the left strip, thus causing the right strip to bend more than the left so that the thermostat contacts touch and close the circuit to the positive-feed magnet coil. Operation of the positive-feed-magnet armature causes the detent to engage with the detent wheel, and thus causes the positive carbon to feed forward. The positive carbon feeds forward until the heat rays again fall equally on both strips. This heats the left strip and allows the right one to cool slightly, opening the thermostat contacts, and therefore, the circuit to the positive-feed magnet. When the feed magnet opens, the detent disengages from the detent wheel, and the feed of the positive carbon is stopped.

| Ref. No. | Designation | Ref. No. | Designation |
|---|---|---|---|
| L146a | Negative-drive-clutch Feed Coil | L232 | Positive-feed Rate-adjustment Knob |
| L146b | Negative-drive-clutch Retract Coil | L273 | Positive-feed-magnet Armature |
| L151 | Negative-drive-clutch Armature | L276 | Positive-feed Button (Manual) |
| L154 | Bevel Gear | L6 | Negative-drive Shaft |
| L61 | Bevel Gear | L4 | Positive-feed Shaft |
| L163a | Negative-drive Disk | L5 | Positive-drive Shaft |
| L163b | Bevel Gear | L342 | Helical Gear with Shaft |
| L156 | Bevel Gear | L344 | Positive-feed Detent |
| L168 | Negative-drive Crank (Manual) | L350 | Positive Rotating Tube |
| | | L355 | Helical Gear |
| La4 | Lamp-mechanism Motor | L360a, L360b | Detent Wheel and Planetary Gear |
| L63 | Spur Gear | | |
| L204 | Spur Gear | L362 | Gear |
| L203 | Worm | L363 | Worm |
| L212, L207 | Worm Gear and Overrunning Clutch | L368 | Worm Gear |
| | | L370 | Gear |
| L218 | Bevel Gear | L373 | Gear |
| L219 | Bevel Gear | L375 | Positive-feed Rollers |
| L224 | Positive-semiautomatic-feed Cam | L380 | Gear with Hub |
| | | L374 | Gear |
| L230 | Positive-drive Clutch (Manual) | L407 | Negative-feed Rollers |
| | | L409 | Worm Gear |
| L77 | Positive-drive Crank (Manual) | L403 | Gears |
| | | L416 | Bevel Gear |
| L245, L246 | Positive-semiautomatic-feed Contacts | L415 | Bevel Gear |
| | | L417 | Worm |

## GENERAL A CHLIGHT AND CONTROL STATION



[The semiautomatic feed, which is described by the directly following paragraph, is also applicable under automatic operation due to the fact that the circuit through positive-feed contacts L245 and L246 is in parallel with the thermostat contacts. When the thermostat contacts are not closed, the feed magnet is intermittently operated by the action of these positive-feed contacts. This gives an intermittent positive-carbon feed. The rate of the feed can be varied by turning knob L232, but should never be set at such a high rate as to cause overfeeding of the positive carbon. Overfeeding is a condition which occurs when the rate of feed is greater than the rate of burning.]

(2) Under semiautomatic operation, the thermostat and electric control provided by it are considered inoperative. Instead of thermostat control, control is obtained through proper setting of positive-feed rate-adjustment knob L232 which positions the positive-feed contacts in relation to feed cam L224 closing them and energizing the positive-feed magnet intermittently, and thus suitably positioning the positive carbon.

(3) Under manual operation, proper feeding of the positive carbon has been described by Paragraph 37 d. Note that control is provided only for forward feed of the positive carbon, and that the positive carbon cannot be retracted after it has been overfed.

### e. Maintenance of Arc Current

It is necessary to keep the negative carbon in such a position with respect to the positive carbon that a nominal current of 150 amperes at the searchlight ammeter is maintained.

(1) Under lamp operation, the current through the arc decreases as the arc length increases. Arc length is the distance from the negative-carbon tip to the positive-carbon crater, and the proper arc length is such as to allow a nominal current at the searchlight ammeter of 150 amperes. To maintain the proper arc current, the negative carbon is fed forward or backward by the negative-drive mechanism which has been described. The control of this mechanism is by arc-current regulator La1 through which proper excitation of the feed and retract coils in drive clutch La2 is obtained. The regulator consists of a magnet coil, a pivoted armature which is attracted by the magnetic pull of the coil, a spring which opposes the magnetic pull on the armature, and contacts L100, L101, L102 and L103, which are actuated by the movement of the armature. When the arc current is at the proper value, the magnetic pull on the regulator armature is exactly balanced by the pull of the regulator spring, and the regulator contacts are not closed. Hence, no excitation is provided for either clutch coil, and the negative drive from the clutch to the lamp is stationary. As the negative carbon burns back, the arc length increases and the current through regulator coil L104 decreases (Refer to Fig. 21), thereby decreasing its magnetic pull. Then the pull of the spring overcomes the magnetic pull of the armature, and the contacts L101 and L102 on the regulator are closed. These contacts complete the circuit to feed coil L146a, causing the revolving

armature of the clutch to make contact with the negative-drive disk and feed the negative carbon forward. As the carbon moves forward, the current through the coil increases until a balanced condition exists and the feed coil is no longer excited, thereby stopping the forward motion of the carbon. In the event of objectionable peaks of current at the arc lamp, retract coil L146b is excited by the reverse of the above process, causing the negative carbon to be withdrawn until the balanced condition is reached. When there is no current flowing through the regulator coil, the pull of the spring is unopposed, closing the feed contacts.

(2) The preceding paragraph explains how the setting of the arc-current regulator will affect its performance and, therefore, the arc current. This adjustment is primarily intended to govern the arc current, so that the best possible arc will be obtained. Detailed instructions concerning the adjustment of the regulator are contained in the Searchlight and Control Station Maintenance Manual.

(3) The lamp is provided with a negative-carbon hand-feed control system to be used in the event of failure of the foregoing automatic system. Detailed instructions have been given above under Paragraph 37 f for manual control of the negative carbon. Electric control under this condition is disconnected by switch L174 when negative-drive crank L168 (Fig. 23 and 24) is pushed in for operation. This switch consists of a metal washer on the drive-crank rod which engages a contact point on the terminal block fastened to the frame of the negative-drive clutch assembly.

### f. Automatic Arc Strike

The arc will be struck automatically when the arc switch is closed, except when the negative-drive crank is pushed in. In automatic operation, when the arc switch is closed, the negative carbon is quickly driven forward, since the regulator contacts L101 and L102 controlling the feed coil are closed as previously explained. When the negative carbon strikes the positive carbon, the resulting high current causes the arc-current regulator to close contact L102 with contact L100 which energizes the retract coil of the magnetic clutch. The negative carbon is retracted until the current drops to the value determined by the setting of the arc-current regulator. It will be noticed that when the current is high, as at the time of arc strike, two contacts are closed instead of the regular retract contact L100. The purpose of this additional contact L103 is to reduce the resistance in series with the retract coil of the magnetic clutch in order to compensate for the drop in the line voltage due to the high current. This insures satisfactory operation of the magnet coils of the magnetic clutch during the striking period.

(1) It may be noticed that, upon opening the arc switch, the negative carbon may feed toward the positive carbon, which will allow a quick restriking of the arc. (Quick restriking of the arc is desirable so that the target can be viewed promptly after it has been picked up by the locator.) The explanation of this is as follows:

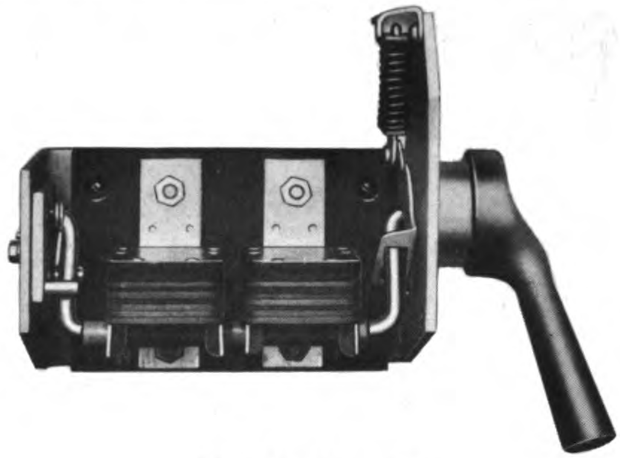


Fig. 25. Arc switch

(*a*) When the arc switch is opened, both the ventilating-fan motor and the lamp-mechanism motor begin to coast to a stop, while the regulator closes the feed contacts. The ventilating-fan motor as it coasts generates an electric current. Since the feed contacts on the regulator are closed, the feed coil in the clutch will be actuated by this current and will cause the clutch armature, which is rotating as the lamp-mechanism motor coasts to a stop, to drive the disk and gearing in a direction to feed the negative carbon forward.

## 38. Arc Switch

Arc switch Ea in the elevation control box, illustrated in Fig. 25, is a special safety switch constructed to prevent excessive contact burning. The quick-make and quick-break feature of this equipment provides for quick positive action both for closing and opening the arc circuit.

## 39. Searchlight Power Instruments

The searchlight power instruments at the elevation control box (See Fig. 8) provide visual indication of the lamp, lamp-control, and ventilation current and voltage. The ammeter and voltmeter are respectively 0-300-ampere and 0-150-volt moving-coil instruments, suitable for the overloads to be expected in normal searchlight operation. Each instrument scale has been marked with a heavy line at the normal lamp-operating point, and each instrument is provided with an external zero-adjustment screw.

## 40. Ventilating System

The drum is equipped with a ventilating system, shown by Fig. 26, so that the interior surfaces of the drum are continuously swept with fresh air. The ventilation system provides for adequate cooling of the lamp-control mechanism by circulation of air through a labyrinth in the lamp-control-box casting. Cooling for the lamp is provided by a stream of air through the lamp column, directed at the positive brushes and the nose cap. Air is drawn by

## GENERAL ARC SYSTEM, DRUM DETAILS

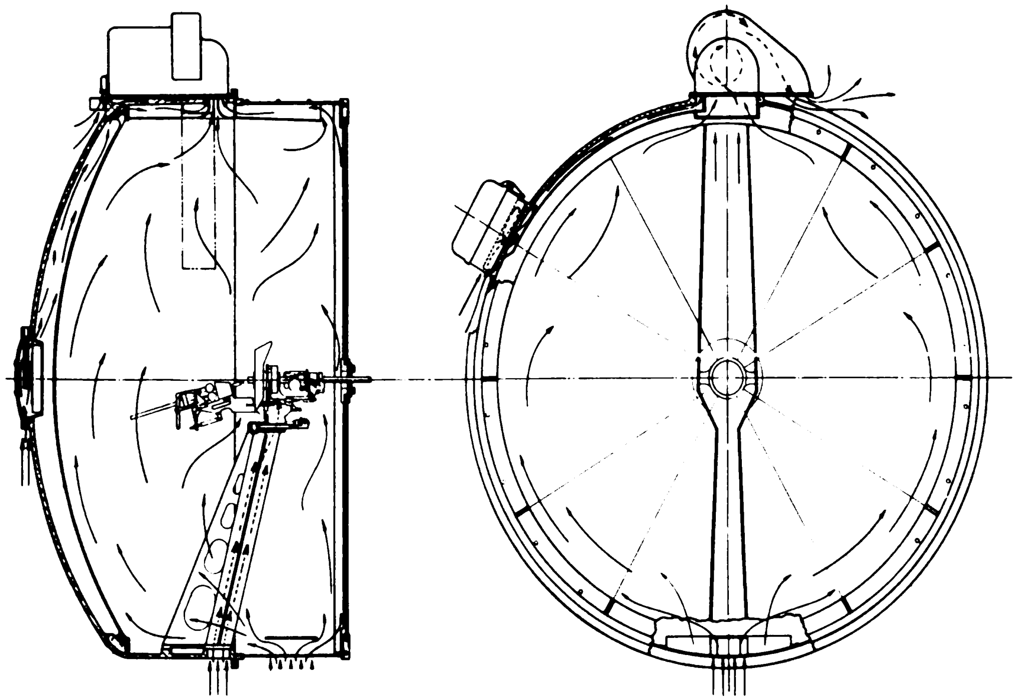


Fig. 26. Ventilating system

a motor-driven fan through openings at the base of the drum, the center of the rear drum dome, the lamp box, and the ventilating-motor housing.

## 41. Drum Details

The following items contained in the drum facilitate lamp operation (refer to Fig. 10):

**a.** The ground-glass finder F29, located at the operator's side of the forward drum, provides an indication of the burning-carbon position and the general arc condition. The ground-glass field contains a black line, indicating the focal point of the mirror and hence the position of the positive-carbon tip when the narrowest and most intense beam is desired. The ground-glass field also contains a red "DANGER" line which indicates the minimum safe protrusion of the positive-carbon tip from the nose cap with the lamp at the preceding focal setting. When the lamp has been moved away from its focal setting, these lines lose their significance. The ground-glass finder assembly includes an adjustable erecting-lens system to provide a distinct image of both carbon tips and the major portion of the arc flame. In order that the correct focal setting of the lamp can be assured, it is essential that the ground-glass finder be in its proper position. When properly focused, the beam provides a spread of approximately 1¼ degrees and should appear as follows:

(1) Slightly contracted, when viewed alongside of the drum.

(2) Parallel edges, when viewed from about 10 feet from the searchlight.

(3) Slightly spread, when viewed from a distance of 50 feet or more from the searchlight.

If the beam does not so appear when the image falls at the black line, make the necessary adjustments in accordance with the instructions found in the Maintenance Manual.

**b.** The focusing knob R50, at the operator's side of the rear drum section, and its connecting linkage to the lamp are for moving the lamp along the mirror focal axis. A spread beam for illuminating a greater field at shorter ranges may be obtained by moving the lamp from its focal setting toward the mirror. This is done by turning the knob counterclockwise.

**c.** Peep sights (F81 and R71) are located on both sides of the drum for direct observation of the general condition of the arc. Each sight is equipped with a suitable filter glass.

**d.** A recarboning lamp R115 to provide illumination for recarboning at night is located inside the drum. A switch for control of this lamp is located at the side of the elevation control box.

### 42. Miscellaneous Devices

The following devices form a part of the general arc system:

**a.** Voltage-adapter relay Jf, Fig. 4, shown in the arc circuit, is for a relay providing voltage adaptation for the dynamotor. The function of this relay will be described in the text covering the zero-reader system. (See Paragraph 47 a.)

**b.** Scale-lamp switch E56, mounted on the side of the elevation control box, is provided for turning ON and OFF the instrument lamps in the elevation control box and in the azimuth control box, the elevation-scale lamp, and the azimuth-scale lamp.

**c.** Receptacle E49, mounted on the bottom of the elevation control box, provides a convenient source of direct current for a portable trouble lamp, a soldering iron, or other low-current tools and instruments.

## ZERO-READER SYSTEM

### 43. Components of Zero-reader System

**The zero-reader system provides indication of the relative positions in azimuth and elevation of the control station, the searchlight, and the locator. It includes the following component parts: the dynamotor, which is also required for the D.E.C. system; a-c transmitters and control transformers; zero-reader instruments; and miscellaneous devices in the zero-reader circuit, all of which are covered in the following text. Fig. 27 schematically shows the general arrangement of the zero-reader system. Although this diagram shows only the azimuth circuit arrangements, it also serves as an indication of the elevation circuit, with the exception that only one zero-reader instrument is used at the searchlight for elevation indication. The cir-**

## ZERO-READER SYSTEM, COMPONENTS

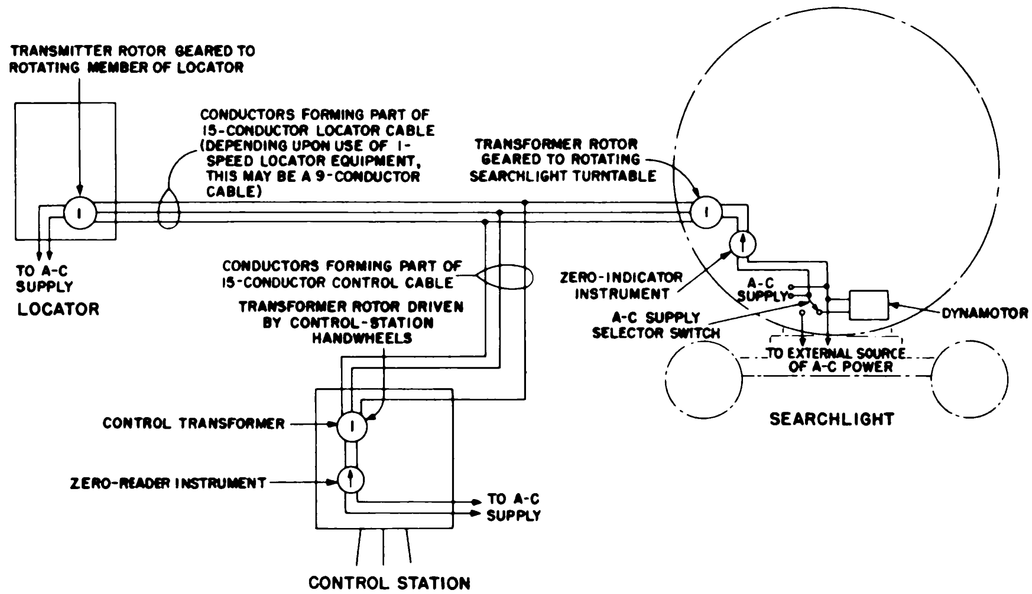



**Fig. 27. Schematic diagram of zero-reader system**

cuit for that instrument is provided with a selector switch for connecting it to either the 1-speed or the 33-speed control transformer.

### a. Function of System

If the searchlight is operated directly from a locator, the zero-reader system indicates the angular position of the searchlight with respect to the locator, and therefore is of material assistance during hand operation in the event of failure of the D.E.C. system. Under the method of D.E.C. used in this system, it serves as a check on the Automatic D.E.C. operation. The voltage output of the control transformer at the searchlight is zero when the searchlight and locator are in correspondence. When the searchlight is controlled from the control station, the zero-reader, or indicator instruments, at the control station indicate the angular position of the control station with respect to the locator. The 1-speed-circuit zero indicators at the searchlight then indicate the angular position of the searchlight with respect to the control station.

### b. Low-speed Synchronism

The angular displacement of the 1-speed (low-speed) transmitter as shown by Fig. 27 is attained by a one-to-one drive ratio between its rotor and the moving assembly of the locator or the control station. A corresponding drive ratio is provided between the control-transformer rotor and the moving assembly of the control station or the searchlight. Therefore, as long as correspondence between the locator and the control station and between the control station and the searchlight is maintained, the voltage output, respectively, of the control-station control transformer and of the searchlight control transformer will be zero. When the locator and the control station are out of correspondence, the control-station control transformer has a voltage output; and when the control station and the searchlight are out of correspondence, the searchlight control transformer will have a voltage output. The variable-magnitude, reversible-polarity control-transformer output is connected to the zero-indicator (zero-reader) instrument.

### c. High-speed Synchronism

In addition to the one-to-one drive ratio, the searchlight is provided with control transformers, both in azimuth and elevation, which are coupled to the searchlight motion at 33-to-1 (high-speed) ratio. These control transformers are used primarily in the D.E.C. system, but are provided with connections to the zero indicators for orientation purposes. Full information regarding orientation has already been given in Paragraph 28 of this Manual.

## 44. Dynamotor

The dynamotor, located on the chassis frame, is provided for converting the direct-current supply to alternating current required for both the zero-reader system and the D.E.C. system. The rating of the input, or driv. ing section, of the dynamotor is 78 volts at 6 amperes, direct current; and the rating of the output, or generating section, is 115 volts, 3 amperes, 210 watts, single-phase, 60-cycle alternating current. The rotational speed of the armature upon which are wound both the a-c and d-c windings is 3600 revolutions per minute. In this dynamotor there is an interconnection in the armature between the a-c and the d-c windings which circulates the a-c through part of the d-c winding to obtain better output voltage regulation. The dynamotor operates when the a-c selector switch mounted in the junction box is in its DYNAMOTOR position.

## 45. Transmitters and Control Transformers

Transmitters and control transformers in the azimuth and elevation zero-reader circuits are provided as a means for electrically detecting angular displacements between the locator, the control station and the searchlight. Both the transmitters and the control transformers are similar in construction to small three-phase alternators. The stators, or stationary parts, of both machines are cylindrical, slotted, laminated magnetic structures with a distributed Y-connected winding. The leads to the stator windings are marked S1, S2, and S3. In operation, the stator windings of the control transformer are electrically connected to those in the transmitter. The single-phase winding on the salient-pole or "dumbbell"-type rotor of the transmitter is energized by alternating current through slip rings. The a-c voltage induced in the single-phase winding on the cylindrical control-transformer rotor is taken off through slip rings. The rotor leads on both styles are marked R1 and R2. Indication of the angular displacement between the transmitters and the control transformers is obtained by the position of the azimuth and elevation zero-reader-indicator pointers.

## ZERO-READER SYSTEM, CONTROL TRANSFORMERS

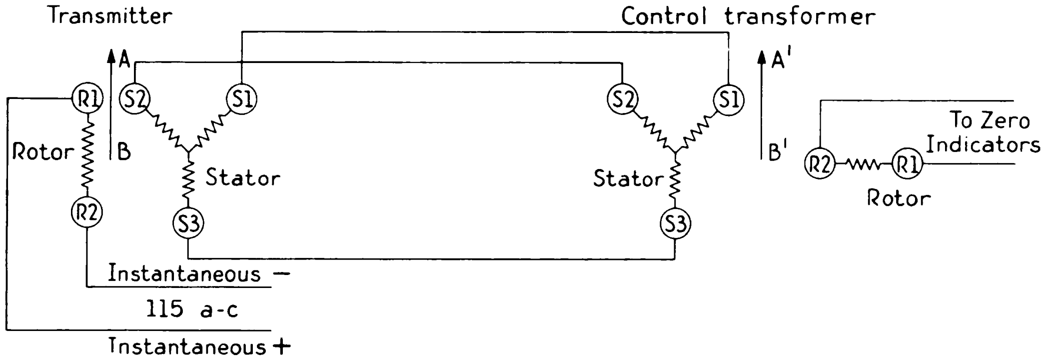



Fig. 28. Schematic diagram of transmitter and control transformer at zero-output position

### a. Theory of Operation

Fig. 28 is a simplified schematic diagram which shows a typical a-c transmitter connected to a control transformer, the rotor of which is connected to the armature winding of a zero-indicator instrument. In the arrangement shown by this figure, the transmitter rotor sets up an a-c magnetic field along the axis AB and, by transformer action, voltages are set up between terminals S1 and S2, S1 and S3, and S2 and S3 of the stator which, when applied to the transformer stator, provide an a-c magnetic field along the axis A′B′.

When the transmitter rotor moves, as it does when transmitting data of angular motion, the axis of the field A′B′ in the control transformer follows exactly the movement of the axis of the field AB or, in other words, exactly follows the movement of the transmitter rotor. With conditions such as shown by Fig. 28, the field A′B′ of the control transformer is at right angles to the axis of the rotor, inducing zero voltage in the rotor. The control-transformer voltage output is, therefore, zero. If the transformer rotor is slightly shifted either clockwise or counterclockwise from the position shown, there is a voltage output. The magnitude of this voltage varies with the angular displacement of the rotor from a position at right angles to the field of the transformer stator. A shift from lead to lag or from lag to lead in relationship between the transformer and the transmitter

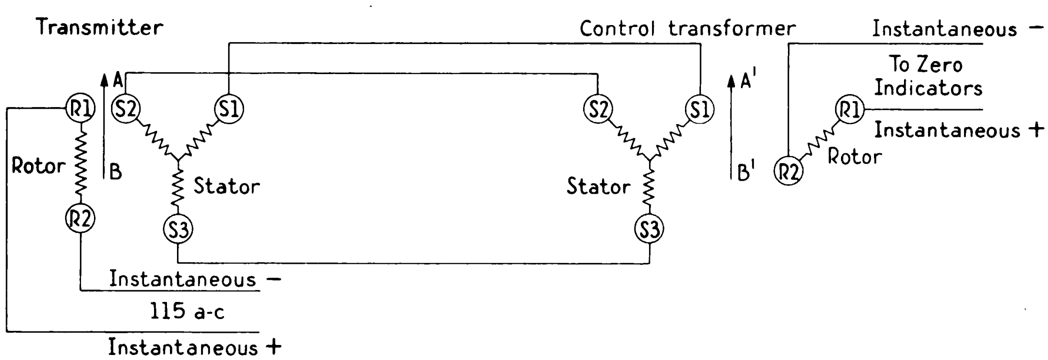



Fig. 29. Schematic diagram of transmitter and control transformer in a non-synchronous position

causes the voltage induced in the rotor to approach zero and then reverse in instantaneous polarity. If the transformer rotor lags in a counterclockwise direction, as shown in Fig. 29, the instantaneous polarity of the output voltage will be the same as the instantaneous polarity of the transmitter supply voltage.

## 46. Zero Indicators

The zero-indicator instruments are two-element meters in which the field and armature windings are electrically isolated but magnetically coupled together. The field winding of each instrument is constantly excited from the same a-c supply that excites the *transmitter* rotor. The armature winding is free to rotate through a limited angle and the indicating pointer is fastened to this winding. The armature winding of each instrument is connected to the leads of its respective *control-transformer* rotor. The normal position of the indicating pointer is at the center of the scale, thus indicating that the voltage across the armature of the instrument is zero and that alignment has been secured. Conversely, deflection of the pointer indicates a voltage across the armature.

### a. Theory of Operation

(1) When the searchlight is being controlled directly from the locator (Automatic D.E.C.) and the locator is moved in relation to the searchlight, a voltage is applied to the searchlight zero-indicator-instrument armature. If the searchlight is moved to follow and catch up with the locator, the voltage applied to the indicator instrument armature will be reduced to zero.

(2) When the searchlight is being controlled from a control station (Manual D.E.C.), movement of the *locator* causes a voltage to be applied to the control station zero-reader-instrument armature. If the control station is moved to follow and catch up with the locator, the voltage applied to the armature will be reduced to zero, regardless of the searchlight position at the time.

(3) The direction in which the pointer moves will depend upon the relation of the instantaneous polarity of the a-c excitation to the control-transformer output voltage. The magnitude of this voltage is indicated by the amount that the pointer is deflected in either direction from the zero position. Therefore, it can be determined from the position of the pointer in which direction and, to a limited extent, how much the equipment must be moved to bring it into alignment. The pointer and the scale of the zero instruments are marked with luminous paint in order that they may be observed at night without the use of scale lights.

## 47. Miscellaneous Devices

The following devices form a part of the zero-reader system:

**a.** The dynamotor voltage-adapter relay (Jf) and resistor (J34 and J35) mounted in the junction box, Fig. 4, are provided to maintain approximately the same d-c supply voltage to the dynamotor under control-load and arc-load searchlight operation. Since the relay winding is in the searchlight d-c supply circuit (Fig. 21) the relay contacts are closed under arc-load conditions and are open under control-load conditions. The resistor is placed in the dynamotor d-c supply circuit, and is cut out of the supply circuit under arc-load conditions by the closing of the voltage-adapter-relay contacts. This maintains an approximately constant dynamotor supply voltage. A tap for adjustment is provided on this resistor so that the proper a-c voltage output from the dynamotor may be obtained under control-load conditions.

**b.** A double-pole, double-throw selector switch (J77) for control of the dynamotor is also provided in the junction box. In addition to controlling the dynamotor, this switch provides for connecting the searchlight a-c circuits to an external source of alternating current which may be furnished by certain locators. When external a-c is used, the switch is thrown to its EXTERNAL position, and the dynamotor does not operate.

**c.** A protective 5-ampere fuse (J60) for the a-c supply is in the junction box, and a red pilot light (E30) for indicating a-c supply availability is located in the elevation control box.

**d.** A 15-ampere fuse (J59) to prevent the dynamotor from drawing excessive d-c input current is also in the junction box.

**e.** A selector switch (E187) is provided in the elevation control box for connecting the elevation zero indicator to either the 1-speed or the 33-speed control transformer.

NOTE: Fig. 71 and 72 are the connection diagram and schematic wiring diagram for the entire searchlight equipment.

# DISTANT-ELECTRIC-CONTROL SYSTEM

## 48. General Description of D.E.C.

The Model 1942 Searchlight differs from the preceding searchlight models primarily in regard to its method of distant electric control (D.E.C. System). This section of these instructions covers a description of the means for directionally controlling the searchlight. It is important that the operator fully understand all the fundamentals of this control system.

### a. Features of System

The control, as will be apparent by observing the searchlight in operation, provides a number of distinctive features. It permits rapid acceleration and movement of the searchlight in azimuth and elevation in order that a low-flying, high-speed target may be more readily followed. It provides for extremely low or creeping, stepless speeds for tracking a distant or high-flying target. Self-synchronization, or means by which the searchlight automatically assumes correspondence with the locator or control station, is provided within the limits of elevation travel and at all locations in azimuth, with the exception of a "knife-edge" position 180 degrees from the true point of correspondence.

### b. Methods of Control

The D.E.C. System is arranged for directional control of the searchlight under various equipment setups as follows:

Method A—By direct control from a locator which may be equipped for only 1-speed control transmission. This is referred to as Automatic D.E.C.

Method B—By direct control from a locator which may be equipped for both 1- and 33-speed control transmissions. This also is referred to as Automatic D.E.C.

Method C—By control from the control station under a 1-speed transmission system. This is referred to as Manual D.E.C.

Means have been provided for quickly transferring control from the locator (Automatic D.E.C.) to the control station (Manual D.E.C.) and back to the locator.

### c. General Theory of Operation

Before entering into a detailed description of the various methods and devices, reference is made to Fig. 30, which schematically outlines the azimuth control, and which is essentially duplicated by the elevation control. The various notations on this schematic outline are self-explanatory; however, the following points are of particular interest:

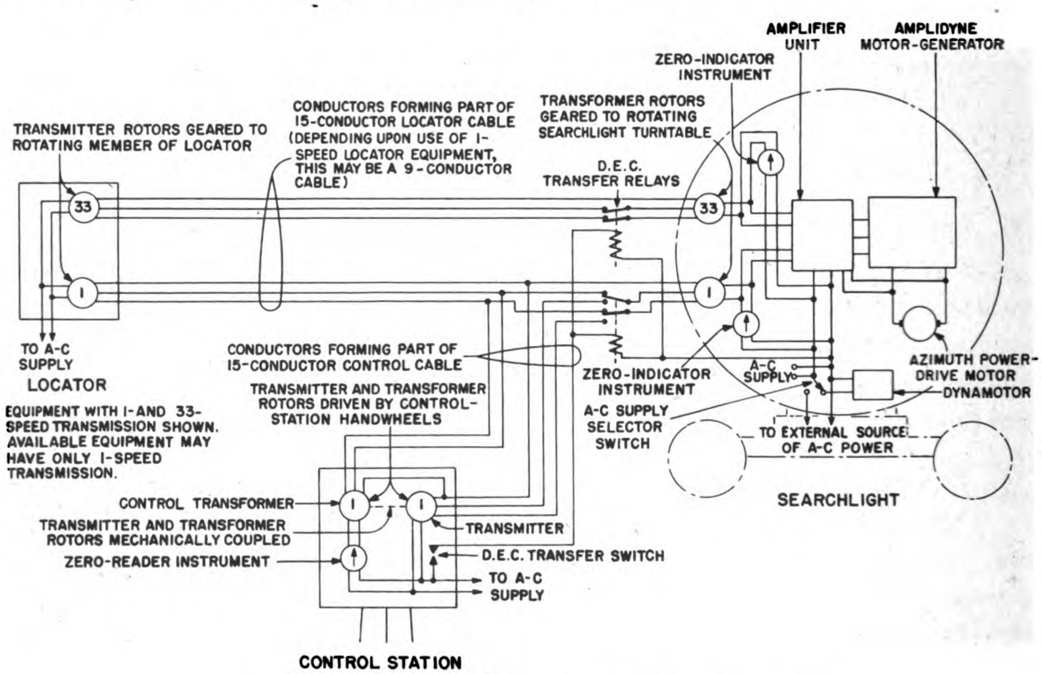



Fig. 30. Schematic diagram of azimuth D.E.C. system

## D.E.C. SYSTEM, TRANSFER BETWEEN METHODS

(1) The searchlight directional control is suitable for operation to a fine degree of accuracy with the combination of the 33-speed and 1-speed controls and to a lesser degree of accuracy with the 1-speed control only. The locator control may, therefore, be arranged either for the combined control as shown or with the 33-speed transmitter circuits omitted.

(2) By operation of the D.E.C. transfer switch at the control station, the D.E.C. transfer relays at the searchlight are energized, causing the 33-speed (high-speed) D.E.C. transfer relays to disconnect the 33-speed transmission circuits from the searchlight and causing the 1-speed (low-speed) D.E.C. transfer relays to shift the 1-speed searchlight-transformer input circuits from the locator to the control station.

(3) As indicated by Fig. 30, the searchlight control-transformer rotors are geared to the rotating members of the searchlight in such a manner as to provide for the proper speed ratios. The terms 1-speed and 33-speed mean that the rotors of the control transformers or transmitters are geared to the rotating members at ratios of 1 to 1 and 33 to 1, respectively.

### 49. D.E.C. Devices at Searchlight and Control Station

The D.E.C. System consists of mechanical and electrical devices at the searchlight and at the control station for directional movement of the searchlight. The devices at the searchlight are required for all methods of D.E.C. operation; whereas those at the control station are required only for Manual D.E.C.

#### a. Transfer between Methods of D.E.C.

In order that proper transfer, however, may be made between Automatic and Manual D.E.C., it is essential that control-station follow-up or synchronization be maintained immediately prior to and during such transfer. The reason for the latter requirement has previously been stated in Paragraph 31c and is repeated here for emphasis.

(1) Assume that connections have been made for Automatic D.E.C. as in Fig. 30; and that a target has been picked up by the locator and is illuminated by the searchlight. For tactical reasons, it may be desirable to release the locator for detecting other targets while the searchlight will continue to track the original target. If proper follow-up has been maintained at all times at the control station, the binoculars are in a suitable position for the target pickup and very little, if any, jump will be apparent in the searchlight beam at the instant of transfer from Automatic D.E.C. to Manual D.E.C. The latter condition is important, as a target may easily be lost by too great a movement of the searchlight beam during the transfer. Mechanical and electrical devices for both units of equipment are, therefore, essential to the D.E.C. System.

### b. D.E.C. Subsystems

For clarity of detail description, the D.E.C. System may be divided into: The Mechanical Subsystem; the Power-drive Subsystem; the Electrical-actuation Subsystem; and the Protective Subsystem. These subsystems are individually described in the following paragraphs.

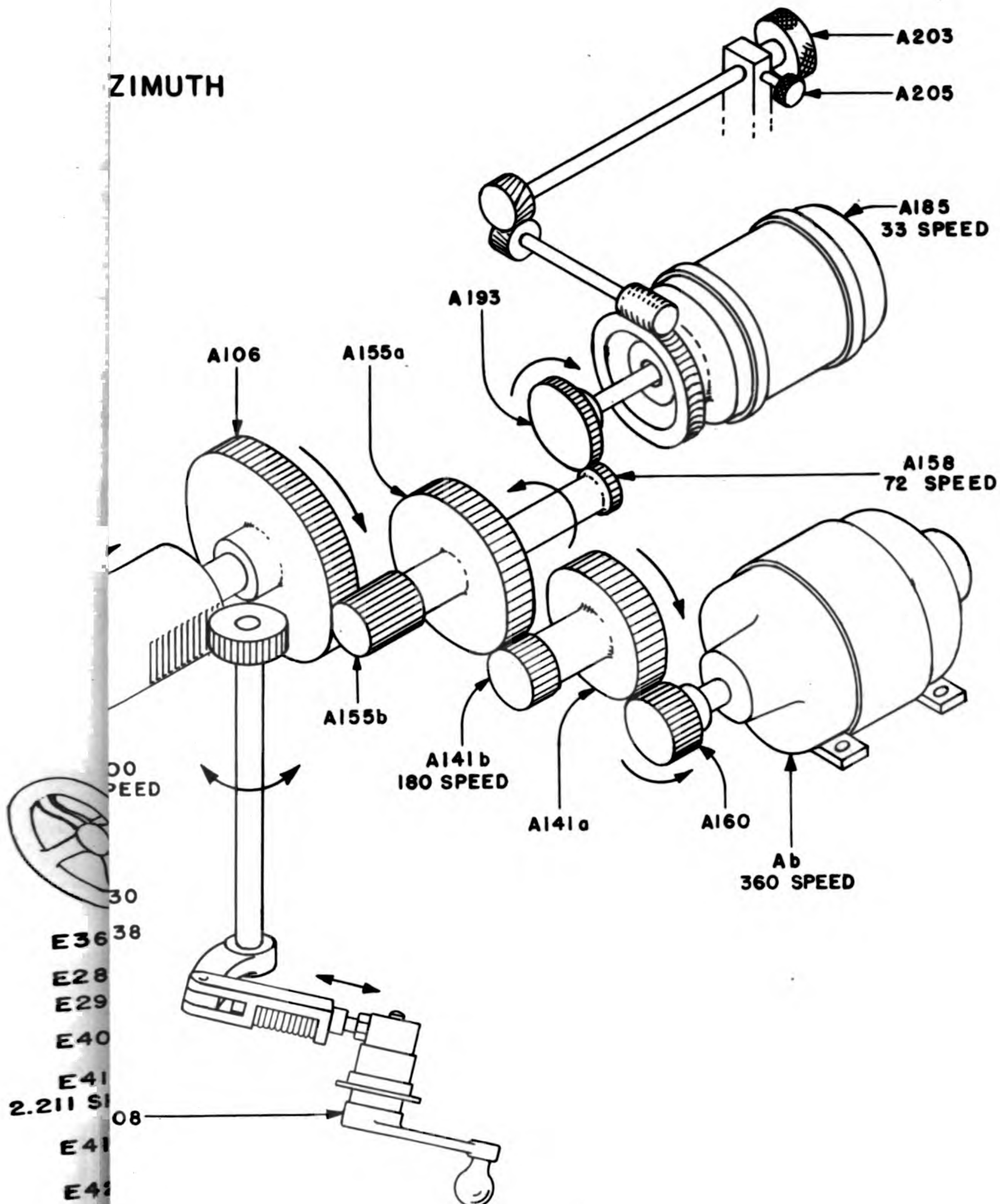
## 50. Mechanical Subsystem at Searchlight

The mechanical devices of the D.E.C. System at the searchlight include means for moving the searchlight both in azimuth and in elevation, and means for driving the control-transformer rotors in accordance with this motion, as well as arrangements for initial control-transformer adjustment. The mechanical devices for D.E.C. at the searchlight are shown in Fig. 31, and operate as described in the following text:

| Ref. No. | Designation | Ref. No. | Designation |
|---|---|---|---|
| A108 | Azimuth Clutch-lever Assembly | E274 | Gear (Pinion) |
| A102 | Shift Assembly (Bushing) | R23 | Elevation Rack Gear |
| Ab | Azimuth Drive Motor | E256 | Gear |
| A185 | Azimuth 33-speed Control Transformer | E255a | Shaft |
| A100 | Shaft | E255b | Shaft Coupling |
| A104 | Pinion | CB2a | Extended-hand-controller Coupling |
| A106 | Gear | E283 | Shaft with Worm Gear |
| A158 | Gear | E289a, E289b E289c | Elevation 33-speed Corrector Coupling, Brake Disk, and Gear |
| A193 | Spur Gear | E361 | Brake-lever Disks |
| A155a, A155b | Gears | E369 | Brake Handle |
| A141a, A144b | Gears | E290 | Adjustment Worm |
| A160 | Motor Gear | E293 | Lock Screw |
| A203, A205 | Azimuth 33-speed Corrector and Thumbscrew | E403 | Gear |
| B14 | Azimuth 1-speed Control Transformer | E387 | 33-speed Control Transformer |
| B15 | Extension Shaft | E410 | Gear |
| T30 | Worm-wheel Gear | E406 | Shaft with Gear |
| T119 | Worm | E422, E423 | Gears |
| T138, T130 | Azimuth 1-speed Corrector and Thumbscrew | E412 | Gear |
| T9 | Turntable Ring Gear | E418 | Elevation Electrical-limit Arms |
| Ed | Elevation Drive Motor | E415 | Adjusting Screws for Arms |
| E131 | Elevation Clutch Lever | E399a, E399b | Upper- and Lower-limit Switches |
| E325 | Motor Gear | T72 | Elevation 1-speed Control Transformer |
| E314a, E314b | Gears | T207, T212 | Elevation 1-speed Corrector and Clamp |
| E300 | Gear and Bearing | | |
| E281 | Clutch Assembly | | |
| E302 | Gear | | |
| E268 | Gear | | |

# ODEL 1942 SEARCHLIGHT AND CONTROL STATION

ZIMUTH



# MODEL 1942 SEARCHLIGHT AND CONTROL STATION

| Ref. No. | Designation |
|---|---|
| S37 | Controller Stationary Ring Gear |
| S258 | Zero-reader's Handwheel (Azimuth) |
| S250 | Bevel Gear |
| S288 | Bevel Gear |
| S260 | Shaft |
| S286 | Worm |
| S306 | Clutch |
| S308a | Worm Gear |
| S308b | Gear |
| S171a | Gear |
| S180a | Gear |
| Sa5a | Transmitter (Azimuth) |
| Sa6a | Control Transformer (Azimuth) |
| S298 | Shaft |
| S309 | Gear |
| S284 | Clutch |
| S280 | Gear |
| S293a, S293b | Gears |
| S276 | Gear |
| S273 | Flywheel |
| S265 | Bevel Gear |
| S261 | Bevel Gear |
| S233 | Bevel Gear |
| S220 | Bevel Gear |
| S222 | Clutch |
| S185 | Observer's Handwheel (Azimuth) |
| S188 | Gear-rato Shifter |
| S348 | Zero-reader's Handwheel (Elevation) |
| S351 | Bevel Gear |

| Ref. No. | Designation |
|---|---|
| S376 | Bevel Gear |
| S374 | Worm |
| S406 | Worm Gear |
| S409 | Gear |
| S171b | Gear |
| S180b | Gear |
| Sa5b | Transmitter (Elevation) |
| Sa6b | Control Transformer (Elevation) |
| S372 | Helical Gear |
| S350 | Shaft |
| S394 | Helical Gear |
| S400 | Gear |
| S381 | Gear |
| S55 | Gear |
| S442 | Binocular-mount Shaft |
| S443a | Rack |
| S425a | Pinion |
| S425b | Worm Gear |
| S428 | Worm |
| S429 | Height-adjustment Crank |
| S447 | Binocular Azimuth Clutch |
| S478 | Binocular Elevation Clutch |
| S470 | Shaft |
| S469 | Worm Gear |
| S461 | Worm |
| S369 | Gear |
| S388a, S388b | Gears |
| S320 | Observers' Handwheel (Elevation) |
| S366 | Gear |
| S363 | Flywheel |
| S351 | Bevel Gear |
| S327 | Bevel Gear |

# MODEL 1942 SEARCHLIGHT AND CONTROL STATION

## 51. Mechanical Subsystem at Control Station

The mechanical devices of the D.E.C. system at the control station include means for driving the control-station control transformers which were described above in connection with the Zero-reader System; for driving the control-station transmitters; and for moving the controller housing in azimuth, and the binoculars in azimuth and elevation. These movements are obtained by means of handwheels. The mechanical devices for D.E.C. at the control station are shown in Fig. 32, and operate as follows:

### a. Azimuth

(1) The controller housing and binoculars are rotated in azimuth by means of zero-reader-operator's handwheel S258, bevel gears S250 and S288, shaft S260, worm S286, worm gear S308a, clutch S306, shaft S298, gears S309, and stationary ring gear S37. Clutch S306, just referred to, permits the controller housing to be moved in azimuth independently of any motion on the handwheel-drive side of the gear train. The purpose for such movement has previously been discussed in Paragraph 28 under orientation. The binocular mount may be shifted in azimuth with respect to the controller housing by slipping clutch S447, for correction of parallax, as also previously described. This movement is not limited by stops, but attention is directed to the slight effect of such azimuth movement on the position of the binoculars in elevation.

(2) The controller housing and binoculars may also be rotated in azimuth by means of observer's handwheel S185, through clutch S222, and bevel gears S220 and S265, or S233 and S261, depending upon the drive ratio desired. Clutch S222 is so arranged that shifting plunger S188 in the knob of handwheel S185 changes the speed ratio between the handwheel and the controller motion in azimuth. For normal, or distant-target, tracking the plunger will be so positioned that its smooth end will be flush with the handwheel knob. In this case, the drive is through bevel gears S220 and S265, giving a ratio of 72 to 1. When relatively low handwheel speed accompanied by high-speed tracking is desired, the plunger at the handwheel knob is pushed in the opposite direction, thus engaging the clutch with bevel gear S233 which in turn drives shaft S260 through bevel gear S261, giving a ratio of 30 to 1.

(3) Flywheel S273, turning freely on shaft S260, is driven from this shaft through clutch S284, and gears S280, S293b, S293a, and S276. The purpose of the flywheel is to prevent excessively rapid accelerations and decelerations of the searchlight in azimuth under Manual D.E.C. operation, and, in general, to promote smooth control of the searchlight motion in this type of operation. The friction clutch in the gearing to the flywheel is provided so that, with the observer's handwheel in its low-speed ratio, it is unnecessary for the observer to accelerate and decelerate the flywheel as rapidly as the handwheel. This permits the searchlight to be moved more quickly than if the flywheel were positively geared to shaft S260.

(4) Controller azimuth transmitter Sa5a is driven in fixed relation to shaft S260 by means of worm S286, worm gear S308a, and gears S308b and S171a. Controller azimuth control transformer Sa6a is geared directly to the transmitter, through gears S171a and S180a. No hand-operated adjustments are provided for either the transmitter or the control transformer. Instructions for necessary adjustments are given in the Maintenance Manual.

### b. Elevation

(1) The binocular mount is moved in elevation about shaft S470 by means of worm gear S469, worm S461, shaft S442, gears S55, S381 and S400, helical gears S394 and S372, shaft S350, and zero-reader's handwheel S348 through bevel gears S376 and S351, or observer's handwheel S320 through bevel gears S327 and S351. The position of the binocular mount with respect to shaft S470 may be changed by loosening the two large adjusting nuts of clutch S478.

(2) Flywheel S363, turning freely on shaft S350, is driven from this shaft by means of gears S369, S388b, S388a and S366. This flywheel prevents excessively rapid accelerations and decelerations of the searchlight in elevation under Manual D.E.C. operation, and, in general, promotes smooth control of the searchlight motion in this type of operation.

(3) Controller elevation transmitter Sa5b is driven in fixed relation to shaft S350 by means of worm S374, worm gear S406, and gears S409 and S171b. Controller elevation control transformer Sa6b is geared directly to the transmitter, through gears S171b and S180b. Neither the transmitter nor the transformer is provided with any hand-operated adjustments. Instructions for necessary adjustments are given in the Maintenance Manual.

(4) The height of the binocular mount with respect to the controller housing may be adjusted to suit the observer. This is accomplished by means of crank S429, worm S428, worm gear S425b, pinion S425a, and rack S443a.

## 52. Power-drive Subsystem

The D.E.C. Power-drive Subsystem, which is shown in Fig. 33, comprises the electrical means for driving the searchlight in azimuth and elevation. Briefly, the searchlight is driven in azimuth and elevation by the drive motors through gearing which has already been described. The power to operate these motors is furnished by two amplidyne motor-generator sets, each comprising a motor directly driving an amplidyne generator. The magnitude and polarity of the output current of each amplidyne generator depend upon the current supplied to its control field. The source of this field current will be discussed in a later paragraph of this section.

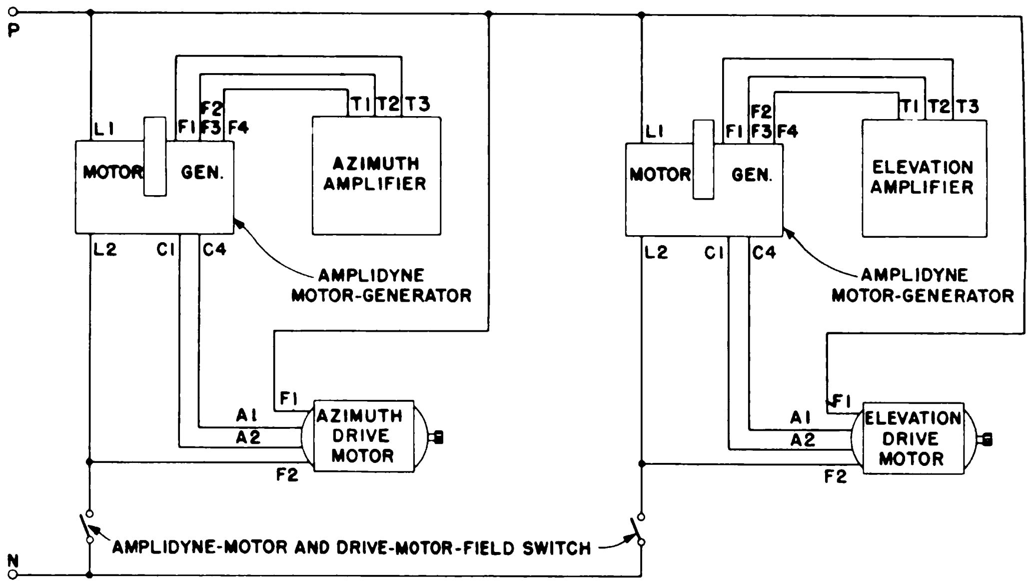



Fig. 33. Schematic diagram of power-drive subsystem

## a. Amplidyne Motor-generator

The amplidyne motor-generator is similar to the conventional d-c motor-generator set in that it is a rotating machine which converts mechanical energy into electrical energy. This amplidyne set is enclosed in a single housing with the armatures of the drive motor and the amplidyne generator mounted on a common shaft. The motor is a compound-wound, d-c motor designed to operate satisfactorily over the range of d-c supply voltage that exists during searchlight operation.

(1) The amplidyne generator, however, has some additional characteristics that make it highly desirable for use in this system. These are:

(*a*) Its high ratio of amplification. That is, it requires little power for excitation of its control field to generate a substantial output voltage. Thus, the comparatively weak output of the electronic amplifier will excite the control field to generate enough power to operate the drive motor.

(*b*) Its sensitivity. This second feature, of almost equal importance, is its speed of response to changes of the excitation signal. Not only will it pick up the drive motor from rest in an extremely short time, but its voltage output will respond almost instantaneously to small or rapid changes in the excitation signal.

(2) The explanation of the theory of operation of the amplidyne may be developed by first considering the conventional separately excited field, d-c generator.

(*a*) Fig. 34a shows in schematic form this type of generator with a resistance load in the armature circuit. When a current is passed through this field coil and the armature is rotating, a voltage is generated in the armature. A current then flows in the armature through the commutator

## D.E.C. SYSTEM, AMPLIDYNE MOTOR-GENERATOR

brushes and the external load. The value of this current is directly proportional to the generated voltage and inversely proportional to the armature-circuit resistance. This current through the armature windings produces, in turn, a magnetic flux (magnetic lines of force) which is always at right angles to the control-field flux; it is stationary, even though the armature is continuously rotating. The force that produces this armature flux is called armature reaction, and, in the ordinary generator, is a nuisance, preventing good commutation. Attempts usually are made to neutralize armature-reaction effect. In the amplidyne generator, however, this armature-reaction flux is used to advantage.

(*b*) If these brushes are short-circuited, the external resistance would be zero and the total armature-circuit resistance would be very low. Since the induced armature current is inversely proportional to this resistance, it is obvious that a very small control-field flux would cause a high armature current and, consequently, a high armature-reaction flux. Since the control-field flux has to build up only to a low value and the reactance of the short-circuited armature is very low, full load current will be obtained in an exceptionally short time.

(*c*) The armature-reaction flux may be utilized by adding another set of brushes at right angles to the short-circuited brushes, as shown in Fig. 34b. The stationary armature-reaction flux induces a voltage in the armature windings of these new "load-axis" brushes. If a resistance load is connected to these load-axis brushes, the current through this load will obey, in a much greater amplitude, the fluctuations of the current flowing through the control-field coil.

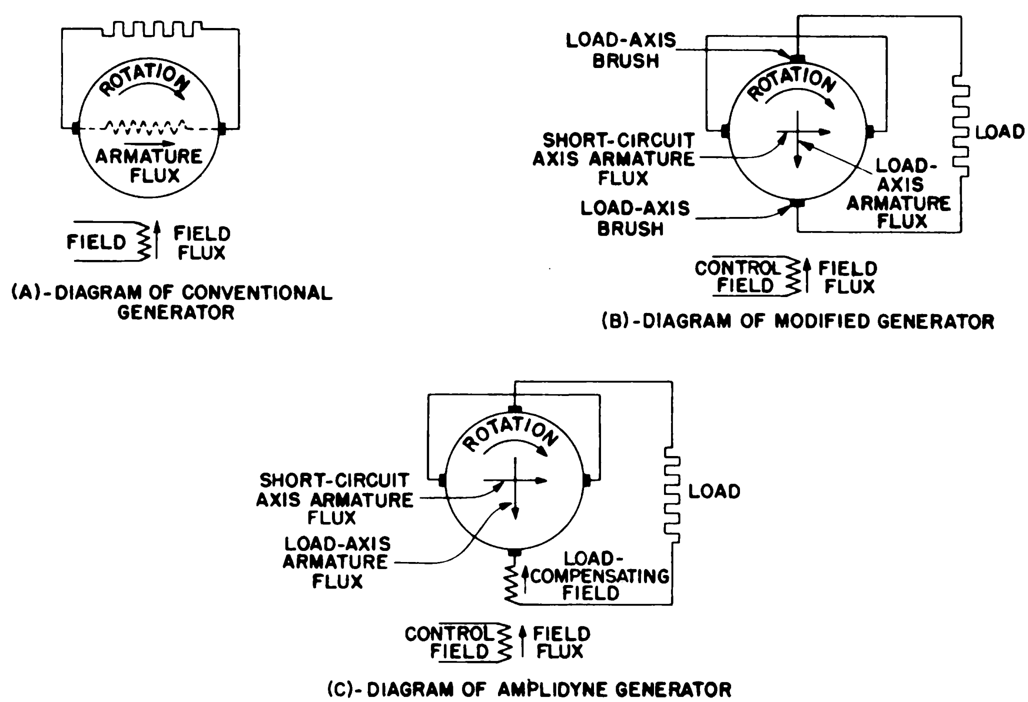



**Fig. 34. Amplidyne motor-generator theory**

(*d*) This load current, however, which flows in the armature causes a new magnetic flux to appear, opposing that of the control-field coil. To overcome this so-called "load-axis armature reaction" there is introduced a load-compensating field coil in series with the load-axis brushes and in such a position as to neutralize the load-axis armature flux completely. By employing this compensating field the control-field coil is thus required to produce only enough field flux to overcome the very low voltage drop in the short-circuited armature. The rate of response is, therefore, maintained very high, even under load conditions.

(3) It should be noted that, in the amplidyne generators used on the searchlight, the control-field winding is tapped at its midpoint and can be considered to be composed of two coils which have a common connecting lead. The field coils are so wound and connected that the current in one coil opposes that of the other coil. When the current is the same in each coil, the magnetic fields set up by the coils are equal and opposite, thus neutralizing each other. Hence there is no field flux and, consequently, no voltage is generated. When there is a difference in the field-coil currents, a resultant field is set up and an armature voltage is generated. The magnitude of the generated voltage is determined by the difference in magnitudes of the two field-coil currents, that is, the greater the difference the greater is the voltage. The polarity of the generated voltage depends upon which field coil carries the greater current.

(4) These two qualities of the amplidyne generator (control of a large amount of power with low field current and rapid response to changes in field current) make it particularly useful for controlling the searchlight, where it is desired to exercise control by the D.E.C. control-transformer signal which is of very low magnitude. The speed of the amplidyne-generator response makes it possible for the searchlight to follow this signal accurately. In the above discussion, the effect of residual magnetism in the amplidyne generator was neglected. Due to retentivity of the steel in the magnetic circuit of the control field, a reduction to zero of the net control-field currents does not reduce the magnetic flux to zero. Therefore, even with the control-field currents balanced, it is possible to have a small voltage output from the amplidyne generator. In normal operation, this is not troublesome, since any creep from the correspondence position would produce a control-transformer signal counteracting the effect.

### b. Drive Motor

(1) The drive-motor fields are continuously excited when the two amplidyne switches are in their ON positions. The fields are designed to be magnetically saturated when the d-c supply voltage is at the arc-load (low-voltage) value so that when the d-c supply voltage increases to the control-load (high-voltage) value, the field flux will increase only a small amount. For a given armature voltage in the drive motor, then, its speed will change only a small amount as the d-c field voltage changes in search-

light operation. The drive-motor armatures receive their voltage from the respective amplidyne generators.

(2) It will be seen, therefore, that the speed and direction of rotation of each drive motor is variable, depending, respectively, upon the magnitude and polarity of the output current of the associated amplidyne generator. The latter current has its magnitude and polarity determined, in turn, by the control-field current which is supplied to the amplidyne generator by the electronic amplifier to be described in the following paragraphs.

## 53. Electrical-actuation Subsystem

The operation of the Electrical-actuation Subsystem is fundamentally identical for azimuth and elevation performance, so that the following description for azimuth control is applicable to elevation control. As explained in the general description of the D.E.C. System, 1- and 33-speed control transformers together, or the 1-speed control transformers alone may be used at the searchlight to receive directional data from the associated locator transmitters. Also, control may be shifted at will to or from the 1-speed transmitters at the control station. As described and illustrated in connection with Fig. 30, this switching is obtained by operation of the D.E.C. transfer switch at the control station. As shown by the marking on that switch, turning the switch to AUTOMATIC provides for control from the locator, and turning the switch to MANUAL provides for control from the control station.

### a. General Operation

Assuming that the switch has been set for Automatic D.E.C. and that combined 1- and 33-speed transmission is employed, the operation is as follows:

(1) Both the 1- and the 33-speed control transformers receive directional data from the locator. From the description of the Zero-reader System, it should be understood that the voltage output of the searchlight control transformers varies in magnitude and instantaneous polarity, respectively, in accordance with the amount and direction by which they are out of directional correspondence with their associated locator transmitters. Briefly, with the searchlight and locator out of correspondence, the control-transformer output voltages are applied to the input circuits of a pair of vacuum tubes which act as both rectifiers and amplifiers. The resultant pulsating direct current in the output circuits of these tubes is used for excitation of the amplidyne-generator control field, and thus serves to generate a voltage which is supplied to the armature of the separately excited drive motor. The rotation of the drive motor drives the searchlight and the mechanically connected control transformers into correspondence with the locator. Thus, the control-transformer output voltages are reduced to zero and further motion ceases.

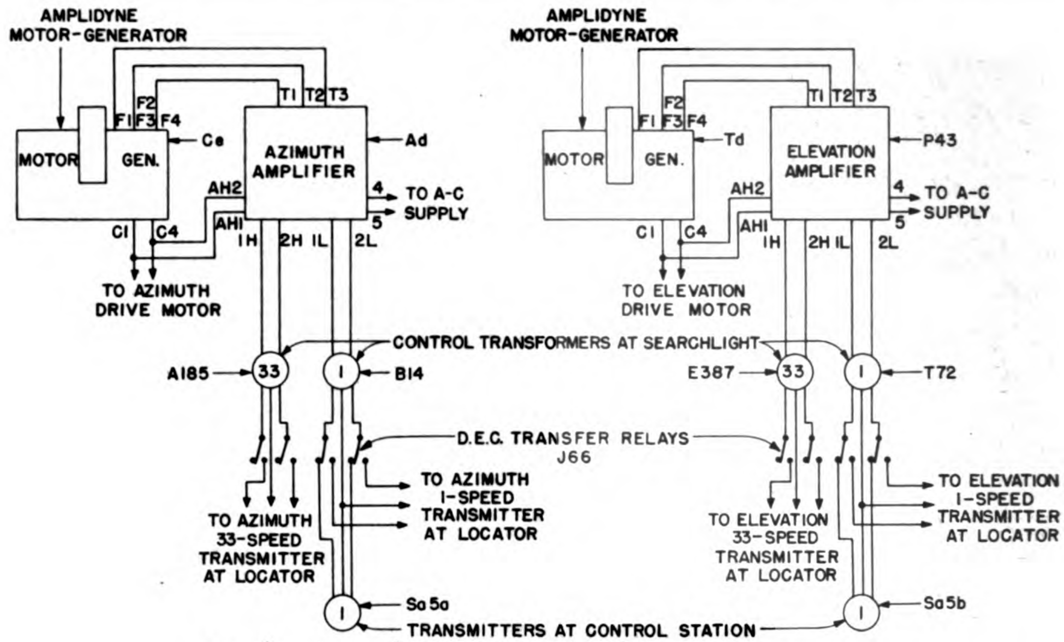



**Fig. 35. Schematic diagram of electrical-actuation subsystem**

| Ref. No. | Designation | Ref. No. | Designation |
|---|---|---|---|
| B14 | Azimuth 1-speed Control Transformer | T72 | Elevation 1-speed Control Transformer |
| A185 | Azimuth 33-speed Control Transformer | E387 | Elevation 33-speed Control Transformer |
| Ad | Azimuth Amplifier | P43 | Elevation Amplifier |
| Ce | Azimuth Amplidyne Motor-generator | Td | Elevation Amplidyne Motor-generator |
| Sa5a | Controller Azimuth Transmitter | Sa5b | Controller Elevation Transmitter |
| | | J66 | D.E.C. Transfer Relays |

## b. Components of System

The Electrical-actuation Subsystem is shown in Fig. 35. The principal components of this subsystem, are the transmitters and control transformers already described in connection with the Zero-reader System, and the amplifiers. Since the azimuth and elevation electronic amplifiers, Ad and P43 respectively, are identical, the following detailed description applies to either one. The over-all operation of the Electrical-actuation Subsystem is discussed in detail after the description of the amplifier.

## 54. Description of Amplifier

As indicated in the previous general description, the voltage output of the searchlight control transformers is applied to the grids of vacuum tubes which act as rectifiers and amplifiers. Fig. 36 is a schematic connection diagram of the amplifier, either azimuth or elevation.

# D.E.C. SYSTEM, ELECTRONIC AMPLIFIER

## a. The Amplifier Tubes

The two tubes, VT1 and VT2, used in the amplifier are type 6L6 metal beam-power tubes. A schematic diagram and a cutaway view of this type of tube are shown in Fig. 36a. The tube elements are numbered in accordance with the socket terminal numbers.

(1) All of the elements of the tube are contained within the metal envelope or shell (1) from which the air has been removed. The cathode (8) is a thin metal sleeve coated on the outside surface with an electron-emitting material. Within this sleeve, and insulated from it, is a heating element. The purpose of the cathode is to supply the electrons necessary for tube operation. (Electrons are minute negative charges of electricity.) As the temperature of a surface is raised, the electron emission from that surface greatly increases. It is the function of the heater (2-7) within the

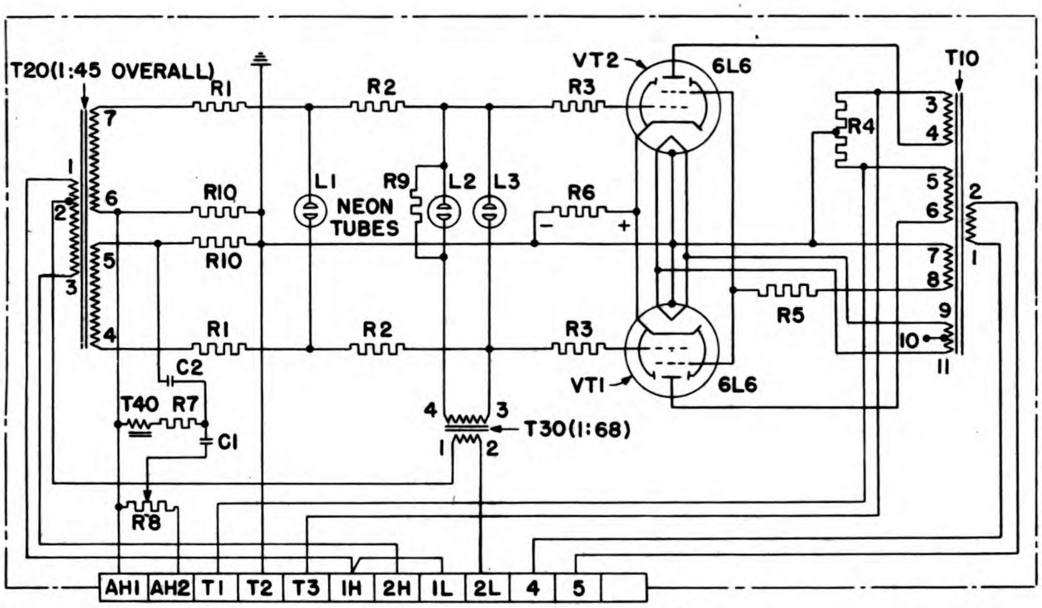
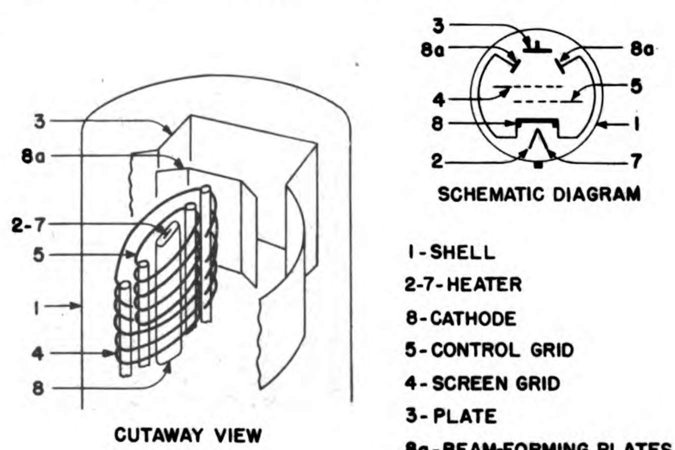



**Fig. 36. Schematic diagram of electronic amplifier**

**(a) Schematic diagram of 6L6 tube**



cathode to raise the temperature of the cathode to the point where it freely emits electrons.

(2) The plate (3) is a metal shell surrounding the cathode. As long as the plate is maintained at a positive potential with respect to the cathode, the electrons emitted from the cathode will be attracted to the plate. The passage of electrons from the cathode to the plate constitutes an electric current whose direction of flow, from the conventional viewpoint, is opposite to the electron flow; that is, the electric current flows from the plate to the cathode.

(3) The control grid (5) is a spiral winding of wire extending the length of the cathode placed between the cathode and the plate. The spacing between adjacent turns is comparatively large, so, mechanically, the control grid does not appreciably obstruct the electron flow. The purpose of the control grid is to control, electrically, the flow of electrons to the plate. With the control grid at a negative potential with respect to the cathode, the electron flow to the plate is reduced, since the negative charge on the control grid tends to repel the electrons back toward the cathode. As the control grid is made increasingly negative relative to the cathode, the electron flow is further reduced; and when the grid is made less negative, the electron flow is increased. Hence, when the control-grid voltage is varied in accordance with a signal, the plate current also varies with the signal. Because a small control-grid voltage can control a comparatively large amount of plate current, the signal is "amplified" by the tube.

(4) The screen grid (4) is a spiral winding of wire placed between the control grid and the plate. It is maintained at a positive potential with respect to the cathode, but since its turns are shaded from the cathode by the control-grid wires, relatively few electrons hit the screen grid. Hence, the screen-grid current is low compared with the plate current. The purpose of the screen grid is to make the plate current practically independent of the plate voltage over the operating range. The screen grid also acts as an electrostatic shield between the control grid and the plate, thus reducing the grid-to-plate capacitance. These two effects allow greater amplification to be obtained in the tube.

(5) The beam-forming plates (8a) are vertical metal shields which are placed between the screen grid and the plate at opposite sides of the grid structure. Both beam-forming plates are internally connected to the cathode. The purpose of these plates is to concentrate the electrons into a beam. When the electrons coming from the cathode hit the plate at high velocity, electrons may be dislodged from the metal of the plate. These are known as secondary electrons, and the phenomenon as secondary emission. By having the electrons from the cathode travel to the plate in a well-defined beam, the secondary electrons are repelled back to the plate. Otherwise these electrons would travel to the screen grid, thereby lowering the plate current and increasing the screen-grid current.

These tubes become very hot during operation, and caution should therefore be used in handling them immediately after operation. They require approximately ten to fifteen seconds to reach normal operating condition after the heater current is applied, and allowance should be made for this delay in general operation.

## b. Amplifier Operation

It was explained in the foregoing paragraphs how a small change in control-grid voltage produces an appreciable change in the plate current. In other words, the tube amplifies the input signal. It was also explained that the tube will pass current only when the plate is positive with respect to the cathode. If an a-c voltage is applied between the plate and the cathode, the tube will pass current only during that half of the a-c cycle when the plate is positive. During the other half of the cycle, the plate current will be zero. Thus the plate current will be interrupted and unidirectional; that is, it will be a pulsating direct current. This process is known as rectification. During the time that the plate is positive, the magnitude of the plate current can be controlled by the magnitude and polarity of the control-grid voltage.

The output voltages of both the 1- and the 33-speed control transformers are fed into the control-grid circuits in the amplifier. The instantaneous polarity of these a-c voltages with respect to the a-c supply voltage, and their magnitude, are a function of the angular position of the searchlight relative to the locator or the control station; their frequency, however, is the same as that of the searchlight a-c supply voltage. The output of the amplifier is connected to the amplidyne generator in such a way that the plate current of tube VT1 flows through one half of the control-field winding and the plate current of the tube VT2 flows through the other half. Any change in the amplifier input voltage, either in magnitude or polarity, results in a change in the field excitation of the amplidyne generator which, in turn, affects the output voltage of the generator.

The amplifier itself will now be described in greater detail, by considering separately the various circuits shown in Fig. 36.

(1) The searchlight 115-volt, a-c supply is connected to the amplifier at terminals 4 and 5, which connect to power transformer T10 at its primary-winding terminals T10/1 and T10/2. This transformer has four secondary windings supplying the necessary plate, screen-grid, and heater voltages. Winding T10/9-11 supplies approximately six volts to the heaters of tubes VT1 and VT2. (Terminal T10/10 is not used.) Winding T10/7-8 supplies screen-grid voltage to tubes VT1 and VT2 through resistor R5. The purpose of this resistor is to limit the screen-grid current to a suitable value by reducing the voltage applied to the screen grids below the 300-volt output of winding T10/7-8. The plate voltage for tube VT1 is supplied by winding T10/5-6 and for tube VT2 by winding T10/3-4. Each of these is a 300-volt winding.

(2) The amplidyne-generator control field is connected to terminals T1, T2 and T3. The center tap of the control field is connected to terminal

T2, and the direction of current flow is from T2 to T1 and from T2 to T3. Resistor R4 is connected in parallel with the control field, and serves to prevent instantaneous high voltages from being induced in the control field due to sudden changes in the pulsating field-excitation current furnished by the amplifier. The cathodes of tubes VT1 and VT2 are grounded through resistor R6. The flow of the plate and screen-grid currents through this resistor causes a voltage drop of the polarity indicated. Since the control-grid circuits are connected to the grounded end of this resistor, the control grids will be initially negative with respect to the cathode. The potential difference between the cathode and the control grid is called grid bias.

In the absence of a control voltage, the voltages applied to the control grids of both tubes will be the same, and therefore the currents flowing through the two halves of the amplidyne-generator control field will be equal in magnitude and opposite in direction. Under this condition, and neglecting the effect of residual magnetism, the output of the amplidyne generator will be zero. The magnitude of the tube plate current which flows depends principally upon the grid-bias voltage and to a lesser extent upon the screen-grid voltage. These voltages are functions respectively of the values of resistors R6 and R5, which have been so chosen that the plate current of each tube will be approximately equal to one-half of its maximum value.

When control voltage is applied to the grids as described below, however, the plate current of one tube will increase and that of the other tube will decrease. The resulting unbalance in the currents flowing through the two halves of the control field will determine the magnitude and polarity of the amplidyne-generator output voltage.

(3) The control voltage developed by the 33-speed (high-speed) control transformer is applied, through terminals 1H and 2H, to primary winding T20/1-3 of 33-speed input transformer T20, which has an overall step-up turns ratio of approximately 4.5 to 1. By transformer action a-c voltages will be developed across secondary windings T20/4-5 and T20/6-7; and the instantaneous polarity will be such that, when terminal T20/1 is negative with respect to terminal T20/3, terminal T20/4 is negative with respect to terminal T20/5, and terminal T20/7 is positive with respect to terminal T20/6. Since no grid current flows during normal operation, the secondary voltages of input transformer T20 are applied effectively to the grids of tubes VT1 and VT2. Neon tube L1 breaks down and begins to draw current whenever the voltage across it reaches approximately 65 volts. It limits the voltage at its terminals to approximately the above value, since any increase in voltage would cause the neon tube to draw more current which in turn would produce an increase in the voltage drop across the resistances in the circuit. Resistors R1 in series with the grid circuit at this point serve to limit the current which neon tube L1 can draw. An excessive current drawn by the neon tube would be undesirable, due to the fact that it would cause a large voltage drop across antihunt resistors R10

## D.E.C. SYSTEM, AMPLIFIER OPERATION

which would charge capacitor C2. This would upset the antihunt circuit and cause spurious oscillations in the system. Furthermore, such an excessive current would saturate windings T20/4-5 and T20/6-7 of 33-speed input transformer T20.

(4) The control voltage developed by the 1-speed (low-speed) control transformer is applied, through terminals 1L and 2L, to winding T30/1-2 of 1-speed input transformer T30 in series with portion T20/1-2 of the primary winding of 33-speed input transformer T20. This particular arrangement is used merely to provide more stable characteristics to the amplifier. The a-c voltage developed across secondary winding T30/3-4 of transformer T30, which has a step-up turns ratio of approximately 68 to 1, is applied to the control grids of tubes VT1 and VT2 through resistor R9 in parallel with neon tube L2. The purpose of resistor R9 is to allow 1-speed control voltage to reach the control-grid circuits at all times, so that the D.E.C. system can operate on 1-speed control alone. Neon tube L2 prevents the voltage drop across resistor R9 from exceeding approximately 65 volts, and thus keeps the system fully self-synchronous during combined 1- and 33-speed operation in a manner which will be explained. Resistors R2 prevent high-reactance secondary winding T30/3-4 of transformer T30 from being loaded by the relatively low impedances of neon tube L1 (after it breaks down) and of the 33-speed input circuit. The effective isolation of the 1- from the 33-speed circuits due to resistors R2 insures that the 1-speed control voltage will predominate when the searchlight is out of correspondence with combined 1- and 33-speed operation during the time that the 1-speed control voltage is opposite in polarity to that of the 33-speed control voltage. Neon tube L3 is provided to limit the voltage applied between the control grids of tubes VT1 and VT2 to approximately 65 volts in order to protect them. In performing this function, neon tube L3 operates in co-operation with resistors R2 in the same manner as previously described in connection with neon tube L1 and resistors R1. Resistors R3 serve to limit grid emission in tubes VT1 and VT2, thus preventing transformer saturation due to grid-current flow.

(5) As will be explained later in connection with the detailed operation of the system as a whole, an antihunt voltage is applied to terminals AH1 and AH2 of the amplifier. A portion of this voltage, depending on the strength of the antihunt signal desired, is taken off by means of adjustably tapped resistor R8, and is supplied to a high-pass filter comprising capacitor C1, resistor R7 and reactor T40. It is characteristic of this high-pass filter circuit to pass the higher-frequency variations in the voltage supplied to it and to block the lower-frequency variations. The values of the reactor, capacitor and resistor are such that, for constant velocity or for regular operating rates of acceleration, no antihunt signal is passed by the filter; but for abnormally high rates of acceleration, such as occur when the system is hunting about the point of correspondence or synchronism, a high antihunt signal is passed by the filter. Capacitor C2 prevents any direct current from

# MODEL 1942 SEARCHLIGHT AND CONTROL STATION

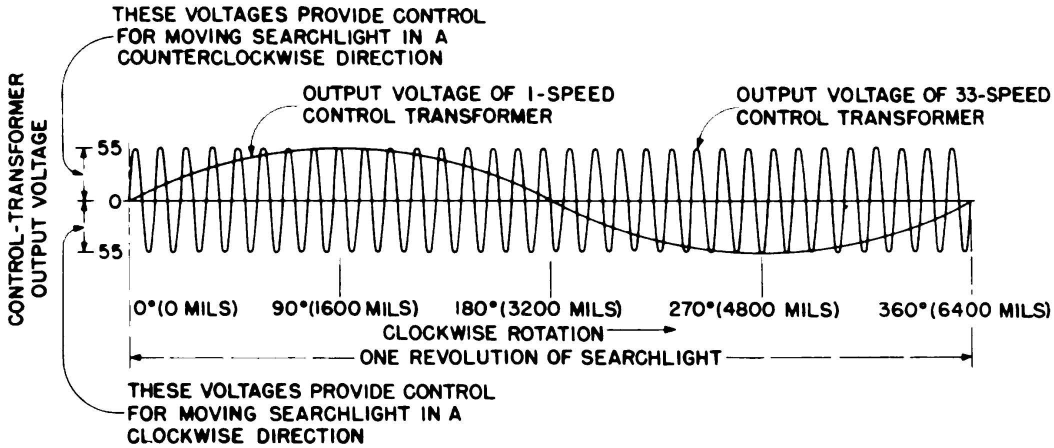



**Fig. 37. Graph showing relation between 1-speed and 33-speed systems**

reaching the control-grid circuits, but it passes a current the value of which depends upon the time rate of change of the antihunt voltage. The antihunt signal is applied to terminals T20/5 and T20/6 of 33-speed input transformer T20. Antihunt resistors R10 are connected in series between these terminals, and, therefore, the antihunt signal passes through them. The resulting voltage drop changes the control-grid bias of each tube.

## 55. Operation of High- and Low-speed Systems Combined

The operation of the Electrical-actuation Subsystem will be more readily understood by reference to Fig. 37 which shows, in simplified form, how the output voltages of the 1- and 33-speed control transformers vary as the searchlight is rotated through the complete 360 degrees in azimuth. It should be understood that these voltage curves represent effective values of an a-c voltage whose frequency is 60 cycles per second. It is assumed that the locator is held in a stationary position; that combined 1- and 33-speed control is used; and that the searchlight is rotated by hand. The curves shown are for the azimuth control transformers, but would apply equally well to the elevation control transformers except that the movement of the drum in elevation is restricted to less than one-half revolution.

### a. Accuracy Compared with Low-speed System Alone

From Fig. 37, it will be noted that the output voltage of the 1-speed control transformer completes one cycle for each revolution of the searchlight; whereas that of the 33-speed control transformer completes 33 cycles. These two control transformers differ in mechanical construction, but have the same electrical characteristics. This difference between the voltage curves is due to the difference in the rotational speeds of the two control transformers. The 1-speed control transformer is driven at a 1:1 ratio by the moving member of the searchlight, and the 33-speed control transformer is geared at a ratio of 33:1. As the searchlight is moved a small amount

# D.E.C. SYSTEM, TWO-SIGNAL SYSTEM

from the correspondence point (where the output voltages of both control transformers are zero), the 33-speed control transformer will be rotated through an angle 33 times as great as that of the 1-speed control transformer, and therefore its output voltage will vary at a greater rate than that of the 1-speed control transformer. Consequently, the 33-speed system is more sensitive and accurate than the 1-speed system. The error varies inversely as the gear ratio between the rotor of the control transformer and the searchlight, making the 33-speed control transformer 33 times more accurate than the 1-speed. From this it can be seen that the purpose of incorporating the 33-speed control transformers (this is called the two-signal system) in this D.E.C. system is to increase the accuracy of control over that obtainable from a 1- or low-speed system.

## b. "Knife-edge" Position

The 33-speed system has 66 zero-voltage points. Of these, 33 points, one at the end of each voltage cycle, are stable points; and, therefore, for any position of the locator, the 33-speed system has 33 correspondence points at any one of which the searchlight could come to rest in operation. The 1-speed system is incorporated in the searchlight control to provide self-synchronous operation; that is, for any position of the locator or the control station there will be only one point of correspondence (other than the "knife-edge" position to be described below) which the searchlight can assume.

It is shown in Fig. 37 that at the 180 degree point the output voltages of both the 1- and 33-speed control transformers are zero. Further examination of the curves will show that, if the searchlight is moved a very small amount beyond this point in a clockwise direction, the polarity of the output voltage of the 1-speed control transformer will be such as to cause the control system to rotate the searchlight in a clockwise direction to the point of correspondence. Displacement from the 180 degree point in a counterclockwise direction, on the other hand, will cause the control system to drive the searchlight in a counterclockwise direction to the point of correspondence. This 180-degree point, then, is an unstable point of "knife-edge" width; so, in practice, the 1-speed system may be considered to be self-synchronous. A similar condition exists once during each revolution of the 33-speed control transformer rotor and, if this control system were used alone, the searchlight would be driven to the nearest one of its 33 stable correspondence points.

As explained in the description of the amplifier, the 1-speed input transformer has a much greater step-up ratio than that of the 33-speed input transformer. As a result, when the searchlight has been displaced more than approximately 4° (71 mils) from the correspondence point, the 1-speed voltage will have increased to such a value that, after being "stepped-up" in the 1-speed input transformer, it will control the amplifier and will cause the system to drive the searchlight back to the point of correspondence.

When the displacement from the correspondence point is less than the above value, the 33-speed signal is effective in controlling the system. At the same time, however, a 1-speed signal is also being applied to the control-grid circuits in the amplifier. When the displacement from correspondence is greater than the above value, the 1-speed signal is of such magnitude that it predominates, and the control system is not appreciably affected by any changes in the 33-speed signal.

### c. Use in Automatic and in Manual D.E.C.

The D.E.C. system has been designed so that the searchlight will operate in Automatic D.E.C. with combined 1- and 33-speed control, or with 1-speed control alone.

In Manual D.E.C., the system operates solely with 1-speed control. No provision has been made for using the 33-speed control alone.

## 56. Hunting

This system, in common with most automatic control systems, tends to hunt, or oscillate, about the point of correspondence unless means are provided to overcome this tendency. Hunting is due to the fact that, as the searchlight approaches the correspondence point, the output voltages of the control transformers decrease until they reach zero at the point of correspondence. As a result the power input to the drive motor decreases until it is zero at the correspondence point. However, the inertia of the rotating parts carries the searchlight slightly beyond the point of correspondence. This in turn causes the output voltages of the control transformers to increase, and their polarity is now such as to cause the searchlight to be driven back to the point of correspondence. Repetition of this action constitutes hunting. To counteract the inertia of the rotating parts of the searchlight, the output voltage of the amplidyne generator is applied to the antihunt circuit in the amplifier. The connections are so made that the polarity of this antihunt voltage is always such as to oppose the control-transformer voltages that cause it.

## 57. Protective Subsystem

A simplified connection diagram of the D.E.C. Protective Subsystem is shown in Fig. 38. This subsystem comprises a network of miscellaneous interlocks, switches and relays as described below:

**a.** The drum-door interlock switches (F10, F11) are mounted at the drum doors and are so arranged that it is necessary for both of the drum doors to be closed before either the azimuth or elevation D.E.C. system can be operated. These switches are provided to prevent accidental directional-control operation when an operator is inside the drum.

**b.** Azimuth clutch switch A134 is mounted in the azimuth control box and upon positioning the azimuth clutch lever to the D.E.C. position, it completes the circuit to the azimuth control contactor A28. The prime

## D.E.C. SYSTEM, PROTECTIVE SUBSYSTEM

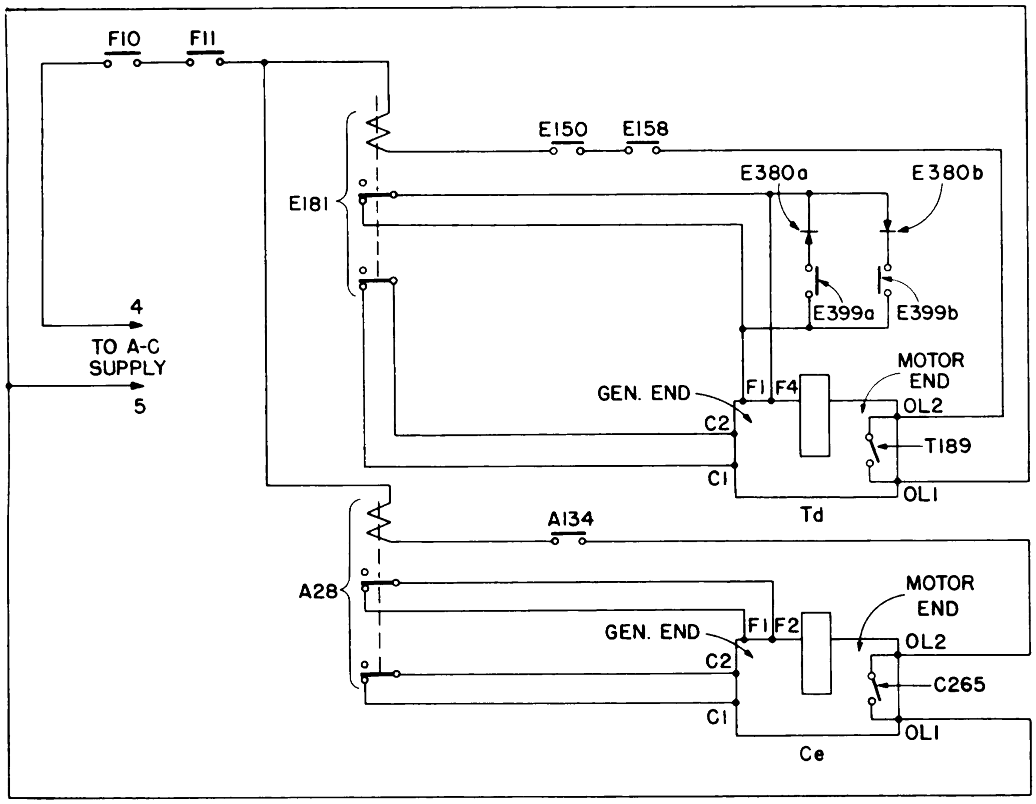



**Fig. 38. Schematic diagram of protective subsystem**

| Ref. No. | Designation | Ref. No. | Designation |
|---|---|---|---|
| F10, F11 | Drum-door Interlock Switches | E158 | Elevation Brake Switch |
| A134 | Azimuth Clutch Switch | E181 | Elevation Control-contactor Relay |
| A28 | Azimuth Control-contactor Relay | Td | Elevation Amplidyne Motor-generator |
| Ce | Azimuth Amplidyne Motor-generator | T189 | Overload Switch (Elevation Amplidyne) |
| C265 | Overload Switch (Azimuth Amplidyne) | E399a | Upper-limit Switch |
| | | E399b | Lower-limit Switch |
| E150 | Elevation Clutch Switch | E380 | Selenium Rectifiers |

purpose of this switch is to prevent the control-contactor coil from being energized when the azimuth clutch lever is in its HAND position.

**c.** Azimuth control contactor A28 is in the azimuth control box and is operated upon application of voltage to the coil through the closing of the azimuth clutch switch and the drum-door switches previously described. This contactor, when not energized, short-circuits the control field (F1-F4) and a portion of the compensating field (C1-C2) of the azimuth amplidyne generator. Its purpose is to prevent the amplidyne generator from producing any voltage when the searchlight is to be hand operated.

## MODEL 1942 SEARCHLIGHT AND CONTROL STATION

**d.** Elevation brake switch E158 and elevation clutch switch E150 are mounted in the elevation control box, and are mechanically operated upon release of the elevation brake and positioning of the elevation clutch lever to the D.E.C. position. These switches are in series and complete the circuit to the elevation-control-contactor coil. Their purpose is to prevent the elevation-control-contactor coil from being energized when the elevation brake is in its locked position or when the elevation clutch lever is in its HAND position.

**e.** Elevation control contactor E181 is in the elevation control box and its operation depends upon application of the voltage to the coil by closing the two drum-door switches, the elevation brake switch and the elevation clutch switch. Its purpose is the same as that for the azimuth D.E.C. control contactor which was described in Paragraph 57c.

**f.** Elevation electrical-limit switches E399a and E399b, mounted in the elevation control box, are closed when the searchlight drum approaches its upper or lower mechanical limits, respectively, of travel in elevation.

In order to prevent the drive motor from driving the drum into the mechanical stops, electrical-limit circuits are provided whose purpose is to stop the drive mechanism before the drum reaches the mechanical stops. The upper-limit circuit which limits the drum travel in a direction of increasing angle consists of limit switch E399a and selenium rectifier E380a, and the lower-limit circuit which limits the drum travel in a direction of decreasing angle is composed of limit switch E399b and selenium rectifier E380b.

When the drum is traveling in an increasing angle, terminal F4 is negative with respect to terminal F1. This is due to the fact that the half of the amplidyne-generator control field connected to terminal F4 is carrying more current than the other half which connects to terminal F1.

Assuming that the locator or control station continues to elevate with the drum following, upper limit switch E399a will be closed, thereby effectively placing terminals F1 and F4 at the same potential due to the unidirectional short circuit through selenium rectifier E380a. With terminals F1 and F4 at the same potential, the currents through each half of the amplidyne-generator control field will be equal and opposite in direction; and, hence, the amplidyne-generator output will be zero. The inertia of the rotating drum now rotates the armature of the drive motor, causing it to act as a generator. This generator action absorbs the inertia of the rotating parts and prevents the drum from coasting into the mechanical stop. The above effect is known as dynamic braking.

As the locator or control station begins to move in a decreasing angle in elevation, the polarities of terminals F1 and F4 will be reversed when the angle of elevation of the locator or the control station is less than that of the searchlight drum. Since selenium rectifier E380a will pass current only when terminal F1 is positive with respect to terminal F4, it no longer passes a current, and the effective short circuit across the amplidyne-generator control field is removed. This allows the system to operate so as to depress the drum and to open limit switch E399a. A similar condition occurs when the drum depresses enough to close lower-limit switch E399b, thereby completing a circuit including selenium rectifier E380b.

Due to residual magnetism in the amplidyne generator, the drum may slowly rotate after the limit switch has closed until it comes to rest against the mechanical stop. This action is normal and will not harm the equipment.

**g.** Signal buzzers J12 and S44 which may be located in the main connection and schematic diagrams (Fig. 71 and 72), are located in the searchlight junction box and the control station, respectively, and are connected in parallel. These buzzers are operated by means of buzzer switch S77 at the control station or by a buzzer switch at the locator. The purpose of the buzzer system is to provide means for signalling from the control station to the searchlight or from the locator to the searchlight and control station.

**h.** In addition to the above protective devices, each amplidyne motor-generator set is equipped with a thermostatically operated overload switch (T189 and C265). This is a single-pole, single-throw switch mounted inside the motor and connected to terminals OL1 and OL2. The switch opens whenever the motor temperature reaches too high a value, and recloses automatically when the motor cools down.

Switch T189 in the elevation amplidyne motor is in series with the elevation protective circuit, and switch C265 in the azimuth amplidyne is in series with the azimuth protective circuit. Operation of the switch opens the circuit of the respective control contactor, rendering the corresponding D.E.C. system inoperative.

## 58. Additional Precautions

While the various interlock switches which comprise the Protective Subsystem provide reasonable protection against injury to personnel or damage to the equipment due to improper operation, they cannot take the place of care and attention on the part of the operator. Two points are particularly to be noted:

**a.** THE MECHANISM WHICH DRIVES THE SEARCHLIGHT IN AZIMUTH AND ELEVATION HAS SUFFICIENT POWER TO INFLICT SERIOUS INJURY ON A PERSON IN A POSITION TO OBSTRUCT ITS TRAVEL. CARE SHOULD BE TAKEN, THEREFORE, THAT ALL PERSONNEL ARE CLEAR OF THE SEARCHLIGHT WHENEVER IT IS MOVING OR LIKELY TO MOVE UNDER D.E.C. OPERATION.

**b.** When the searchlight is moving rapidly in either azimuth or elevation, approximately 440 volts may exist in the drive circuits. These high voltages are produced by the amplidyne generators, and are carried throughout the searchlight by the wiring having its terminals marked C1 and C4.

In particular, such high voltages may be found in the terminal boxes of either amplidyne generator, in the elevation control box, in the azimuth control box, and in the elevation amplifier box. It is therefore important to exercise caution, when the searchlight is operated with the covers of any of these boxes removed, not to come into contact with terminals or other live parts.

# SECTION III
# CLEANING LUBRICATION AND ADJUSTMENTS

# SECTION III—CLEANING, LUBRICATION, AND ADJUSTMENT

## 59. General

The routine maintenance of the searchlight equipment requires the intelligent care and handling that any competent machine operator would give to a piece of fine machinery placed in his care. Thorough cleaning, lubrication, and adjustment, as indicated in this Manual, may save shut-downs for more extensive repairs.

## CLEANING AND LUBRICATION

### 60. Explanation of Tables

The routine cleaning and lubrication given in this Manual is important to provide long life and efficient operation of the equipment. The procedure to be followed for the searchlight and control station is covered by general descriptions supplemented by tabulations and photographic charts. This information includes detailed instructions where necessary.

**a.** Table I gives the detail parts to be cleaned and lubricated, with specific references to figures illustrating the specified parts. This tabulation also lists the operations to be performed and the normal time interval between these operations. Tables II and III describe in detail the types of cleaning and lubrication, respectively, which are listed in Table I.

**b.** In addition to the tabulated instructions, the following precautions are to be observed:

(1) Satisfactory lubrication requires that the lubricants be applied so as to reach relatively moving surfaces, and that all excess oil and grease be removed to prevent the collection of dirt.

(2) If gear teeth, bearings, or surfaces have collected dirt or foreign matter, do not add grease or oil until the part has been thoroughly cleaned.

(3) Do not oil or grease to excess. A little lubricant applied periodically is more satisfactory than heavy applications at infrequent intervals.

(4) Do not try to lubricate sealed ball bearings such as are used on the various shafts in the azimuth box, the elevation control box, and the control station. These bearings were packed by the manufacturer with sufficient grease to last for the life of the bearing. Any attempt to disassemble these bearings will damage them.

(5) Do not use anything except the lubricants specified on lamp parts which are exposed to high temperature. Ordinarily oil or grease will carbonize, discolor the glass and mirror, and gum the lamp mechanism.

(6) The suggested frequency for lubricating and cleaning the various parts given in Table I is based upon normal operation of the equip-

ment. If numerous long periods of continuous operation are encountered, the equipment should be lubricated more often than is indicated in this table. This does not apply to parts which are to be lubricated and cleaned after a given number of hours of operation, to parts that are to be cleaned after each night of operation, or to parts that are to be cleaned before being installed in their operating positions.

(7) In locations where excess dust and sand are blown around, it is essential, in so far as practicable, that exposed, relatively moving, operating surfaces be kept clean and free from excessive amounts of lubricants which, under these conditions, will collect abrasive matter and carry it between wearing surfaces. Exposed parts, such as the elevation rack and pinion, point 18, Fig. 41; the jackscrew threads, point 25, Fig. 41, 42, and 51; the jackscrew feet, point 24, Fig. 41, 42, and 51; the stowing-spring plunger, point 19, Fig. 41 and 44; and the binocular-mount sleeve, point 37, Fig. 51, should be cleaned and lubricated daily when the equipment is operated under such conditions. If the equipment is left "set-up" when not in use, the searchlight and the control station should be covered with the canvas covers which are furnished.

(8) Do not mix different brands, or even different grades of the same brand of grease. If the grade or brand of grease is changed, remove all of the old grease before applying the new grease.

(*a*) The lubricants specified in Table III will provide satisfactory searchlight operation throughout an atmospheric temperature range from +130F to −40F.

(*b*) When spraying the various parts on the lamp head with colloidal graphite, do not allow the graphite to get onto the insulation.

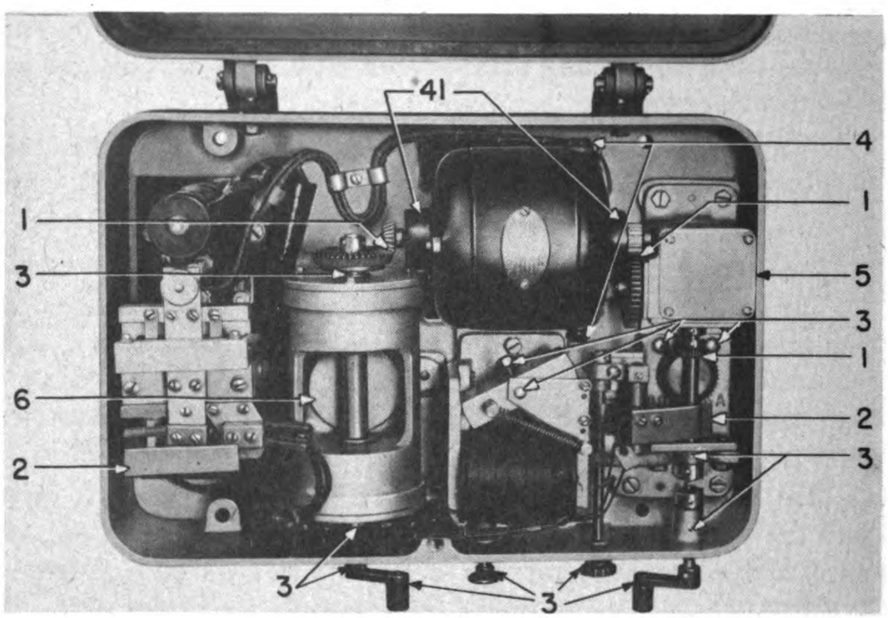



**Fig. 39. Lubrication points on lamp-mechanism box**

## TABLE I

| Fig. | Point No. | Description | Required Disassembly | Type of Cleaning See Table II | Schedule of Cleanings | Type of Lubrication See Table III | Schedule of Lubrications |
|---|---|---|---|---|---|---|---|
| 39 | 1 | Lamp control gearing. | None. | 2 | Monthly | 1 | Weekly |
| 39, 46, 47, 50 | 2 | Contacts—arc-current regulator, positive intermittent feed, control contactors, D.E.C. transfer relays, voltage-adapter contactor, and d-c power receptacles. | Remove box covers and guards where necessary. | 4 | Monthly | None | — |
| 39, 41, 44, 45, 47, 48, 49, 51, 52 | 3 | Handles, knobs, control shafts, joints, clutch operating levers, sleeve bearings, and extended-hand-controller latch. | Remove box covers where necessary. | 5 | Monthly | 3 | Monthly |
| 39, 41, 42, 43, 44, 47, 50 | 4 | Brushes—lamp mechanism, power drive, and ventilating motors; dynamotor; amplidyne motor-generator; and collector-ring brushes. | Remove box covers where necessary and unscrew brush caps. | 10 | Every 3 months | None | — |
| 39 | 5 | Worm and worm-gear housing. | Remove cover. | 1 | Annually | 1 | Annually |
| 39 | 6 | Negative drive clutch. | None. | 5 | Monthly | None | — |
| 40 | 7 | Front glass (not shown) and thermostat window. | None. | 5, 8 | After each night of operation | None | — |
| 40 | 8 | Mirror and thermostat mirror. | None. | 7 | After each night of operation | None | — |

# MODEL 1942 SEARCHLIGHT AND CONTROL STATION

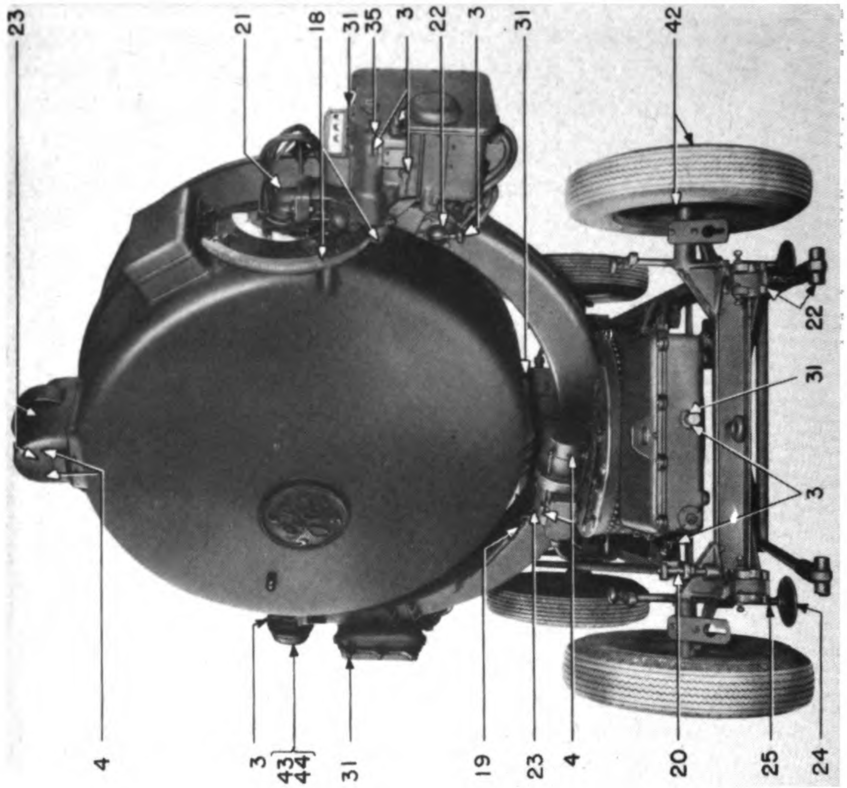



Fig. 41. Lubrication points on searchlight assembly

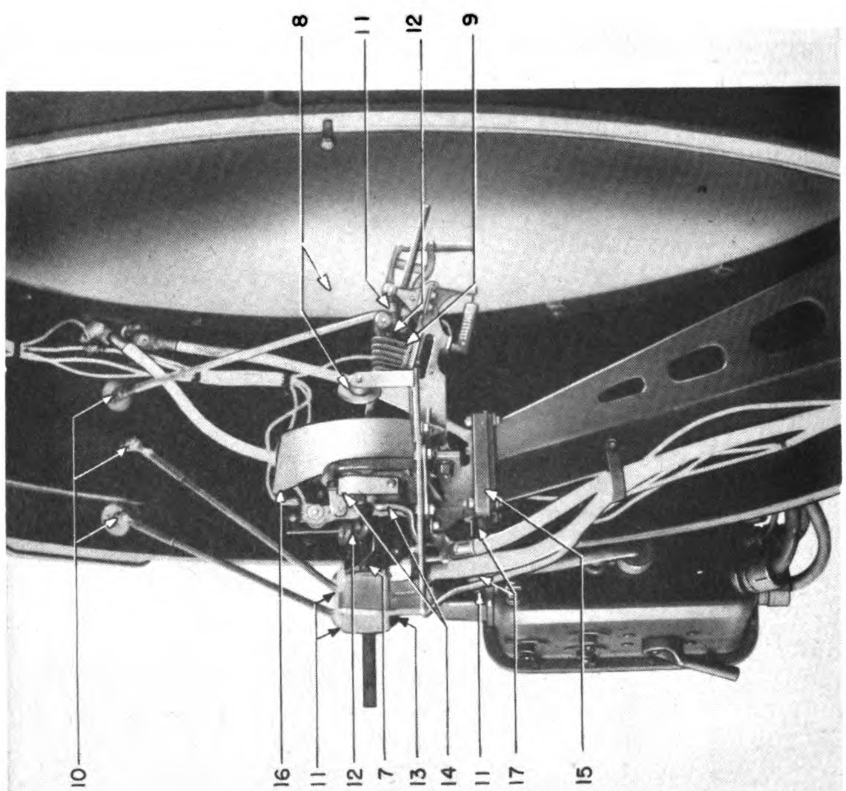



Fig. 40. Lubrication points on lamp and mirror

## TABLE I (Continued)

| Fig. | Point No. | Description | Required Disassembly | Type of Cleaning See Table II | Schedule of Cleanings | Type of Lubrication See Table III | Schedule of Lubrications |
|---|---|---|---|---|---|---|---|
| 40 | 9 | Negative nose and brush. | None. | 6 | Every 4-6 hours of operation | None | — |
| 40 | 10 | Upper universal joints on lamp drive shafts. | None. | None | — | 3 | Monthly |
| 40 | 11 | Lower universal joints on lamp drive shafts and focusing shaft, and bearings for positive-feed detent shaft. | None. | None | — | 6 | Monthly |
| 40 | 12 | Positive and negative lamp-head gearing. | None | None | — | 6 | Every 4-6 hrs of operation |
| 40 | 13 | Lamp-head gearing—positive-drive helical gears. | None. | 2 | Monthly | 5 | Every 8 hrs of operation |
| 40 | 14 | Positive brushes. | None. | 3 | Every 16 hrs of operation | None | — |
| 40 | 15 | Lamp base and carriage. | None. | 2 | Semi-annually | None | — |
| 40 | 16 | Positive nose cap. | None. | 9 | Every 16 hrs of operation | None | — |
| 40 | 17 | Lamp focusing gears and screw. | None. | 2 | Semi-annually | 5 | Semi-annually |
| 41 | 18 | Gear teeth—exposed | Remove guard. | 2 | Weekly | 3 | Weekly |

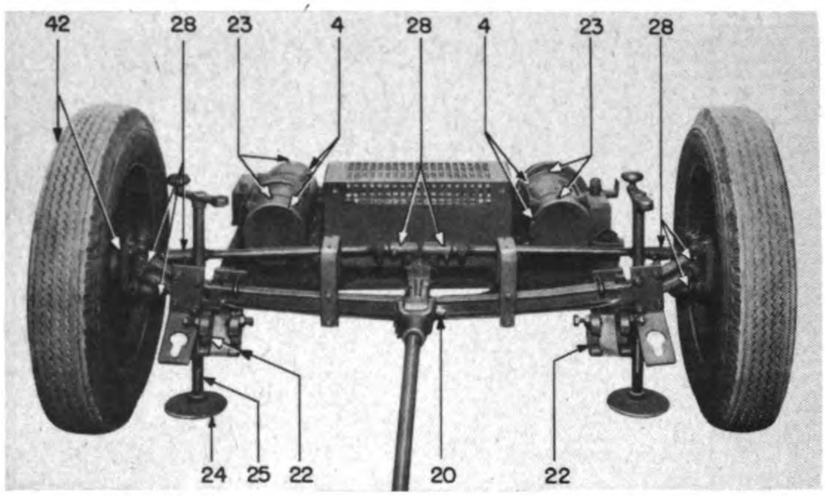



Fig. 42. Lubrication points on chassis

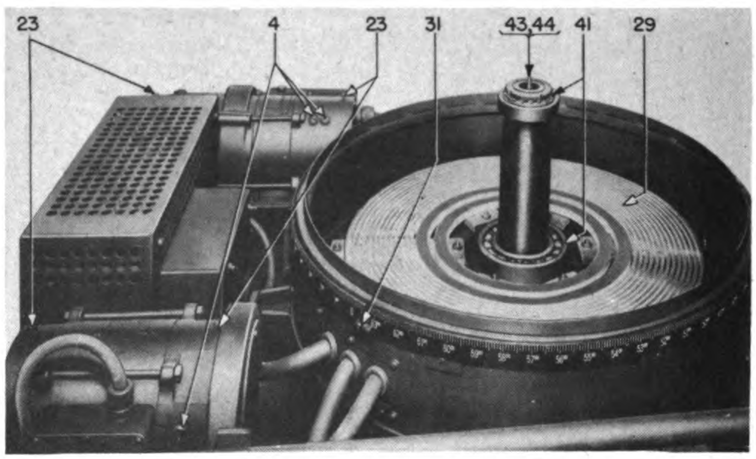



Fig. 43. Lubrication points on base

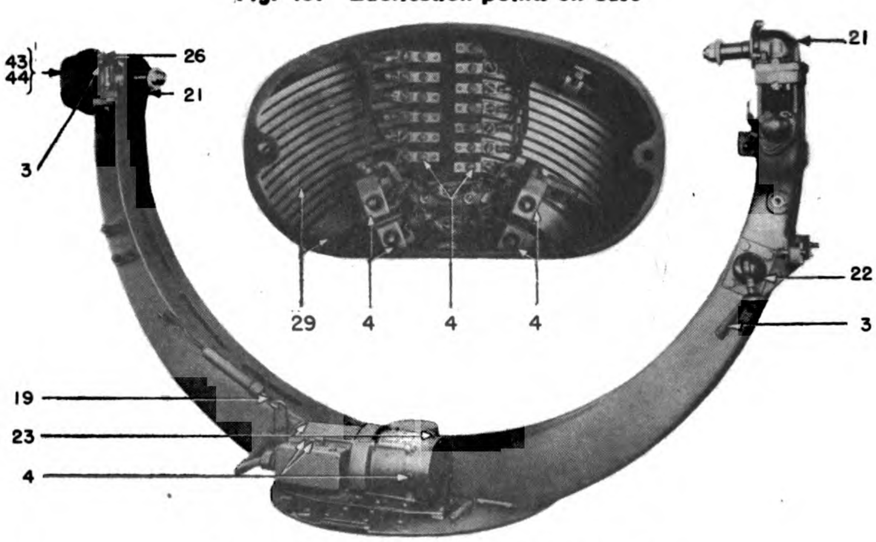



Fig. 44. Lubrication points on turntable

## TABLE I (Continued)

| Fig. | Point No. | Description | Required Disassembly | Type of Cleaning See Table II | Schedule of Cleanings | Type of Lubrication See Table III | Schedule of Lubrications |
|---|---|---|---|---|---|---|---|
| 41, 44 | 19 | Stowing-spring plunger. | None. | 2 | Monthly | 1 | Monthly |
| 41, 42 | 20 | Pins. | None. | 5 | Weekly | None | — |
| 41, 44 | 21 | Trunnion bearing. | None. | None | — | 2 | Semi-annually |
| 41, 42, 44 | 22 | Joint supports, "A"-frame clamps, and all "A"-frame bearing surfaces. | None. | 5 | Every time searchlight is being prepared for transportation | None | — |
| 41, 42, 43, 44, 47, 48, 49 | 23 | Bearings—ventilating and power-drive motors, dynamotor, and amplidyne motor-generator. | Remove box covers where necessary. | None | — | 3 | Every 3 months |
| 41, 42, 51 | 24 | Jackscrew feet. | None. | 1 | Weekly | 3 | Weekly |
| 41, 42, 51 | 25 | Jackscrew threads. | None. | 2 | Weekly | 3 | Weekly |
| 44, 45 | 26 | Elevation low-speed corrector gearing and coupling; and azimuth low-speed corrector gearing and bearings. | Remove cover plate. | None | — | 1 | Annually |
| 47 | 27 | Azimuth ring gear and pinion. | Remove the two small shields on underneath side of base casting. | 2 | Every 3 months | 1 | Every 3 months |

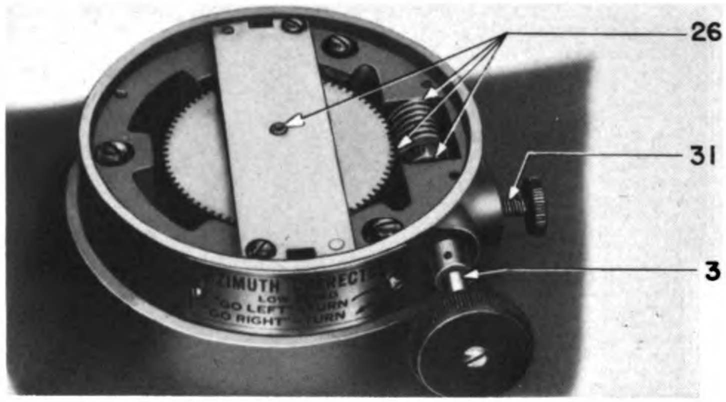



Fig. 45. Lubrication points on azimuth corrector

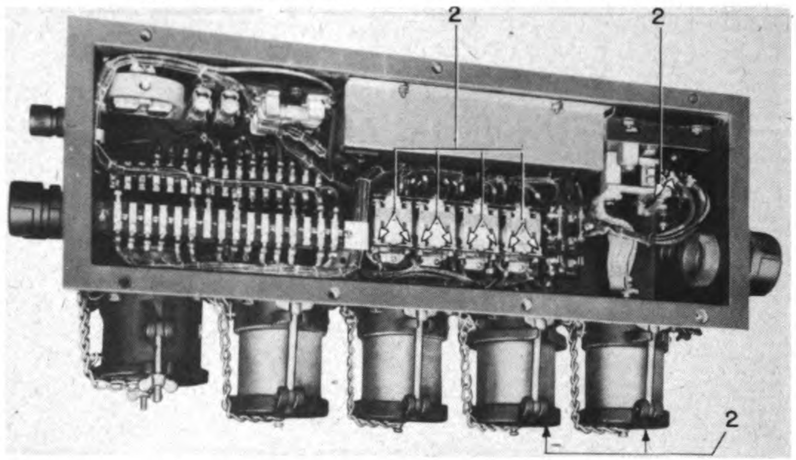



Fig. 46. Lubrication points on junction box

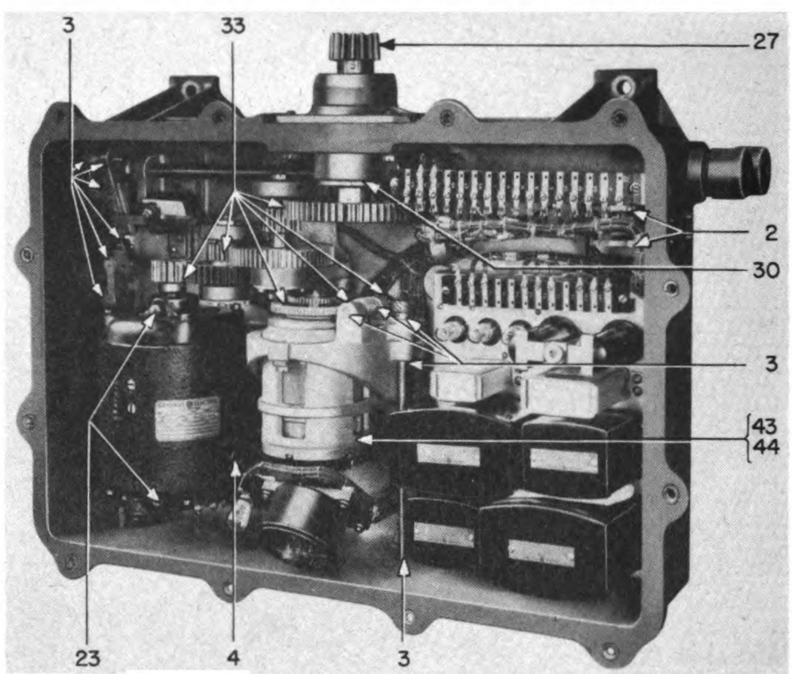
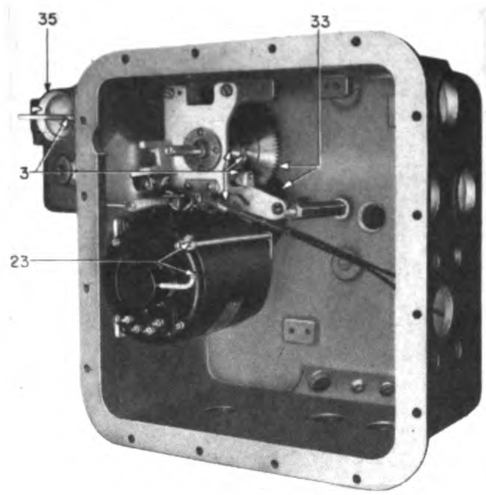



Fig. 47. Lubrication points on azimuth control box

## TABLE I (Continued)

| Fig. | Point No. | Description | Required Disassembly | Type of Cleaning See Table II | Schedule of Cleanings | Type of Lubrication See Table III | Schedule of Lubrications |
|---|---|---|---|---|---|---|---|
| 42 | 28 | Front axle. | None. | None | — | 2 | Semi-annually |
| 43, 44, 52 | 29 | Collector rings. | Remove inspection cover or box cover. | 5 | Every 3 months | None | — |
| 47 | 30 | Sliding bushing | Remove box cover and place clutch lever in its HAND position | 2 | Monthly | 1 | Monthly |
| 41, 43, 45, 50, 51, 52 | 31 | Thumbscrew threads—azimuth scale, junction box, elevation amplifier box, meter-housing covers, control station, and corrector clamp screws. | Remove thumbscrews. | 2 | Semi-annually | 3 | Semi-annually |
| 49, 50 | 32 | Actuating cams—elevation brake. | Remove box cover. | None | — | 3 | Monthly |
| 47, 48, 49, 52 | 33 | Gear teeth—enclosed. | Remove box covers. | 2 | Monthly | 1 | Monthly |
| 49, 50 | 34 | Elevation brake. | Remove box cover. | 5 | Monthly | None | — |
| 41, 48, 49, 50 | 35 | Extended-hand-controller socket and cover. | Remove socket cover. | 5 | Before using extended hand controller | None | — |
| 51 | 36 | Binocular-mount gear teeth—enclosed. | Remove covers. | 2 | Semi-annually | 1 | Semi-annually |



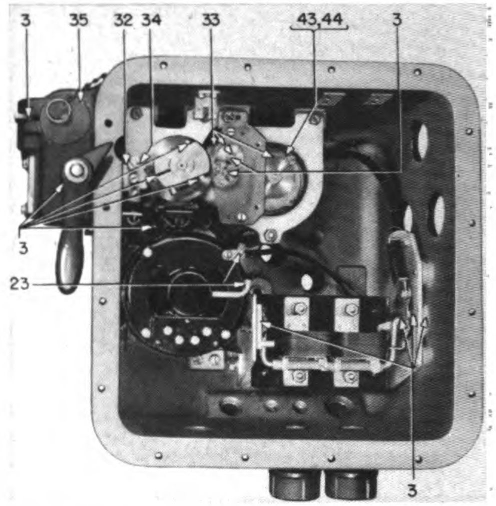




**Fig. 48. Lubrication points on elevation control box—Fig. 49**

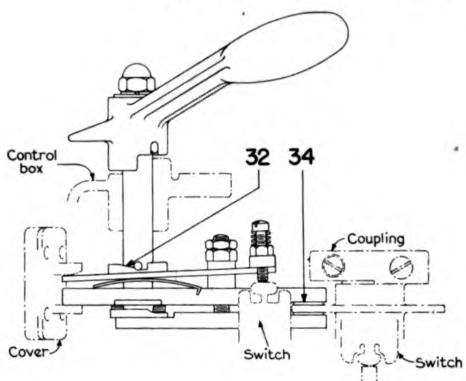
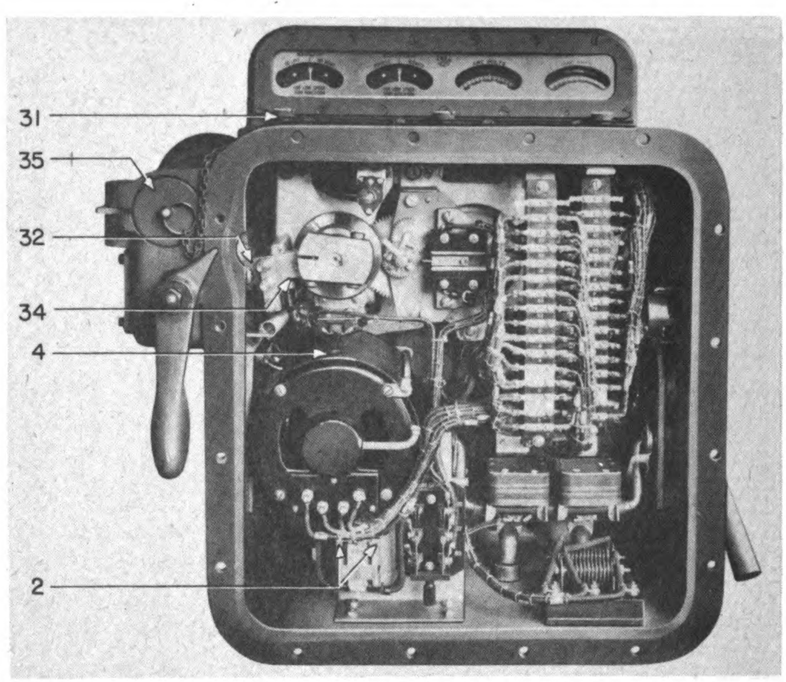



**Fig. 50. Lubrication points on elevation control box**



## TABLE I (Continued)

| Fig. | Point No. | Description | Required Disassembly | Type of Cleaning See Table II | Schedule of Cleanings | Type of Lubrication See Table III | Schedule of Lubrications |
|---|---|---|---|---|---|---|---|
| 51 | 37 | Binocular-mount sleeve. | None. | 2 | Monthly | 3 | Monthly |
| 51, 52 | 38 | Binocular-mount-column cover and socket | Remove socket cover. | 5 | Before installing binocular mount | None | — |
| 51, 52 | 39 | Slip clutches. | Do not lubricate. | — | — | — | — |
| 52 | 40 | Azimuth-flywheel clutch. | Remove box cover. | None | — | 3 | Monthly |
| The following list of items of cleaning and lubrication will be done by the maintenance men. It is included in this table, however, to furnish a complete schedule of cleaning and maintenance. | | | | | | | |
| 39, 43 | 41 | Ball bearings—lamp-mechanism motor, spindle. | Remove and disassemble motor; remove turntable. | 1 | At overhaul | 1 | At overhaul |
| 41, 42 | 42 | Wheel bearings. | Remove wheels from spindle | 1 | Annually | 1 | Annually |
| 41, 43, 44, 47, 49, 52 | 43 | Transmitter and control-transformer bearings | Remove and disassemble unit | 1 | At overhaul | 4 | At overhaul |
| 41, 43, 44, 47, 49, 52 | 44 | Transmitter and control transformer brushes and collector rings | Remove and disassemble unit | 5 | At overhaul | None | — |
| 52 | 45 | Azimuth orientation clutch. | Remove box cover, mounting bracket, and disassemble clutch. | 2 | At overhaul | 1 | At overhaul |

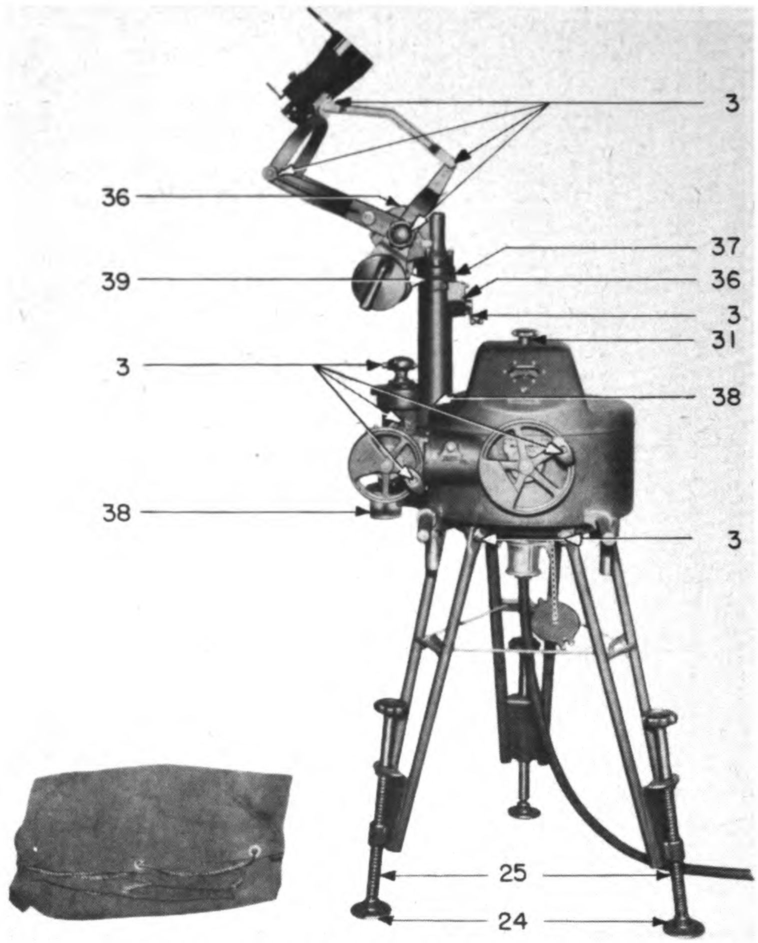



Fig. 51. Lubrication points on control station

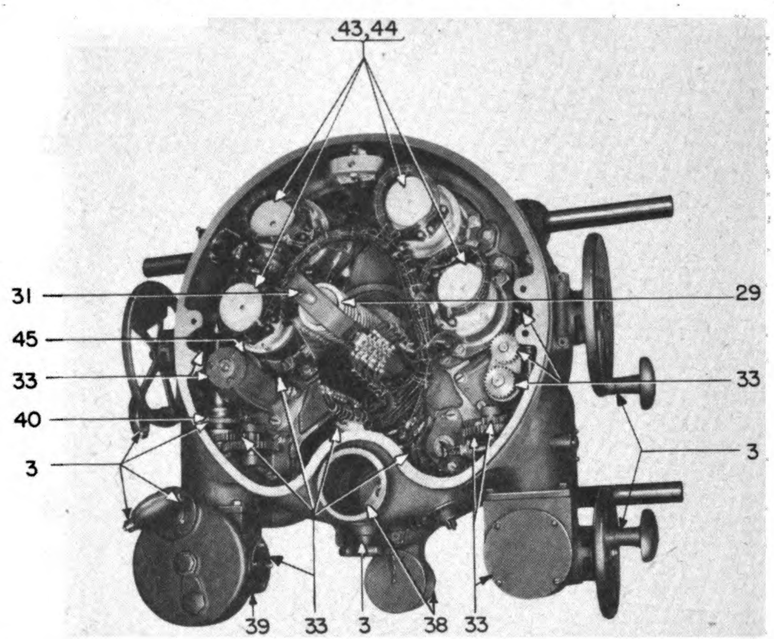



Fig. 52. Lubrication points on controller

# CLEANING AND LUBRICATION, TABLES

## TABLE II TYPES OF CLEANING

| Type No. | Description |
|---|---|
| 1 | Flush with gasoline, Varsol, petroleum spirits, or some non-corrosive grease solvent. |
| 2 | Wipe surfaces clean with a cloth moistened with the same solvent as used for Type 1 cleaning. |
| 3 | Make certain that no carbons are in the lamp before attempting to clean the lamp brushes. If carbons are in the lamp, remove them as explained in Paragraph 30. Then raise the positive-carbon clamping lever, L384, to spread apart the positive-feed roller arms. Insert the cleaning-stone end of the positive aligning gage through the opening in the front-door glass and into the positive head until the cleaning stone is between the positive brushes L316. (Refer to Fig. 17, 67 and 68.) Lower the positive lever to release it and to allow the positive-feed rollers to grip the aligning gage. Turn the positive-drive crank, Fig. 66, on the lamp control box until the aligning gage has made several revolutions. Raise the positive lever and withdraw the aligning gage. Blow out any loose dust or abrasive. |
| 4 | Remove any burrs or burned spots on the contact tips with the fine file found in the tool kit. |
| 5 | Wipe with a soft, lint-free cloth and remove any excess oil or accumulated dust. |
| 6 | Make certain that no carbons are in the lamp. Move the lower end of the negative lever, L410, forward toward the positive head to the position shown in Fig. 11. Insert the cleaning-stone end of the negative aligning gage between the negative contacts L391. Move the gage cleaning stone back and forth in engagement with the negative contacts while keeping the brass part of the gage in engagement with the lower negative-feed roller. DO NOT RUB THE CLEANING STONE ALONG THE NEGATIVE FEED ROLLERS. Withdraw the aligning gage from the lamp and blow out any loose dust or abrasive. |
| 7 | Proper cleaning of the mirror is extremely important because of the danger of scratching or otherwise damaging the mirror reflecting surface through incorrect cleaning procedure. The frequency with which this cleaning operation is done is important since dirty mirrors materially decrease the beam intensity. Carbon deposits from the arc tend to etch the mirror if allowed to remain on the surface for any extended period. The mirror should be cleaned only with the solutions supplied with this equipment or with agents subsequently determined by the Corps of Engineers. |

## MODEL 1942 SEARCHLIGHT AND CONTROL STATION

### TABLE II TYPES OF CLEANING (Continued)

| Type No. | Description |
|---|---|
| 7 | Before using a cleaning agent (and also at intervals as determined by inspection) accumulation of dust on the mirror should be removed with a camel's-hair brush. Extreme care must be taken in dusting to apply the brush lightly in order not to scratch the polished surface of the mirror. The mirror should be lightly soaked with clean drinking water to remove any grit or dirt left after brushing with the camel's-hair brush. The cleaning agent should be applied only with clean, long-fibered medical absorbent cotton.<br>CAUTION: Never wipe the mirror with a rotary motion. Pass the pad in a radial direction towards the center of the mirror from the outer edge. Rubbing should never be concentrated at any point or small portion of the mirror surface. When the solution used contains ammonia, ample ventilation of the drum should be provided. Adequate ventilation shall not be interpreted as requiring the use of the motor-driven ventilating system. When the cleaning agent has dried, the mirror should be wiped with clean, dry cotton pads. Do not attempt to clean the mirror until it has cooled down. |
| 8 | The front glass and the thermostat window should be thoroughly cleaned, occasionally, in a manner similar to that used on ordinary glass windows. |
| 9 | Insert the reamer found in the tool box into the positive-carbon hole in the nose cap, L337, and rotate until scale and dirt are loosened. Blow out any material that is deposited in the hole of the nose cap. |
| 10 | If the brush tends to stick in the brushholder tube or appears oily or gummy, wipe the brush clean with a cloth moistened with carbon tetrachloride. |

# CLEANING AND LUBRICATION, TABLES

## TABLE III TYPES OF LUBRICATION

| Type No. | Description |
|---|---|
| 1 | Apply a ball-bearing grease, such as Beacon M285 which is made by the Standard Oil Company of New Jersey, Colonial Beacon Division, or Norma 66 which is marketed by the Norma-Hoffmann Bearings Corporation, Stamford, Connecticut. Either one of these two greases will provide satisfactory operation over a wide temperature range and both have good corrosion-resisting properties. A can of the Beacon M285 grease is furnished in the spare-parts and tool box of each searchlight. |
| 2 | Apply a ball-bearing grease with a grease gun. Use the same grease as is used for Type 1 lubrication. |
| 3 | Apply one or two drops of light machine oil, such as engine oil, grade SAE No. 10, to wearing surfaces, to each oil cup, and to each oil hole. In the case of gears, all teeth must be lightly lubricated with a thin coating of oil. |
| 4 | Apply a moderate amount of the grease used for Type 1 lubrication to the rotating assembly in the ball bearings. Do not pack the bearings full of grease. |
| 5 | Apply Gredag to wearing surfaces. A tube of this special grease is furnished in the spare-parts and tool box of each searchlight. |
| 6 | Spray the parts with colloidal graphite WHILE THEY ARE STILL HOT FROM LAMP OPERATION. The colloidal-graphite solution is made by placing ½ teaspoonful of either Cograph or Aquadag paste in the glass atomizer jar and filling the jar with clean water up to the line indicated. Screw on the atomizer top and shake the jar until the paste is thoroughly mixed with water. Plug in the atomizer bulb. Both the atomizer and Cograph paste are furnished in the spare-parts and tool box of each searchlight. When placing the atomizer jar back in the box, replace the atomizer top with the solid top to prevent leakage of the solution out of the jar. |

# ADJUSTMENTS

## 61. General

The basic adjustments which are described in this section were properly made prior to shipment; consequently, probably the only time additional adjustments will be required is when there is operating trouble or when parts are replaced. There are only a few operating adjustments which may be necessary under field conditions.

## 62. Instruments

The adjusting screw on each instrument on the elevation control box can be reached by removing the screw caps E45, Fig. 53, in the instrument housing and inserting a small screwdriver. Adjust the arc voltmeter E243 and ammeter E244 so that their pointers are at zero when there is no d-c voltage applied to the searchlight.

**a.** For adjustment of the zero-indicator instruments E245 at the searchlight, connect the d-c supply to the searchlight and place a-c selector switch J77 in the junction box in its DYNAMOTOR position; but do not connect the control-station cable or the locator cable to the searchlight. Adjust the zero-indicator instruments so that their pointers are at the center of the scale, which is the zero position.

**b.** For adjustment of the zero-reader instruments S104, Fig. 54, at the control station, connect the control station to the searchlight by means of its cable, but do not connect the locator cable to the searchlight.

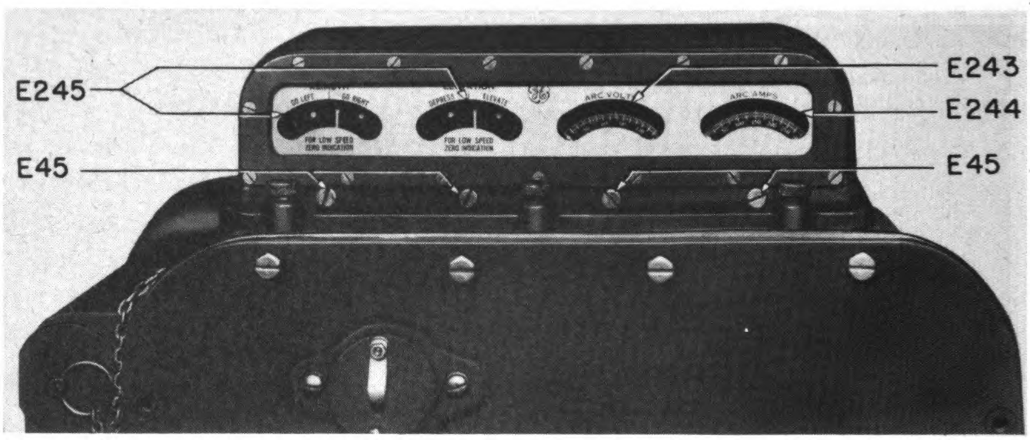



Fig. 53. Adjustment points on elevation instrument housing

| Ref. No. | Designation | Ref. No. | Designation |
|---|---|---|---|
| E45 | Instrument Adjusting Screws | E244 | Ammeter |
| E243 | Voltmeter | E245 | Zero-indicator Instruments |

## ADJUSTMENTS, INSTRUMENTS

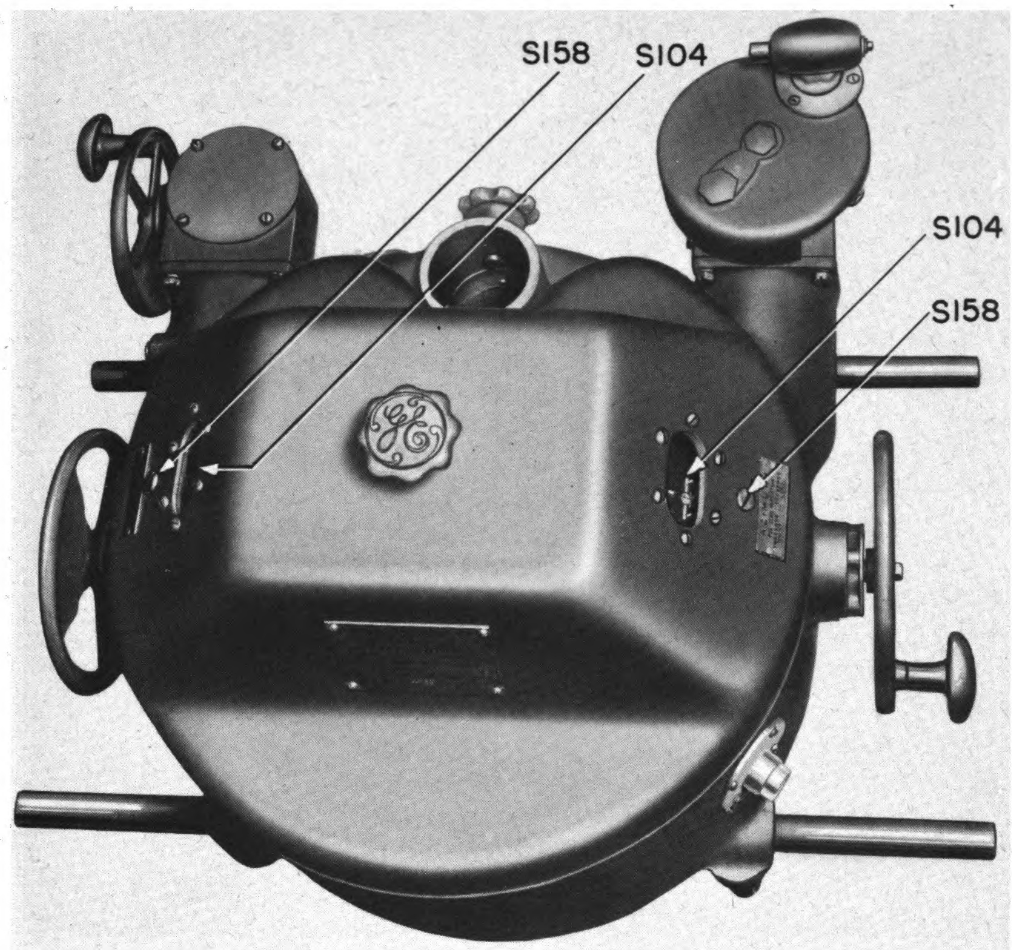



Fig. 54. Adjustment points on controller instruments

| Ref. No. | Designation |
|---|---|
| S104 | Zero-reader Instrument |
| S158 | Adjustment Cap |

With d-c voltage applied to the searchlight and with the a-c selector switch J77 in its DYNAMOTOR position, zero the pointers of the instruments as described above by removing the screw caps S158 and turning the adjusting screws of the instruments.

### 63. Searchlight Levels

The levels T50, Fig. 55, may be adjusted by means of the adjustable mounting screw T53 which is at one end of each level. Correct setting, without the use of a master level, should be made as follows: turn the searchlight so that the drum is pointing toward the junction-box end of the chassis. Adjust the jackscrews C21 until the level bubbles are centered. Turn the searchlight through 180 degrees and observe the shift of the bubbles from

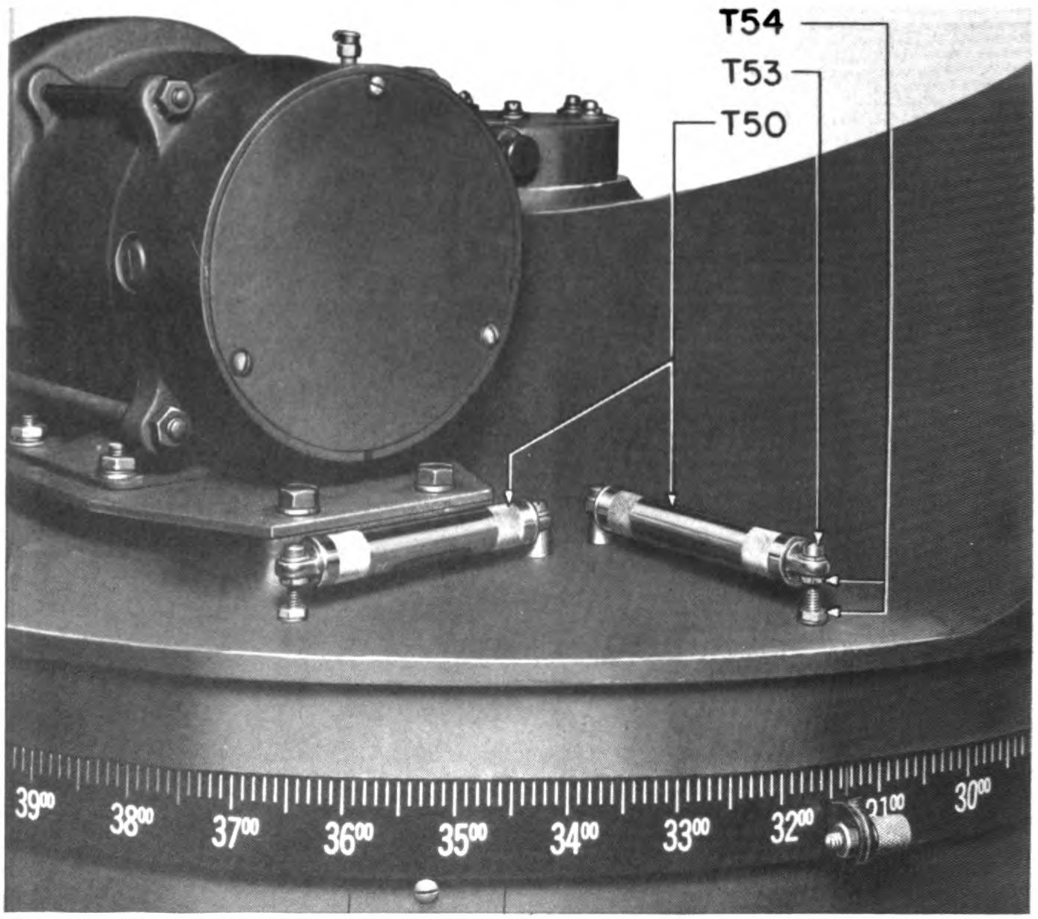



Fig. 55. Adjustment points on turntable levels

| Ref. No. | Designation |
|---|---|
| T50 | Levels |
| T53 | Adjusting Screws |
| T54 | Adjusting-screw Lock Nuts |

their centered position. Eliminate half of the observed shift by adjustment of the jackscrews and the other half by adjustment of the level adjusting screw. Before the level adjusting screws T53 are turned, both of the nuts T54 must be loosened; and these nuts must be tightened again before the new setting of the level is checked. This may require several attempts before the level bubbles will be centered in both positions of the searchlight.

## 64. Elevation Control Transformers

Both the 33(high)- and 1(low)-speed elevation control transformers E387 and T72, respectively, were set, prior to shipment of the searchlight, at their electrical-zero positions with the searchlight drum at zero-mils elevation. It is desirable to have the control transformers set in this manner, for then the searchlight will operate with any locator whose elevation transmitters are at their electrical-zero positions at zero-mils elevation, without requiring any adjustment in elevation when orienting the equipment.

**a.** Provided the adjustments have not been changed since the searchlight was shipped from the factory, the elevation control transformers are set as described above. If, in orientation, the elevation zero indicator at the searchlight does not read zero when the searchlight and the locator are both at zero-mils elevation, adjust the transmitters in the locator (in accordance with the instructions which are assumed to have been provided with that equipment) until the elevation zero indicator at the searchlight reads zero. Always check first that the pointer of the zero indicator has been correctly zeroed in accordance with the instructions in Paragraph 62 before making adjustments to the transmitters of the locator.

**b.** If the setting of an elevation control transformer has been changed however, the control transformer may be reset on its electrical zero by the method described in the following paragraphs. Whenever the setting of one of the control transformers is checked, the setting of the other one should be checked at the same drum position.

## 65. High-speed Elevation Control Transformer

To set the high-speed elevation control transformer E387 at its electrical-zero position or to check its setting:

**a.** Remove the cover of the elevation control box as shown in Fig. 8.

**b.** This control transformer has windings with the usual rotor-winding terminals R1 and R2 and stator-winding terminals S1, S2, and S3, but does not have a separate transformer terminal board to which these terminals are connected. Refer to Fig. 56. The rotor terminal wires R1 and R2 are brought to the right terminal board and connected to the left sides of terminals 65 and 64 respectively; and the stator terminals S1, S2, and S3 are black wires brought to the left terminal board and connected to the left sides of terminals 51, 52, and 53 respectively.

(1) To check this transformer setting, disconnect the wires from the right side of points 51, 52, and 53, and disconnect the wires connected to the right side of points 64 and 65 (which are connected to the elevation amplifier).

(2) Place elevation zero-indicator selector switch E187 in its LOW SPEED position so as to disconnect the zero-indicator instrument from the control-transformer rotor. Thus, the terminal boards are now, in effect, the control-transformer terminal board. (See connection diagram, Fig. 71.)

(3) Wire up the control transformer as shown in Fig. 57 according to the following steps:

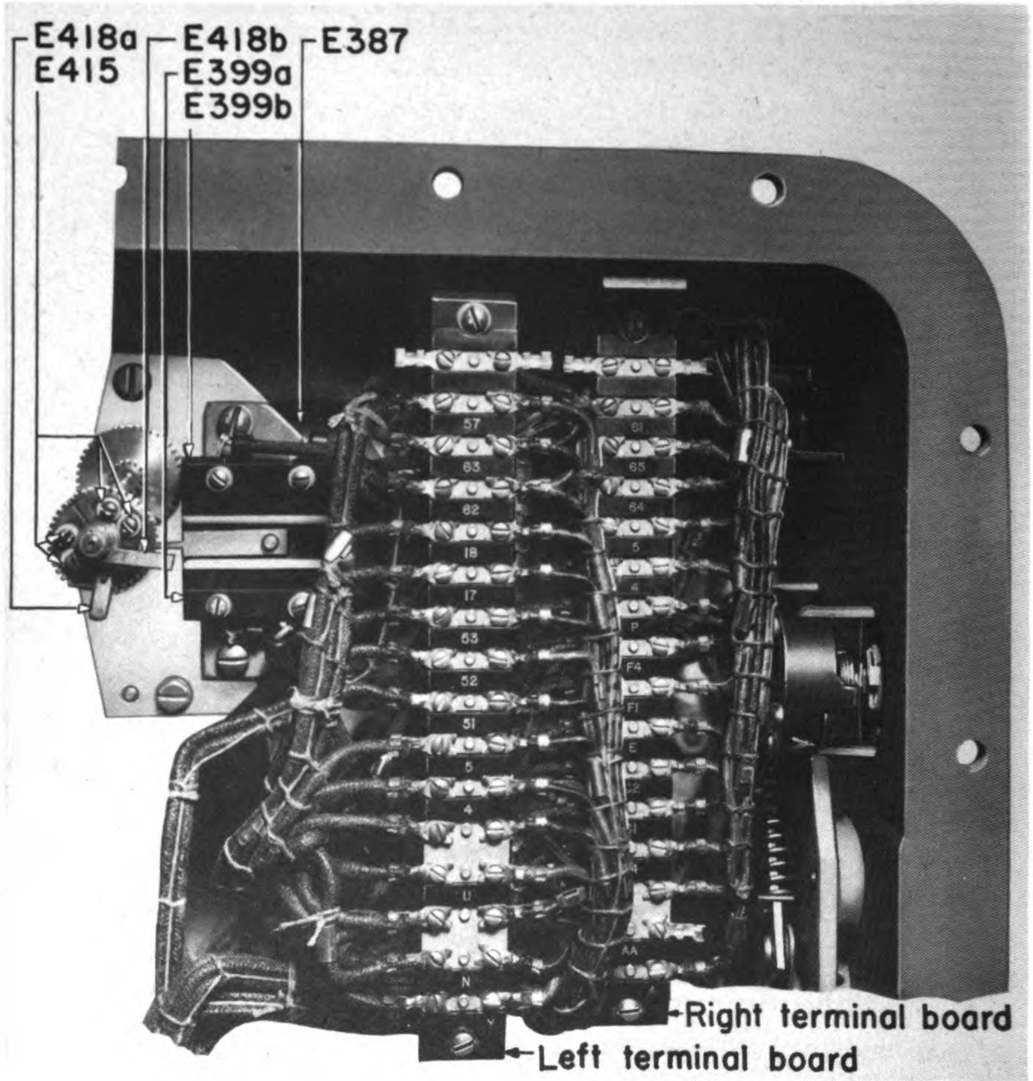



Fig. 56. Adjustment points on elevation control box

| | | | |
|---|---|---|---|
| Left Terminal Board | Term. S1 to Pt. 51<br>Term. S2 to Pt. 52<br>Term. S3 to Pt. 53 | Right Terminal Board | Term. R2 to Pt. 64<br>Term. R1 to Pt. 65 |

| Ref. No. | Designation |
|---|---|
| E387 | Elevation 33-speed Control Transformer |
| E418a, E418b | Upper- and Lower-limit Arms |
| E415 | Adjusting Screws |
| E399a, E399b | Upper and Lower-limit Switches |

# ADJUSTMENTS, H-S CONTROL TRANSFORMER

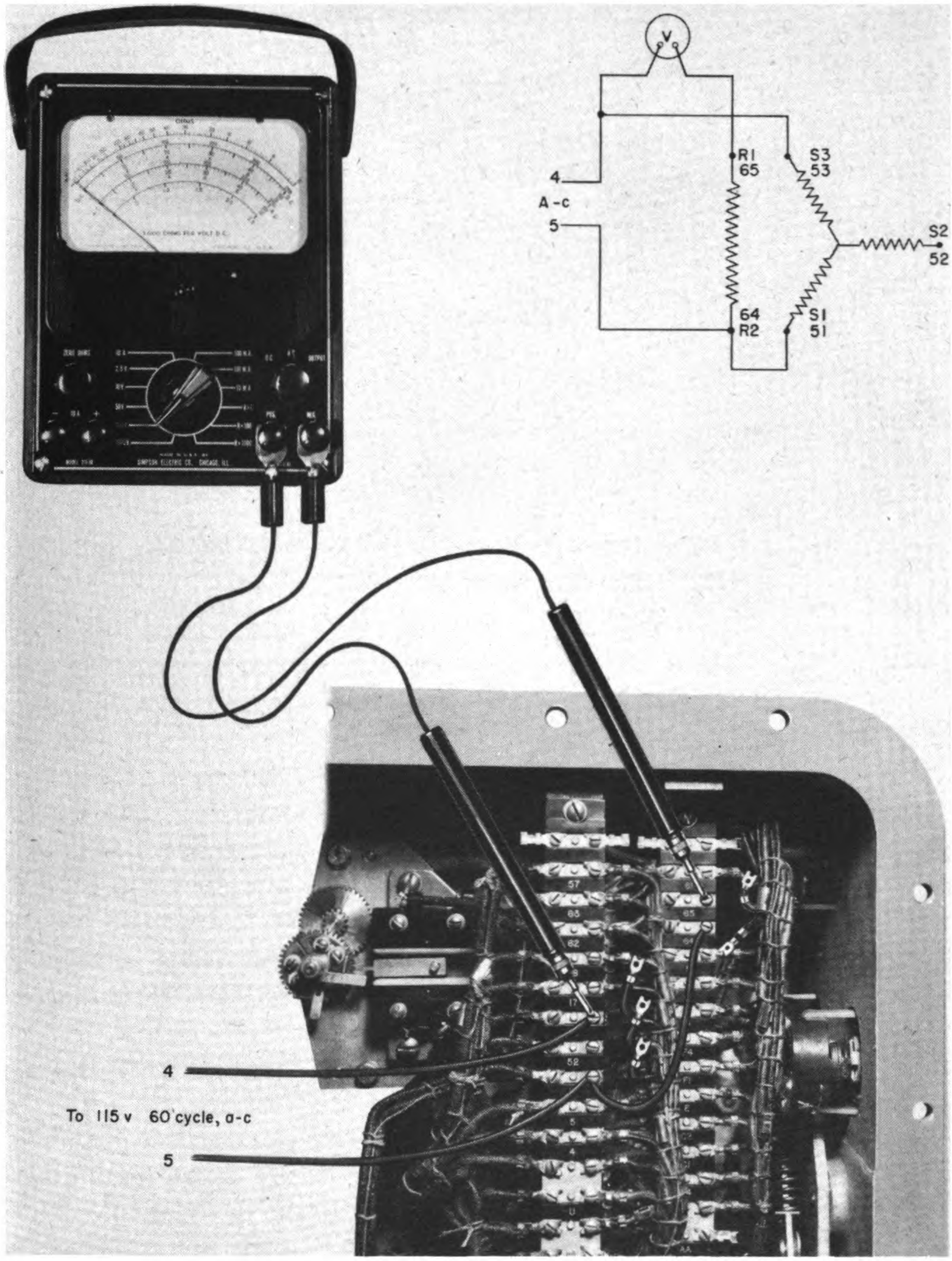



**Fig. 57. First adjustment on elevation high-speed control transformer**

(*a*) Connect a 115-volt, 60-cycle a-c power source to points 51 and 53.

(*b*) Connect a short insulated wire (jumper) from point 51 to point 64.

(*1*) The searchlight itself may be used as the source of a-c power by connecting a d-c supply to it and placing the a-c selector switch (J77) in its DYNAMOTOR position. The d-c supply should be such that

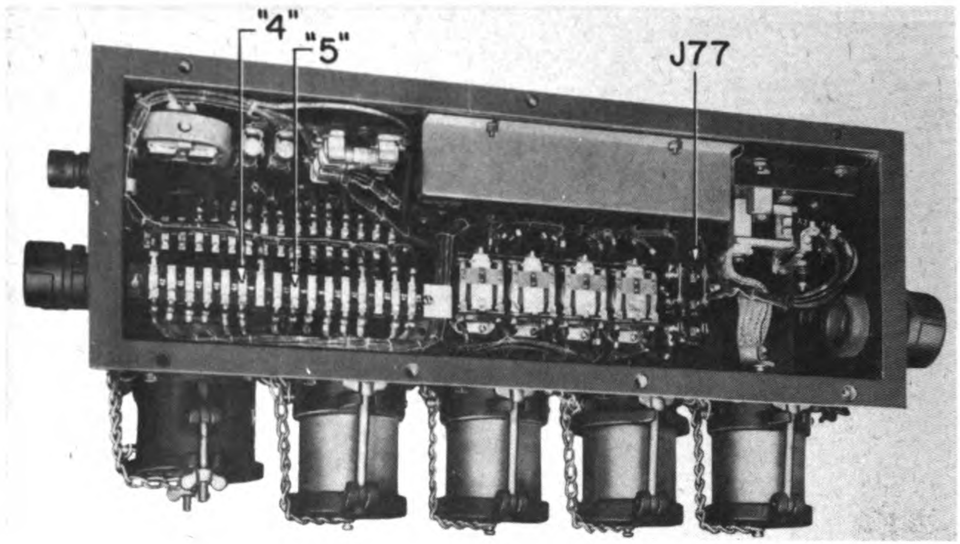



Fig. 58. Selector switch and a-c points in junction box

| Ref. No. | Designation |
|---|---|
| J77 | A-c Selector Switch |
| "4" and "5" | A-c Terminals |

voltmeter E243 on the elevation control box reads about 105 volts. The a-c voltage is present at terminals marked "4" and "5," and connections can be made conveniently to these terminals in the junction box. (See Fig. 58.)

(*c*) Prepare the analyzer for use as follows:

NOTE—The analyzer shown in this picture is furnished in each spare-parts and tool box. Any suitable voltmeter, however, may be used.

(*1*) Connect the pair of test cords to the POS and NEG terminals on the right side of the analyzer case.

(*2*) Set the selector switch, above these terminals, to AC.

(*3*) Set the scale-control indicator, in the center of the case, to 250 volts. (Be sure to read the proper scale on the analyzer.)

(*4*) The test-lead tips of the analyzer cords are connected to points 53 and 65.

(4) Accurately set the searchlight drum at zero-mils elevation as indicated on elevation scale R24, Fig. 59. To prevent the searchlight drum from shifting during these adjustments, turn elevation clutch lever E131 to its D.E.C. position.

(5) Loosen lock screw E293, Fig. 60, of the elevation high-speed corrector in the elevation control box. Turn adjustment worm E290 until the voltage read by the analyzer reaches its maximum value, using the 250-volt scale on the analyzer. The maximum value will be in the range between

# ADJUSTMENTS, H-S CONTROL TRANSFORMER

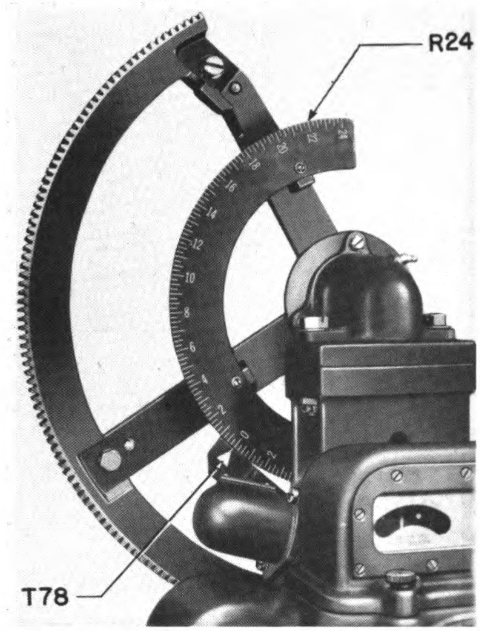



Fig. 59. Elevation scale and zero-index pointer

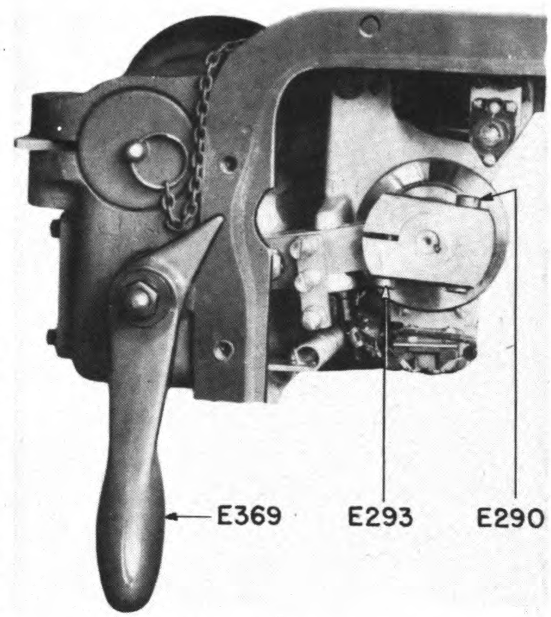



Fig. 60. Elevation high-speed control-transformer adjusting worm

| Ref. No. | Designation |
|---|---|
| T78 | Elevation-scale Pointer |
| R24 | Elevation Scale |

| Ref. No. | Designation |
|---|---|
| E369 | Elevation Brake Handle |
| E290 | Adjustment Worm |
| E293 | Lock Screw |

170 and 200 volts. While turning the adjustment worm, be sure that the drum remains at the zero-mils position.

**c.** The control transformer must now be checked for minimum voltage as follows. (See Fig. 61.)

(1) Connect the jumper wire from point 51 to point 53 and connect one of the a-c leads to either of these two points. Connect the other a-c lead to point 52.

(2) Set the scale-control indicator on the analyzer to 10 volts and connect the test cords to points 64 and 65.

(3) Turn adjustment worm E290, Fig. 60, in such a direction as to reduce the voltage to its minimum value.

(4) Set the scale-control indicator to 2.5 volts and readjust the adjustment worm for minimum reading. Make certain that the drum is still at zero-mils elevation.

(5) Close elevation brake E369 and then tighten corrector locking screw E293.

(6) Recheck the voltage. If it differs from that in step (4) above, loosen the locking screw, release the brake and repeat steps (3), (4), and (5).

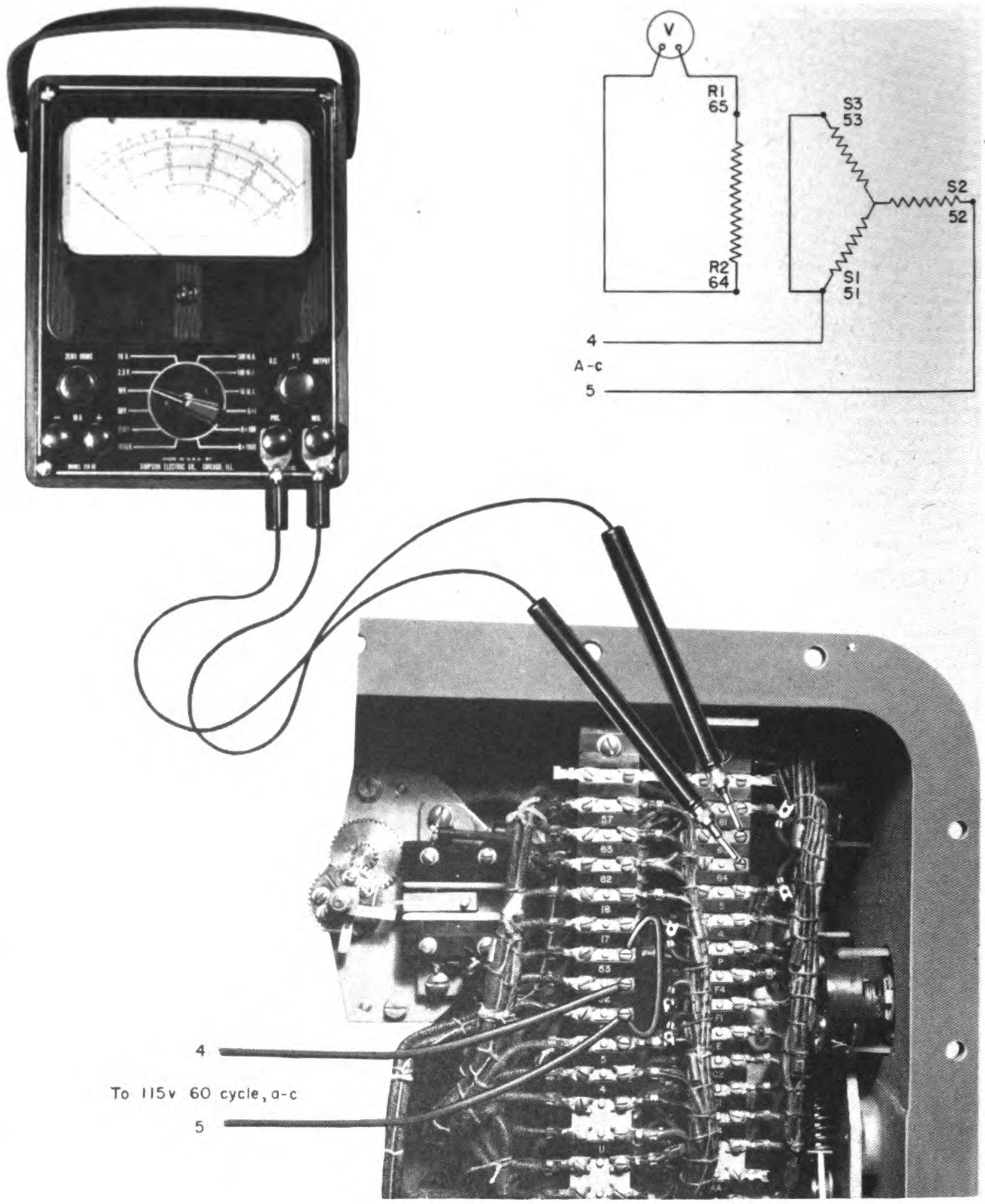



**Fig. 61. Final adjustment on elevation high-speed control transformer**

(7) Remove the testing wires and reconnect the circuit wires as shown in Fig. 56. (Do not put the cover back on the elevation control box, since the settings of the elevation limit switches are to be checked later.)

## 66. Low-speed Elevation Control Transformer

To set the low-speed elevation control transformer T72 at its electrical-zero position or to check its setting:

# ADJUSTMENTS, L-S CONTROL TRANSFORMER

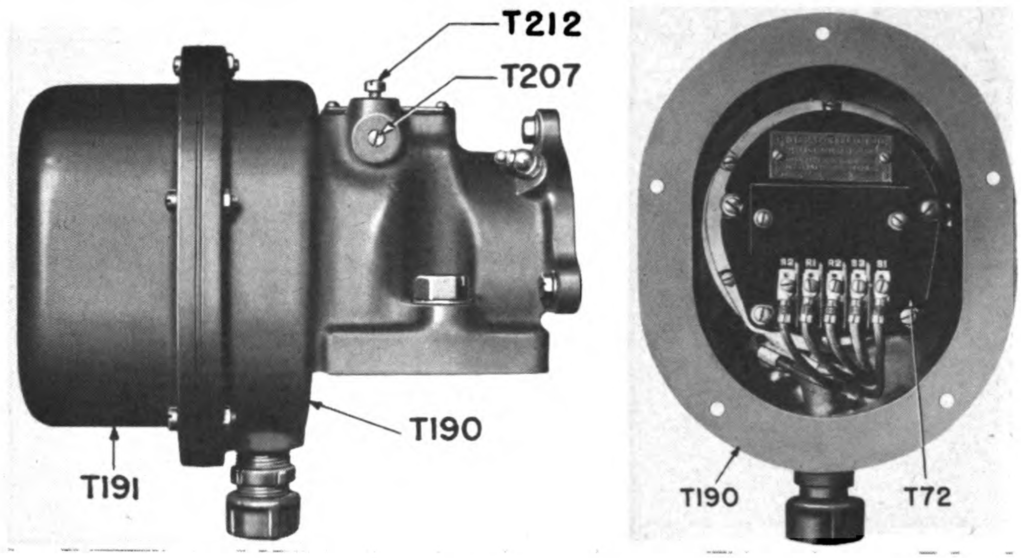



**Fig. 62. Elevation low-speed control transformer**

| Ref. No. | Designation | Ref. No. | Designation |
|---|---|---|---|
| T190 | Housing, Elevation 1-speed Control Transformer | T72 | Elevation 1-speed Control Transformer |
| | | T207 | Corrector Shaft |
| T191 | Cover | T212 | Lock Screw |

**a.** Remove cover T191, Fig. 62, of the low-speed control-transformer housing T190 and disconnect the five wires from their terminals on the control transformer.

**b.** Wire up the control transformer, Fig. 63, for test as follows:

(1) Connect a short insulated wire (jumper) from R2 to S1 and connect one lead from the a-c supply to either of these two points.

(2) Connect the other a-c lead to S3.

(3) Set the analyzer for AC and the indicator at 250 volts. The test cords go to points R1 and S3.

**c.** Loosen lock screw T212, Fig. 62, and turn corrector shaft T207 until the voltage read by the analyzer reaches a maximum.

**d.** Rewire the control transformer as shown in Fig. 64.

(1) Connect a jumper across S3 to S1, and connect an a-c lead to either of these points.

(2) Connect the other a-c lead to S2.

(3) Turn the analyzer indicator to 10 volts. The test cords go to points R1 and R2.

**e.** Turn the correct shaft to reduce the voltage read by the analyzer to a minimum.

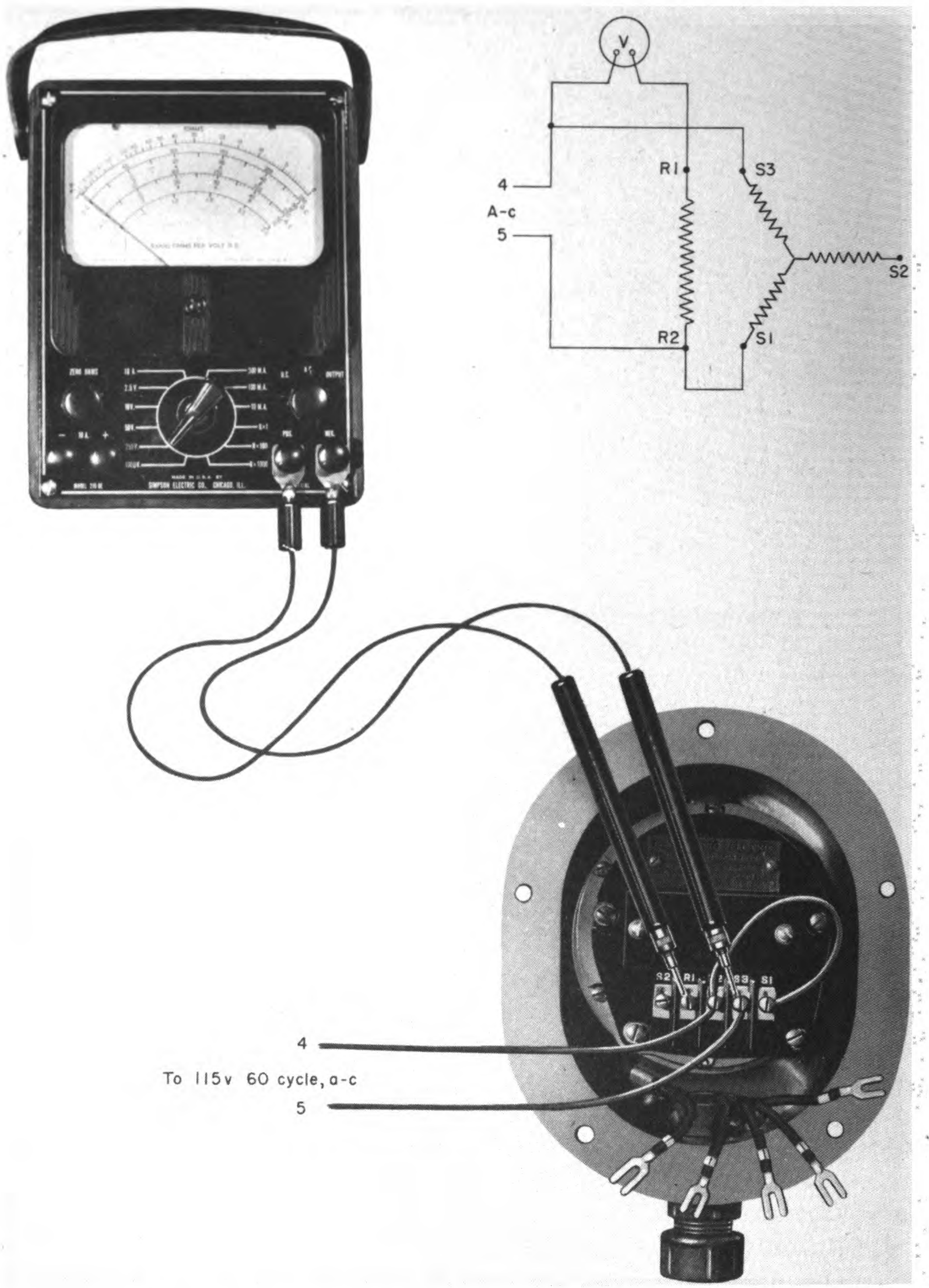



**Fig. 63. First adjustment on elevation low-speed control transformer**

**f.** Recheck step "e" by using the 2.5-volt scale. Tighten lock screw T212, and disconnect the testing wires.

**g.** Reconnect the wires as shown in Fig. 62 and replace the housing cover.

## ADJUSTMENTS, ELECTRICAL LIMITS

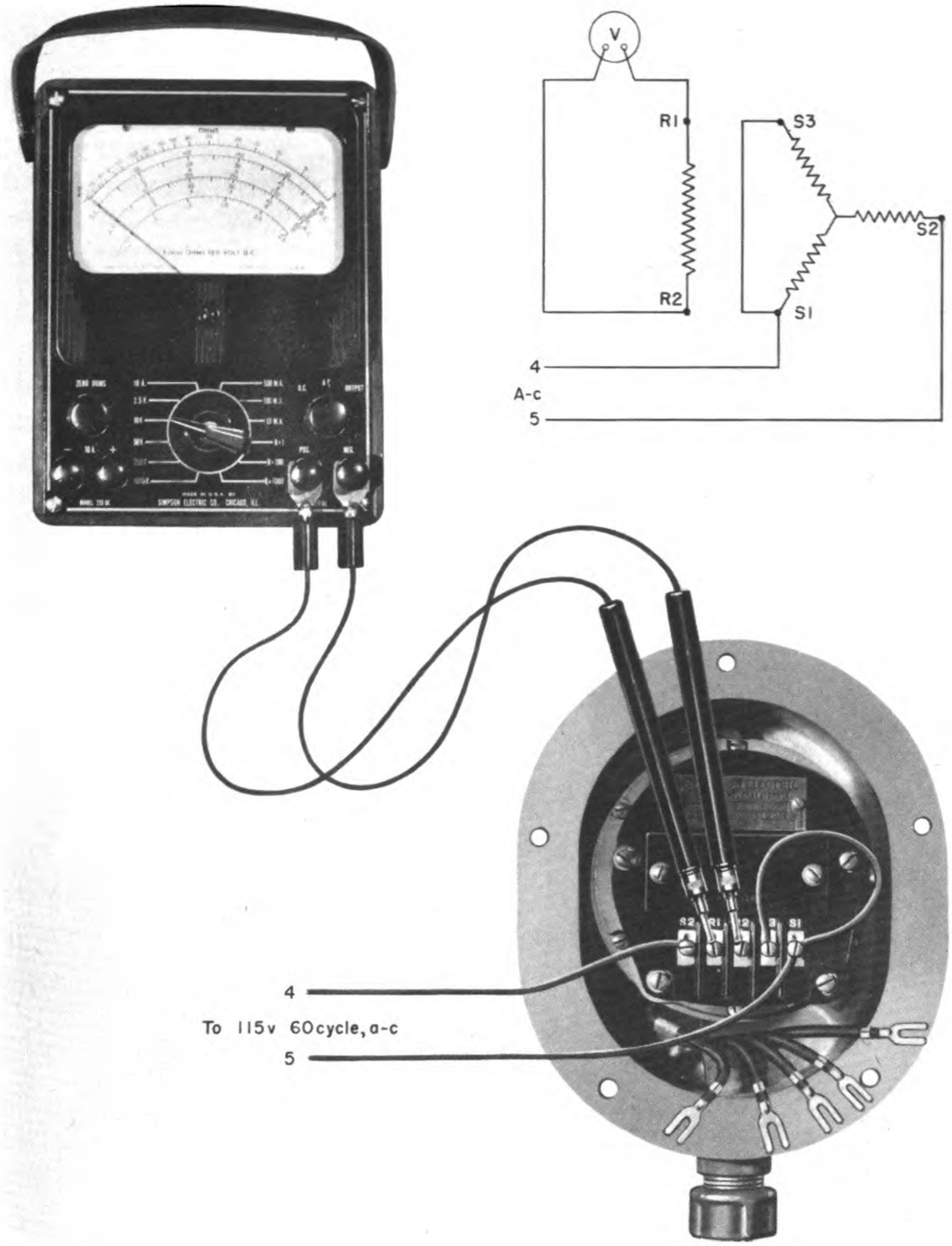



Fig. 64. Final adjustment on elevation low-speed control transformer

## 67. Elevation Electrical Limits

It is not necessary to apply either d-c or a-c power to the searchlight in order to check the settings of the limit switches. Each limit switch produces an audible click when it operates; by listening for this click, the operating point of the limit switch can be determined. Lower-limit switch E399b should operate at −175 mils, and upper-limit switch E399a should operate at −2200 mils. The operating points of the switches should be as near as possible to the above values.

**a.** To change the operating point of a switch, place elevation clutch lever E131 in its HAND position and release elevation brake handle E369. Loosen the two adjusting screws, E415, Fig. 56, which hold the stop for operating arm E418 of that particular switch, and shift the stop until the switch operates at the desired point. Securely tighten adjusting screws. (Changing these settings does not affect the setting of the elevation high-speed control transformer.)

## 68. Arc-current Regulator

Before any attempt is made to adjust the setting of arc-current regulator La1, Fig. 65, the arc should be run for several minutes. After the arc has stabilized, the current indicated by arc ammeter E244 should average 150 amperes except for momentary surges. If the average current is too high or too low, the current regulator should be adjusted as follows:

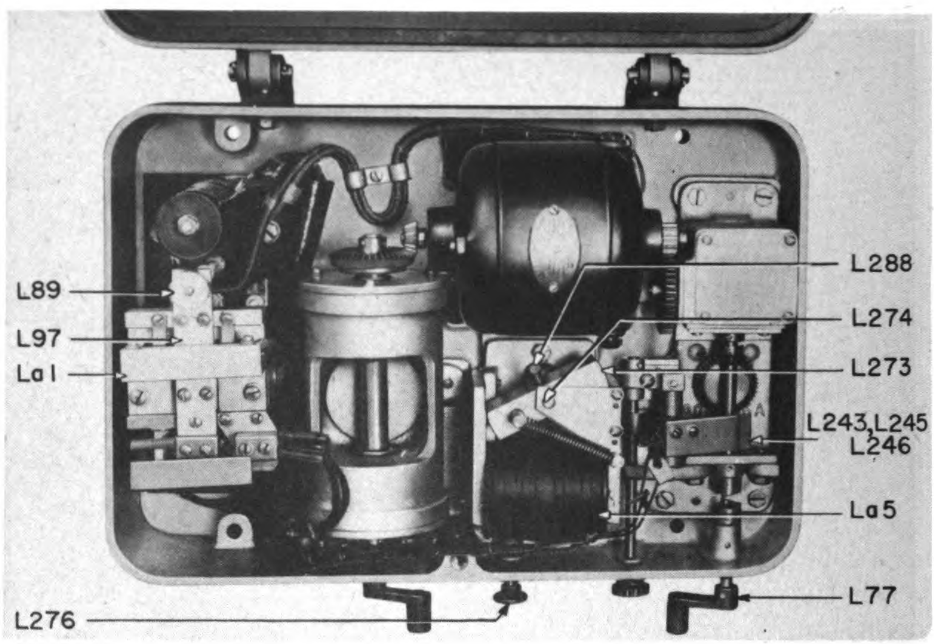



**Fig. 65. Adjustment points on lamp-mechanism box**

| Ref. No. | Designation | Ref. No. | Designation |
|---|---|---|---|
| La1 | Arc-current Regulator | L274 | Positive-feed-magnet-armature Shaft |
| L89 | Adjusting Nut | L288 | Set Screw |
| L97 | Regulator Armature | L245, L246 | Positive-semiautomatic-feed Contacts |
| La5 | Positive-feed Magnet | L243 | Guard |
| L273 | Positive-feed-magnet Armature | L276 | Positive-feed Button |
| L77 | Positive-drive Crank | | |

# ADJUSTMENTS, ARC-CURRENT REGULATOR

WARNING: Push in negative drive crank L168 to cut out the automatic current control before making adjustments while the arc is on.

**a.** Turn arc-current regulator adjusting nut L89 counterclockwise to decrease the current, or clockwise to increase the current. Turn the adjusting nut several notches in the proper direction to obtain an average current of 150 amperes. Pull out negative drive crank L168 and observe the current over a period of several minutes. If further adjustment of the current regulator is necessary, follow the procedure outlined above. When the negative drive crank is pushed in, the current is under manual control, and should be maintained at 150 amperes by turning the crank.

**b.** If the current-regulator armature L97 hunts and causes the negative carbon to feed and retract continually, or if the current varies over more than about an eight-ampere range, the contacts of the current regulator should be reset as described in the Maintenance Manual.

## 69. Lamp-head Alignment

The alignment of the positive and negative lamp heads may be adjusted by loosening the two negative-head support bolts L388, Fig. 66 and 67,

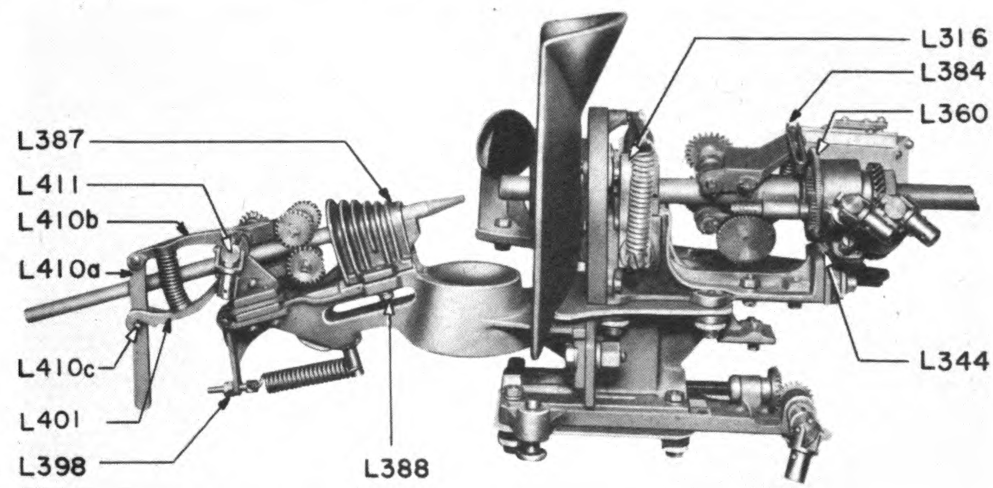



**Fig. 66. Adjustment points on searchlight lamp**

| Ref. No. | Designation | Ref. No. | Designation |
|---|---|---|---|
| L316 | Positive Brush Assembly | L398 | Negative Brush-pressure Adjusting Nuts |
| L384 | Positive Lever | | |
| L344 | Positive-feed Detent | L401 | Lower Negative-roller Arm |
| L360 | Detent Wheel | | |
| L387 | Negative Nose | L410a, L410b | Negative Lever and Upper-roller Arm |
| L388 | Nose Adjusting Screws | L410c | |
| L411 | Negative Drive Shaft | | |

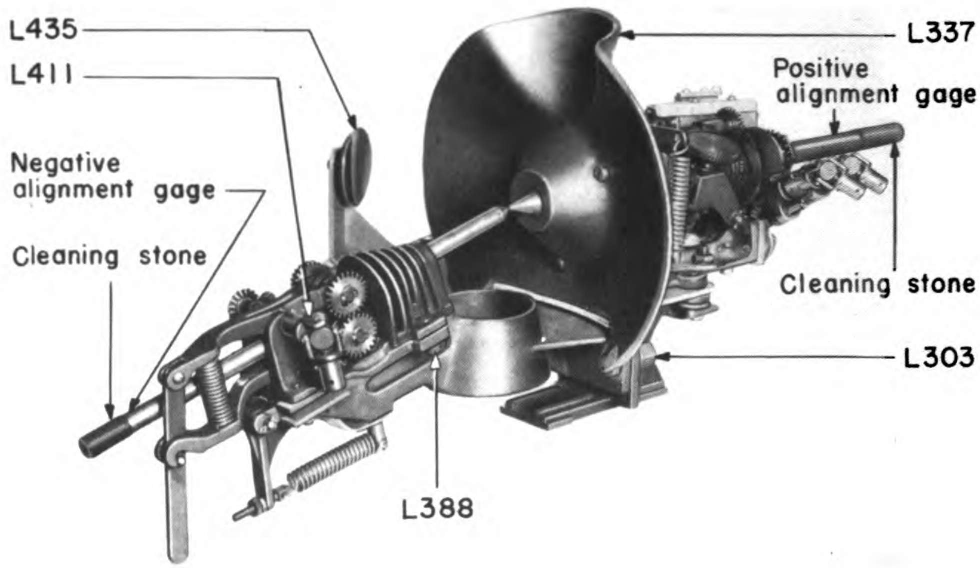



**Fig. 67. Lamp with aligning gages in position**

| Ref. No. | Designation | Ref. No. | Designation |
|---|---|---|---|
| L303 | Negative-head Support Bolts | L337 | Positive Nose Cap |
| L411 | Negative Drive Shaft | L388 | Negative Nose Adjusting Screws |
| L435 | Thermostat Mirror | | |

and shifting the negative head with respect to the positive. The proper alignment is determined by inserting the alignment gages into the lamp, as shown in Fig. 67. The shoulder at the end of the tapered section of the positive alignment gage should be flush with the front of the positive nose cap, L337. With negative lever L410a secured as indicated, turn negative drive rod L411 to feed the negative gage until its tapered tip just touches the tapered tip of the positive gage. The bottom edges of the two tips should be even, and the negative tip should be on a vertical line through the center of the positive tip. As a safety precaution, no d-c power should be supplied to the searchlight while checking the alignment.

## 70. Positive-carbon Protrusion

For satisfactory lamp operation, the positive carbon should project ¾ inch beyond the positive nose cap. If the protrusion of the positive carbon is not correct, the thermostat mirror L435 should be adjusted as follows:

**a.** Place a piece of paper between the positive intermittent-feed contacts L245 and L246 under guard L243 in the lamp-mechanism box, Fig. 65.

**b.** Operate the arc for at least ten minutes. While the arc is on, it will be noted that the armature L273 of the positive-feed magnet La5 picks up and drops out at nearly regular intervals. As has been explained

# ADJUSTMENTS, POSITIVE-CARBON PROTRUSION

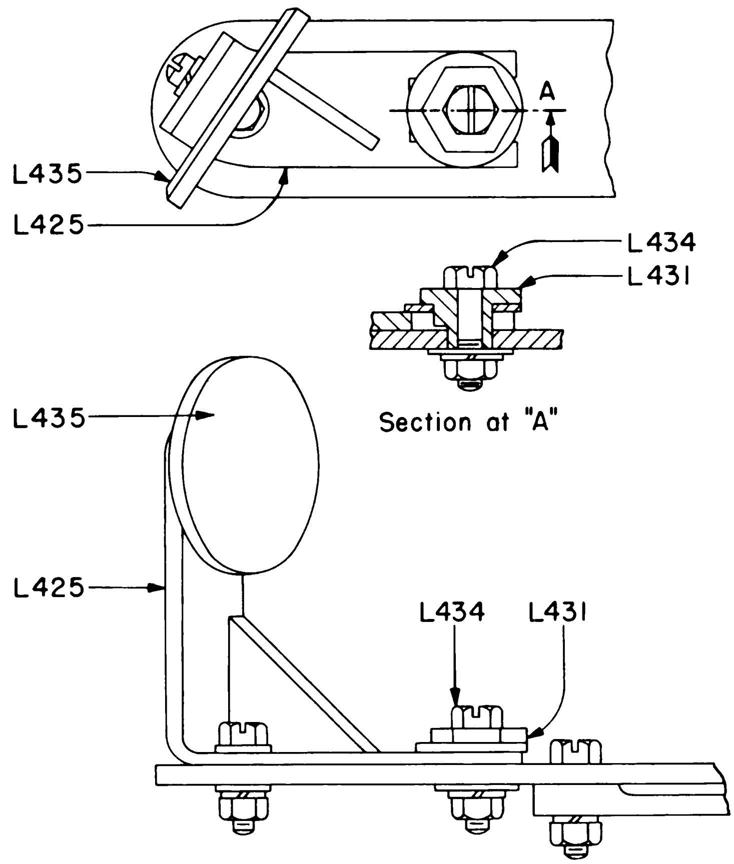



**Fig. 68. Adjustment points for thermostat mirror**

| Ref. No. | Designation | Ref. No. | Designation |
|---|---|---|---|
| L425 | Mirror Mounting Bracket | L434 | Locking Bolt |
| L431 | Adjusting Eccentric | L435 | Thermostat Mirror |

above, the positive-carbon feed occurs only when the armature of the positive-feed magnet is picked up. Hence, the feed starts when the armature picks up and stops when the armature drops out.

**c.** After approximately ten minutes of arc operation, turn the arc off immediately following the beginning of a positive-feed cycle.

**d.** Measure the projection of the positive carbon beyond the positive nose cap. If this projection is less than ¾ inch, loosen locking bolt L434 to adjust the mirror L435, Fig. 68, as follows:

(1) Turn the mirror adjusting eccentric L431 clockwise to move the fork of the mirror mounting bracket L425 toward the lamp; or if the projection is more than ¾ inch, turn the adjusting nut counterclockwise to move the fork away from the lamp. Move the fork only a small amount at a time. Tighten the locking bolt L434 before rechecking the positive carbon protrusion.

**e.** Operate the arc for four or five feeding cycles, and then check the projection of the positive carbon. Repeat the above operations until the positive-carbon projection is held at ¾ inch.

**f.** Remove the paper from between the positive intermittent-feed contacts L245 and L246, Fig. 65.

CAUTION: A visual check should be kept on the positive-carbon position during arc operation by means of the ground-glass finder F29 and the peep sight F81. If, during the adjustment of the thermostat mirror, the positive-carbon protrusion should become less than ⅝ inch, shut off the arc, feed the positive carbon by hand to approximately ¾ -inch projection, and reset the thermostat mirror.

## 71. Ground-glass Finder

The ground-glass finder F29, Fig. 69, which is mounted on the front drum section is adjustable, so that the image of the positive-carbon tip can be made to fall on the black focus line F33a when the lamp is operated at the focal point of the mirror. To check and make this adjustment, operate the arc long enough to obtain stable operation. Turn off the arc and carefully measure the distance from the tip of the positive carbon to the center of the light mirror. This measurement should be checked against the focal length which is stamped on the rim of the mirror. If the measurement does not check, move the lamp, by means of the focusing knob R50, until the distance is the same as the stamped focal length. Loosen the lock nuts F54 on the ground-glass-finder adjusting screws F53 on the inside of the drum. Turn on the arc and observe where the image falls. If it is to the left of the focus line, the two (top and bottom) adjusting screws on the left side should be loosened, while the screws on the right side are tightened. When the image of the positive-carbon tip is on the line, see that all adjusting screws F53 are snug, but not tightened excessively. If the image is to the right of the line, the right-hand screws should be loosened and the left-hand screws tightened as described above. When the finder is properly set, tighten the lock nuts on the adjusting screws.

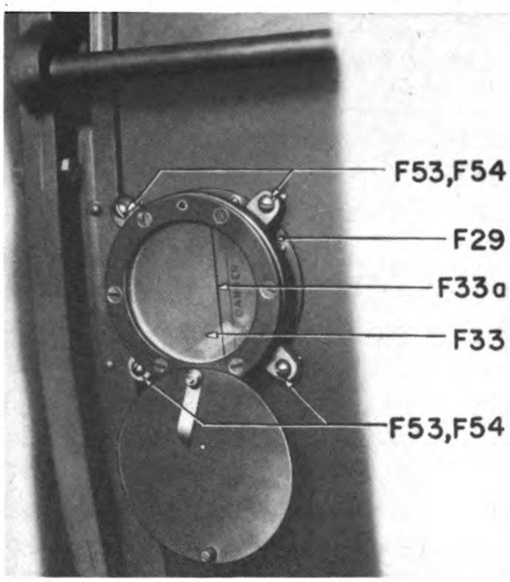



Fig. 69. Adjustment points on ground-glass finder

| Ref. No. | Designation |
|---|---|
| F29 | Ground-glass Finder |
| F33 | Viewing Screen |
| F33a | Focal-line Mark |
| F53, F54 | Adjustment Screws and Nuts |

# ADJUSTMENTS, AZIMUTH CLUTCH

## 72. Positive Feed Magnet

Detent L344, Fig. 66, should fully engage detent wheel L360 when positive-feed button L276, Fig. 65, is pushed in. If it does not, loosen the setscrew L288 in positive-feed-magnet armature L273. Rotate the shaft L274 relative to the armature until the detent fully engages the detent wheel. With the detent in this position, rotate the armature in a clockwise direction until it hits the stop, and then securely tighten the setscrew. Be sure that, when the armature is in its released position, the detent does not engage the detent wheel but clears it by approximately $\frac{1}{32}$ inch.

## 73. Control-station Azimuth Clutch

Friction clutch S306, Fig. 70, in the azimuth drive in the control station

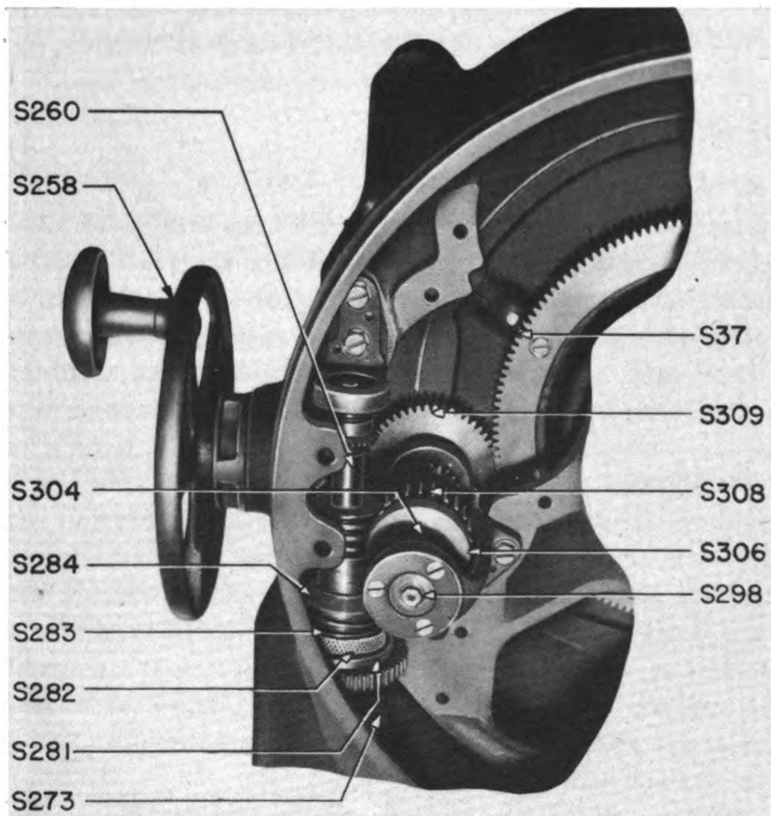



Fig. 70. Azimuth clutches on controller

| Ref. No. | Designation | Ref. No. | Designation |
|---|---|---|---|
| S258 | Zero-reader's Handwheel (Azimuth) | S298 | Azimuth-drive shaft |
| | | S304 | Adjusting Nut |
| S260 | Main-operating Shaft | S306 | Azimuth-drive Clutch |
| S281 | Friction Disk | S273 | Azimuth Flywheel |
| S282 | Adjusting Nut | S308 | Wormwheel |
| S283 | Clutch Spring | S309 | Azimuth-drive Gear |
| S284 | Clutch Coupling | S37 | Stationary Ring Gear |

should be tight enough so that it does not slip during normal operation of either the operator's or the zero-reader's handwheels. On the other hand, it should not be so tight as to prevent the controller housing from being moved, as is required during orientation. To adjust the clutch, it is necessary to remove the azimuth zero-reader instrument and its mounting bracket from its support. Turn hexagonal nut S304 which is on vertical shaft S298 to change the clutch-spring pressure.

### 74. Control-station Azimuth-flywheel Clutch

Friction clutch S281 in the gearing to the azimuth flywheel, S273, should be so set that, with the observer's handwheel in its low-speed ratio, it is unnecessary for the observer to accelerate and decelerate the flywheel as rapidly as the handwheel. To adjust this clutch, turn the round knurled nut S282 on shaft S260, changing the clutch spring pressure.

## TROUBLE SHOOTING

### 75. General

It is impossible to anticipate all circumstances and combinations of circumstances which may cause faulty operation of the searchlight equipment. The symptoms of troubles and their corrections mentioned in this Manual are only those which can be easily detected and which can be corrected by simple adjustments. For a more detailed discussion of troubles and their corrections, reference should be made to the Maintenance Manual.

#### a. The Analyzer

The analyzer instrument provided in the spare-parts and tool box is a combination voltmeter, ammeter, and ohmmeter. It will be found indispensable in trouble shooting and checking the various electric circuits. This instrument is designed to be able to check all the different types of circuits, and, hence, has several ranges of sensitivity. Care must always be exercised to have the analyzer properly connected and adjusted for measuring safely and accurately the voltages, currents, or resistances desired. A front view of the analyzer is shown in Fig. 57.

(1) For a-c and d-c voltage readings, connect the test leads to the terminals marked POS and NEG. Turn the A.C./D.C. knob to the desired position, and turn the range selector (the large center dial) to the desired range of voltage to be measured. In case the voltage to be checked is unknown, set the selector at 1000 volts and reduce the range successively to 250 volts, 50 volts, 10 volts, or 2.5 volts, if the prior reading indicated that the value measured will not be greater than the highest value of the next lower range. When reading d-c voltage, make sure that the POS cord goes to the positive point of the circuit to be read. Be sure to read the proper scale.

(2) For measuring direct current not in excess of 10 amperes, connect the test leads to the terminals marked "−10A.+". For measurement

## TROUBLE SHOOTING, LAMP OPERATION

of currents less than 500 milliamperes (one-half ampere), connect the test leads to the POS and NEG terminals, turn the knob to D.C., and turn the range selector to the desired milliampere range. Read the D.C. scale, multiplying the scale reading by the proper factor. It is recommended that these lower ranges of current measurement are not used, however, unless a check of the circuit with the 10-ampere range indicates that the current is less than 500 milliamperes.

(3) To measure resistance, turn the A.C./D.C. knob to its D.C. position, connect the test leads to the POS and NEG terminals, and turn the range selector to the desired position. Three positions are provided: Rx1000, Rx100, and Rx1. The 1, 100, and 1000 are the factors by which the resistance reading on the ohms scale has to be multiplied to obtain the actual resistance value. Each time before measuring the resistance of a circuit, hold the tips of the test rods firmly together and adjust the ZERO OHMS knob until the pointer indicates zero at the extreme right end of the OHMS scale.

### 76. Faulty Lamp Operation

Some of the symptoms of faulty lamp operation, with cross references to analysis and correction, are listed in the following table:

**TABLE I**

| Symptom | Analysis and Correction (Refer to Table II) Item No. |
|---|---|
| a. Negative carbon does not strike or feed, | |
| (1) With negative-drive shaft turning. | 1, 2, 3, 4, 5, 6, and 8 |
| (2) With negative-drive shaft not turning. | 23 and 24 |
| b. Negative carbon does not retract after automatic strike, | |
| (1) With negative-drive shaft turning. | 2, 3, 4, 5, 6, 8, and 9 |
| (2) With negative-drive shaft not turning. | 23 and 24 |
| c. Negative carbon retracts too far, breaking the arc. | 22, 23 |
| d. Negative carbon hunts back and forth. | 5, 6, and 23 |
| e. Positive carbon does not rotate when positive head rotates. | 11, 12, 13, and 14 |
| f. Arc smokes continuously and gives off soot. | 5, 10, 13, 20, and 21 |
| g. Average arc current more than 150 amperes. | 21, 30 |
| h. Average arc current less than 150 amperes. | 22, 30 |
| i. Variation in arc current too great. | 23 and 24 |
| j. Arc voltage not 78 volts. (See also "g" and "h" above) | 30 and 31 |
| k. Positive projection less than ¾-inch (judged through peep sights) | 11, 12, 13, 15, 17, and 19 |

# MODEL 1942 SEARCHLIGHT AND CONTROL STATION

## TABLE I (Continued)

| Symptom | Analysis and Correction (Refer to Table II) Item No. |
|---|---|
| m. Positive projection more than ¾-inch (judged through peep sights) | 16, 17, 19, 25, and 26 |
| n. Positive tip off black line on arc-image screen with ¾-inch projection of positive carbon. | 27, 28, and 29 |
| o. Variation in positive projection too great. | 18, 19, and 29 |
| p. Negative brush overheats. | 5 and 7 |

## TABLE II

| Item No. | Fault | Correction |
|---|---|---|
| 1. | NEGATIVE LEVER NOT SECURED. | Push negative lever L410a back to the secured position, as shown in Fig. 66. |
| 2. | NEGATIVE LEVER NOT FREE IN THE SECURED POSITION, WITH CARBON IN PLACE. | Use round file from tool box to deepen slot in lower negative-roller arm L401 until the hook does not touch negative-lever pin L410c. (Fig. 66.) |
| 3. | NEGATIVE-FEED ROLLERS NOT GRIPPING CARBON. | Replace negative-feed rollers L407, if teeth appear worn. |
| 4. | NEGATIVE-FEED-ROLLER PRESSURE INSUFFICIENT. | Stretch the negative-feed-roller spring L419 to increase pressure, or replace with new spring. (Fig. 17.) |
| 5. | NEGATIVE BRUSH AND NOSE PITTED, ROUGH, AND DIRTY. | Clean as instructed in Par. 60, Table II, Item 6. Replace brush or nose if badly burned or pitted. |
| 6. | NEGATIVE BRUSH PRESSURE TOO HIGH. | Unscrew negative-brush-pressure-spring adjusting nuts L398 a turn or two on stud. |
| 7. | NEGATIVE BRUSH PRESSURE TOO LOW. | Screw negative-brush-pressure-spring adjusting nuts L398 on to stud. |
| 8. | NEGATIVE CARBON IMPROPERLY ALIGNED IN NEGATIVE HEAD. | Adjust alignment according to instructions in Maintenance Manual. |
| 9. | NEGATIVE CARBON TOO SHORT. | Recarbon. See Par. 30. |
| 10. | NEGATIVE HEAD IMPROPERLY ALIGNED. | Check and adjust alignment according to instructions in Par. 69. |
| 11. | POSITIVE FEED ROLLERS NOT GRIPPING CARBON. | Replace positive rollers L375 if teeth appear worn. |

# TROUBLE SHOOTING, LAMP OPERATION

## TABLE II (Continued)

| Item No. | Fault | Correction |
|---|---|---|
| 12. | POSITIVE FEED-ROLLER PRESSURE INSUFFICIENT. | Stretch the positive-roller spring to increase pressure, or replace with new spring. |
| 13. | POSITIVE BRUSHES PITTED, ROUGH, AND DIRTY. | Clean as instructed in Par. 60, Table II, Item 9. |
| 14. | POSITIVE CARBON BROKEN BETWEEN FEED ROLLERS AND BRUSHES. | Recarbon. See Par. 30. |
| 15. | DETENT DOES NOT ENGAGE DETENT WHEEL. | Adjust positive feed-magnet armature according to instructions in Par. 72. |
| 16. | DETENT DOES NOT RELEASE DETENT WHEEL. | See Item 15. |
| 17. | THERMOSTAT MIRROR IMPROPERLY ADJUSTED. | Adjust thermostat mirror according to instructions in Par. 70. |
| 18. | ARC IMAGE NOT FOCUSED ON THERMOSTAT STRIPS. | Refer to Maintenance Manual. |
| 19. | OTHER THERMOSTAT FAULTS. | Refer to Maintenance Manual. |
| 20. | CARBONS WET. | Recarbon with dry carbons. See Par. 30. |
| 21. | CURRENT-REGULATOR SPRING TOO TIGHT (Arc current high). | Adjust current-regulator as instructed in Par. 68. |
| 22. | CURRENT-REGULATOR SPRING TOO LOOSE (Arc current low). | See Item 21. |
| 23. | CURRENT-REGULATOR CONTACTS IMPROPERLY ADJUSTED. | Refer to Maintenance Manual. |
| 24. | NEGATIVE DRIVE CRANK PUSHED IN TO HAND DRIVE POSITION. | Pull crank out. |
| 25. | POSITIVE-FEED RATE ADJUSTMENT TOO HIGH. | Turn positive-feed-rate knob counterclockwise. |
| 26. | POSITIVE-FEED CONTACTS STUCK CLOSED. | Check and adjust contacts according to instructions in Maintenance Manual. |
| 27. | LAMP OUT OF FOCUS. | Check and adjust focus according to instructions in Par. 71. |
| 28. | GROUND-GLASS FINDER OUT OF ADJUSTMENT. | Check and adjust arc-image screen according to instructions in Par. 71. |
| 29. | LOOSE GROUND-GLASS-FINDER LENSES. | Tighten ring screw on either end of lens tube. |

## TABLE II (Continued)

| Item No. | Fault | Correction |
|---|---|---|
| 30. | BALLAST-RESISTOR CONNECTIONS WRONG FOR LENGTH OF CONNECTING CABLE. | See that connections are made according to instructions in Par. 27d(1). |
| 31. | POWER-PLANT VOLTAGE TOO HIGH OR TOO LOW. | Lower or raise power-plant voltage by turning generator-field-rheostat handle clockwise or counterclockwise to adjust voltage to desired value. |

NOTE: All part reference numerals correspond to those on illustrations in this manual and in the Parts and Price List Manual for this equipment.

## 77. Faulty Operation of the Zero-indication System

Faulty operation of the zero-indication systems in the searchlight is indicated by failure of the indicator pointers to move from their center positions with independent movements of the searchlight by hand in azimuth or in elevation, or of the locator in azimuth or in elevation, or of the various control-transformer correctors at the searchlight.

**a.** Faulty operation of the zero-reader systems in the control station is indicated by failure of the pointers of the zero-reader instruments to move with independent movements of the locator or of the control station in azimuth or elevation.

## 78. Checking the Zero-indication System

In case of faulty operation of the zero-indication system, make an immediate check to see that the following list of conditions is satisfied: (Only the simple and easily applied checks are listed here. For a complete check refer to the Maintenance Manual.)

**a.** Required conditions for normal operation of the complete zero-indication system.

(1) The power plant must be connected to the searchlight, be operating, and be set to supply the proper voltage for searchlight operation, as given in the Power-plant Operator's Manual.

(2) The ballast-resistor connections should correspond to the length of the power cables used. (See Paragraph 27d(1).)

(3) The locator and the control station should be connected to the searchlight by their proper cables.

(4) The a-c selector switch, J77, Fig. 4, must be in the proper position, and the a-c indicating lamp, E30, Fig. 8, must be lighted.

(5) The pointer of each zero-indicator instrument must be properly zeroed. (See Paragraph 62.)

(6) All connections in the internal wiring of the searchlight, the control station, and the locator must be tight and must make good electrical

## TROUBLE SHOOTING, ZERO INDICATORS

contact. In checking for open circuits, particular attention should be given to the brushes used on the locator, searchlight, and control-station collector rings, and to connections at the cable plugs and receptacles.

b. If the a-c indicating lamp, E30, is not on when the a-c selector switch, J77, is in the proper position, check the 5-ampere fuse in the junction box. Replace it with a new fuse if it is blown out. If the indicating lamp still does not light, check that the voltage between terminals 4 and 5 and between AC1 (at the 5-ampere fuse) and 5 is approximately 115 volts a-c. If this voltage is present the a-c indicating lamp is probably burned out or improperly seated in its socket, and should be replaced if necessary. If no voltage is noted and the a-c selector switch is in its EXTERNAL position, check the a-c power source in the locator in accordance with the instructions issued for that equipment.

(1) If the a-c selector switch is in its DYNAMOTOR position, listen to determine whether the dynamotor is rotating, and if it is not, check the lower 15-ampere fuse (P-A3) in the junction box. Replace the fuse if it is blown out. If the dynamotor still does not run, or if it runs but no a-c voltage is present in the searchlight circuits, or if the a-c voltage is low, refer to the Maintenance Manual.

### 79. Checking the Low-speed Indicators

To check the low-speed (1-speed) zero-indication systems in both the searchlight and the control station, place the D.E.C. transfer switch, S71, Fig. 13, at the control station in its AUTOMATIC position, and place the elevation zero-indicator selector switch, E187, at the searchlight in its LOW SPEED position. (This is required only when checking the elevation system.) Leave both amplidyne switches, E58 and A17, turned OFF.

#### a. Azimuth Low-speed Zero Indicators

As a locator (any locator may be used) is rotated in azimuth, the pointer in the azimuth low-speed zero-indicator instrument, E245, Fig. 8, at the searchlight as well as the pointer in the azimuth zero-reader instrument, S104 (left-hand), at the control station should move. If neither pointer moves, the trouble is probably in the locator or its connecting cable and plugs. It should be checked in accordance with the instructions issued for that equipment.

(1) If only one of the azimuth instruments operates, check the a-c voltages applied to the instrument which does not operate. The a-c voltage between the two smaller-diameter studs (These are the terminals marked "1E" and "2E" on the back of the case, or "4" and "5" on the mounting board on the elevation control box.) which project from the back of the instrument should be approximately 115 volts. Since these two studs are connected to the a-c supply circuit, 4-5, this voltage should be the same as that of the a-c supply.

(2) Disconnect the wire (17) from the terminal marked "1L" on

the amplifier terminal board in the azimuth control box. The a-c voltage between the two larger-diameter studs (1G and 2G at the control station, or 17 and 18 at the elevation control box) on the instrument then should vary continuously and smoothly between 0 and 55 volts as the locator is rotated. After checking this voltage, reconnect the wire to terminal 1L of the terminal board.

(3) If both a-c voltages are present and the instrument pointer *does not move,* the instrument itself is defective and should be replaced.

(4) If no voltage is present between the two larger-diameter studs (1G-2G) on the instrument at the control station, the trouble is in the control transformer Sa6a, in that system, in the wiring to the control transformer (terminals 1, 2 and 3 at the collector rings), in the control station cable and plugs, or in the wiring in the searchlight junction box to the receptacle for that cable. Refer to the Maintenance Manual for further instructions.

(5) If no voltage is present between the two larger-diameter studs (17-18) on the instrument at the searchlight, the trouble is in the control transformer, B14, in that system, in the wiring to the control transformer (terminals 41, 42 and 43 in the junction box), or in the D.E.C. transfer relay (or in the wiring, 41-43, to it) in the junction box.

(6) A further check may be made by placing the D.E.C. transfer switch, S71, at the control station in its MANUAL position. Turn the azimuth zero-reader handwheel, S258, Fig. 13, and note if the pointers in both the zero-reader (control station) and zero-indicator (searchlight) instruments move. If the searchlight instrument now operates but did not operate when the transfer switch was in its AUTOMATIC position, the trouble is in the D.E.C. transfer relay (41-43) in that circuit or in the wiring from the locator receptacle to that relay. In order to check the relay, make certain that the upper stationary contacts on this relay are clean and make good electrical contact with the moving contacts when the relay is not energized. If the voltage mentioned in the preceding paragraph is still not present, refer to the Maintenance Manual. Replace any defective wiring.

### b. Elevation Low-speed Zero Indicators

To check the elevation low-speed zero-indication system, use the same procedure as given in part a. of this paragraph, applying it to the elevation system.

## 80. Checking the High-speed Indicators

To check the high-speed zero-indication system in the searchlight, use a locator which has combined low- and high-speed transmitters, place the D.E.C. transfer switch, S71, at the control station in its AUTOMATIC position, place the elevation zero-indicator selector switch, E187, at the searchlight in its HIGH SPEED position (this is required only when checking the elevation system), and leave both amplidyne switches, E58 and A17, turned OFF.

## TROUBLE SHOOTING, ZERO INDICATORS

### a. Azimuth High-speed Zero Indicators

Rotate the locator in azimuth and note if the pointer in the azimuth high-speed zero-indicator instrument, A43, at the searchlight moves. If it does not move, check the a-c voltages applied to the instrument. The a-c voltage between the two smaller-diameter studs, 1E and 2E, which project from the back of the instrument should be approximately 115 volts. Disconnect the wire from terminal marked "1H" on the amplifier terminal board in the azimuth control box. The a-c voltage between the two larger-diameter studs, 1G and 2G, on the instrument then should vary continuously and smoothly between 0 and 55 volts as the locator is rotated. After checking this voltage, reconnect the wire to the terminal 1H of the terminal board.

(1) If both a-c voltages are present and the instrument pointer does not move, the instrument is defective and should be replaced.

(2) If no voltage appears betweeen the larger-diameter studs on the instrument, check that the armature of the azimuth high-speed D.E.C. transfer relay (26, 28-46, 48) is in its de-energized position; that the contacts are closed and are making good electrical contact. If still no voltage appears between the larger-diameter studs on the instrument, check that the a-c voltage between the two upper stationary contacts, 46 and 48, on the relay varies continuously and smoothly between 0 and 105 volts as the locator is rotated in azimuth. If this voltage does not appear, the trouble is in the locator, or the locator cable and plugs. Check these in accordance with the instructions issued for that equipment.

(3) If the latter voltage does appear, but no voltage appears at the larger-diameter studs, 1G and 2G, on the instrument, the trouble is either in the control transformer, A185, in that system or in the wiring to the control transformer. In this case, refer to the Maintenance Manual for further instructions.

### b. Elevation High-speed Zero Indicators

To check the elevation high-speed zero-indication system, use the same procedure as given in part a. of this paragraph, applying it to the elevation system.

### 81. Symptoms of Faulty D.E.C. Operation

The following are general symptoms of faulty operation of the D.E.C. system:

**a.** Neither the azimuth nor the elevation D.E.C. systems will operate. (See Paragraph 82, parts a, c, and d)

**b.** The azimuth D.E.C. system operates satisfactorily, but the elevation system does not. (See Paragraph 82, parts a, c, and e)

**c.** The elevation D.E.C. system operates satisfactorily, but the azimuth system does not. (See Paragraph 82, parts a, c, and e)

**d.** The operation of either the azimuth or the elevation D.E.C. system is faulty. (See Paragraph 82, parts a and e)

(1) The searchlight hunts about the point of correspondence.

(2) Operation of the searchlight is rough and jerky.

(3) The searchlight does not accurately follow the locator or the control station.

(4) The searchlight rotates or moves in one direction only.

## 82. Checking the D.E.C. System

If any of the above symptoms are evident in the operation of the D.E.C. system, make an immediate check of part a. of this paragraph. If these conditions are satisfied continue with the checks that follow. (Only the simple and easily applied checks are listed here. For a complete check refer to the Maintenance Manual.)

**a.** All of the following items are required for normal operation of the entire D.E.C. system:

(1) The power plant must be connected to the searchlight, be operating, and be set to supply the proper voltage for searchlight operation.

(2) The ballast-resistor connections should correspond to the length of the power cables used. (See Paragraph 27d(1).)

(3) The locator and the control station should be connected to the searchlight by their proper cables.

(4) The a-c selector switch must be in the proper position, and the a-c indicating lamp must be lighted. (See Paragraph 78b.)

(5) Both drum doors of the light must be securely closed.

(6) The D.E.C. transfer switch at the control station should be in the proper position for the type of control desired.

(7) Both amplidyne motor-generator sets must be turned on and running; for each set affects only the operation of its respective system. (See part b. of this paragraph.)

(8) The azimuth clutch handle, A109, must be in its D.E.C. position. This affects only the azimuth system.

(9) The elevation clutch handle, E131, must be in its D.E.C. position. (See item 10 of this paragraph.)

(10) The elevation brake, E369, must be in its OFF position. Items 9 and 10 affect only the elevation D.E.C. system.

(11) All connections in the internal wiring of the searchlight, control station, and locator must be tight and must be making good electrical contact. In checking for open circuits or for possible points of high resistance, particular attention should be given to the brushes used on the locator, searchlight, and control-station collector rings, and to connections at the cable plugs and receptacles.

**b.** If either one of the amplidyne motor-generator sets does not start when its switch is turned on, check the fuse in the input circuit to its driving motor. In azimuth, it is the upper 15-ampere fuse (P-A) in the junction box; and in elevation, it is the right-hand 15-ampere fuse (P-A) in the elevation amplifier box. Replace a blown-out fuse with a new one.

## TROUBLE SHOOTING, D.E.C. SYSTEM

(1) If the left-hand 15-ampere fuse (P-AA) in the elevation amplifier box is blown out, the scale lamps, the recarboning lamp, and the instrument lamps will not light; the arc voltmeter will not give an indication; and no voltage will appear at the trouble-lamp receptacle in the elevation control box.

**c.** Before the azimuth or the elevation D.E.C. systems will operate, the control contactor (A28 or E181) in each system must be energized, causing its armature to "pick up." (Refer to Fig. 38.) If both of the contactors are not energized, check the drum-door interlock switches, F10 and F11, to see that they are making good electrical contact.

(1) If one of the control contactors is not energized, check the operation of the interlock switches in that particular system. In the azimuth system (control contactor A28), this is the azimuth clutch switch A134; and in elevation (control contactor E181), the elevation clutch and brake switches E150 and E158. If one of the amplidyne motor-generator sets should overheat, the thermostatically operated overload switch (C265 or T189) in that machine would open, de-energizing the control contactor in that particular system. If this should occur, refer to the Maintenance Manual for instructions.

**d.** Check that the electronic amplifier in the inoperative system is receiving an input signal. This can be done as follows:

(1) Check items 1, 2, 3, 4, and 11 of part a. of this paragraph.

(2) Disconnect the wire from the terminal marked "1L" on the amplifier terminal board, and check by means of the analyzer that the a-c voltage between the disconnected wire and the amplifier terminal 2L varies continuously and smoothly between 0 and 55 volts as the searchlight is moved by hand (with the amplidyne switches turned off) in azimuth or in elevation, depending upon which system is being checked. The above voltage should appear during all types of D.E.C. operation with any type of locator. After checking this voltage, reconnect the wire to terminal 1L of terminal board.

(3) Disconnect the wire from the terminal marked "1H" on the amplifier terminal board, and check that the a-c voltage between the disconnected wire and the amplifier terminal 2H varies continuously and smoothly between 0 and 55 volts as the searchlight is moved by hand as described above. This voltage will be present only during AUTOMATIC D.E.C. operation when the locator used has both high- and low-speed transmitters. After checking this voltage, reconnect the wire to terminal 1H of the terminal board.

(4) If these voltages are not present, check the zero-indication system as described in Paragraph 78. It will be noted by reference to the connection diagram, Fig. 71, of the searchlight that the output voltage of the control transformers is applied to the respective input circuit of the amplifier as well as to the respective zero-indicator instrument. Follow the instructions given in Paragraph 78 if the zero-indicator instruments do not

## MODEL 1942 SEARCHLIGHT AND CONTROL STATION

operate. If they do operate, check the wiring in the searchlight between the amplifier terminals and the respective control transformers as follows:

(*a*) Azimuth

| | Amplifier Terminals | C-T Terminals | Zero-indicator Terminals |
|---|---|---|---|
| Low-speed | 1L<br>2L | (B14) 17-R2<br>18-R1 | 17-1G<br>18-2G |
| High-speed | 1H<br>2H | (A185) 70-R2<br>71-R1 | 70-1G<br>71-2G |

(*b*) Elevation

| | Amplifier Terminals | C-T Terminals | Selector-switch Terminals (E187) | Zero-indicator Terminals |
|---|---|---|---|---|
| Low-speed | 1L<br>2L | (T72) 62-R2<br>63-R1 | 62-66<br>63-67 | 66-1G<br>67-2G |
| High-speed | 1H<br>2H | (E387) 64-R2<br>65-R1 | 64-66<br>65-67 | 66-1G<br>67-2G |

**e.** Check the vacuum tubes in the amplifier of the faulty D.E.C. system. This can be done by removing both tubes from the amplifier and inserting a new pair of type -6L6 tubes. (Spare tubes are furnished in the spare-parts and tool box of each searchlight.)

(1) If no change in operation is noted, the original tubes may be assumed to be good, and may be put back into the amplifier. If a change in operation is noted, one or both of the original tubes are defective. To determine which tube is defective, put one of the original tubes back into the amplifier and check the operation of the D.E.C. system. Remove this tube, insert the other original tube, and recheck the operation. The tube that causes faulty operation is defective. Replace the tube or tubes which are defective. If this does not eliminate the faulty operation, refer to the Maintenance Manual for additional instructions.

COMPLETE CONNECTION

DIAGRAM

receptacles to
power unit

# ADDENDUM

# THE ANTIAIRCRAFT

# PROBLEM

# ADDENDUM

## THE ANTIAIRCRAFT PROBLEM

### 83. General Factors

Many factors affect the use and efficiency of searchlights in the present antiaircraft defensive problem. Furthermore, it is to be expected that procedure will vary with the introduction of changed methods in bombing and defense, increase in speed of aircraft, greater height of attack, etc. However, a discussion of certain features and characteristics of searchlights and their effects may both aid in the operation of the equipment and serve to assist the operating personnel.

**a.** The various elements which determine the effectiveness of searchlights may be divided into two classes.

(1) Internal Elements, i.e., those which depend on the searchlights and which control its luminous ouput.

(2) External Elements, i.e., those which act on the luminous output after projection of the beam of the searchlight.

**b.** The principal internal elements are as follows:

(1) The illumination intensity and power of the arc which is the source of light.

(2) The diameters of the crater and the reflector.

(3) The position of the source with respect to the focus of the reflector.

(4) The efficiency of reflection of the reflector and that of other searchlight parts.

### 84. Illumination Intensity

Since military searchlights employ the high-intensity arc, no effort will be made to present characteristics of other arc forms or sources of light. In the high-intensity arc, the source of light is a ball of luminous gas which is positioned in a crater of the positive carbon. It derives its high intrinsic brilliancy from the temperature to which the gases are raised by the passage of the current through the arc. As in observations of the temperatures on the sun, it is found that temperatures of incandescent gases exceed those of solids. It is due to this fact that the beam intensity exceeds that of other sources employing solids, such as filaments or bare carbons. The positive carbon is composed of a cylindrical shell of solid carbon which is filled by a core, compounded principally of cerium, lathanum, and powdered carbon. The introduction of cerium and lathanum, in addition to making possible high temperatures, also determines the special characteristics of the light. An examination of the spectrum of the high-intensity arc shows that it has the same characteristics as the spectrum of sunlight.

**a.** Due to the passage of the current, the stream of positive ions vaporizes and volatilizes the materials of the core, and since this volatilization takes

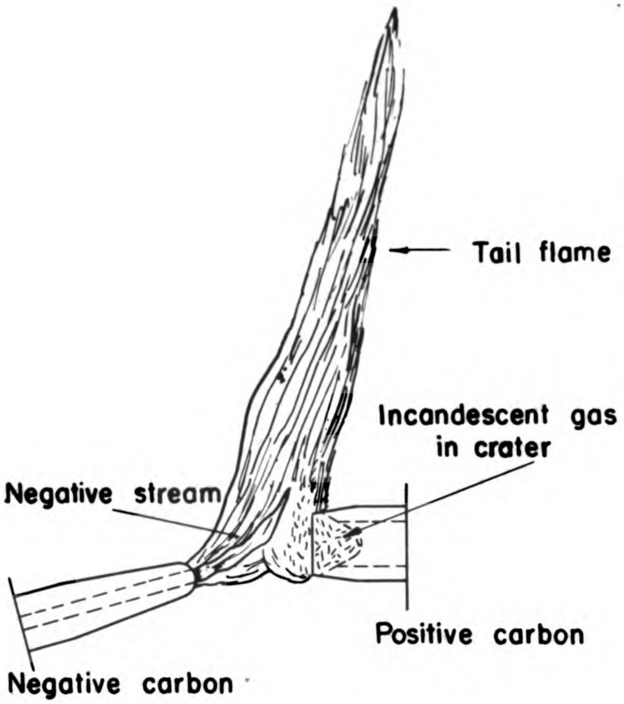



**Fig. 73. Section view of normal arc**

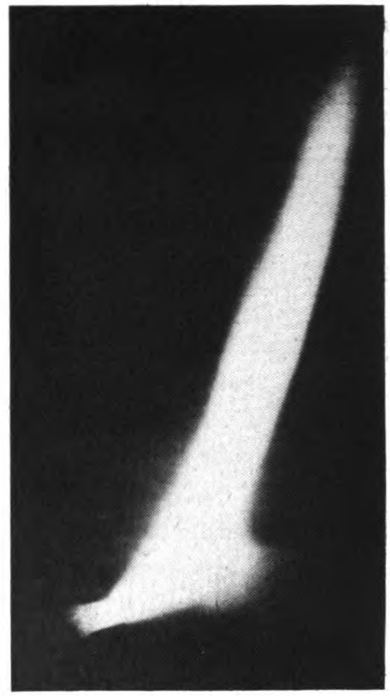


**Fig. 74. Normal appearance of arc**

place at a faster rate than that of the solid carbon shell, the gas vapor expands into the crater formed by the shell. In order to maintain a crater wall of uniform height, the positive carbon is continuously rotated. The ball of incandescent gas in the crater is further confined by the stream of high-velocity negative electrons directed against it from the tip of the negative carbon. Fig. 74 shows a photograph of the normal high-intensity arc, while Fig. 73 gives a sketch of the cross section of the arc. It will be noted that the negative stream, due to the angle at which it is directed toward the ball of incandescent gas, (1) caps the ball of gas, and also (2) causes gas to overflow the crater into the so-called "tail flame."

**b.** Since the temperature of the gases in the crater will increase with the distance from the walls of the crater, the greatest intrinsic brilliancy will occur at the center of the crater where the depth is greatest. In the same manner, the maximum beam candlepower of the searchlight is to be found at the center of the beam. The beam candlepower is dependent upon the size of the reflector, and varies as the ratio of the area of the reflector to the area of the crater of the positive carbon.

## 85. Relative Effect of Reflector Diameter

Each point of the incandescent gas ball may be considered as radiating a pencil of rays of light. The rays that strike the mirror are reflected from it into the beam of the searchlight. This beam is made up of the solid angle of approximately 120 degrees subtended by the mirror. The beam is, there-

## THE ANTIAIRCRAFT PROBLEM

fore, the integrated sum of the pencils of light and, since each point on the reflector conversely receives the radiation from the source, the candlepower of the beam for a given source will vary as the areas of reflectors which may be used, or as the squares of the diameters of the reflectors. Thus, the ratio of beam candlepower of the 60-inch searchlight to the 36-inch searchlight using the same source is 25:9.

**a.** There is another important fact to be noted in the comparison of reflector sizes. Due to the size of the arc, a cone of light, instead of a single ray, is received by each point of the reflector. Therefore, in reflection, the beam will be composed of a large number of small beams, the angular divergence of which will depend upon the size of the source and its distance from the point of reflection. Fig. 75 shows diagrammatically the effect of size of the reflector upon the beam divergence of searchlights.

**b.** It will be noted that for a given reflector, the angle of divergence changes with the radius of the point of reflection from the axis of the reflector, this effect tending to increase the intensity of illumination toward the center of the beam. By a comparison of the angles of divergence for the upper and lower portions of Fig. 75, it will be noted that the positive crater subtends a larger angle at the point of reflection on the 36-inch reflector and, therefore, the total angle of divergence of the 60-inch searchlights (approximately one degree, ten minutes) is smaller than that for a reflector of less diameter. With this decrease in total beam angle, there must come an increase in maximum beam candlepower as is shown in Fig. 75.

**c.** Because the range of a searchlight is dependent upon the maximum beam candlepower, the effectiveness of the 60-inch searchlight is superior, provided the beam spread is satisfactory for its intended use. In this regard, note that the area illuminated increases with distance from the searchlight, and that an equal intensity of illumination will occur at a much greater distance for the 60-inch searchlight. Thus, the beam area becomes comparable, and the greater beam candlepower of the 60-inch greatly increases its range and finding power as compared with smaller-diameter searchlights.

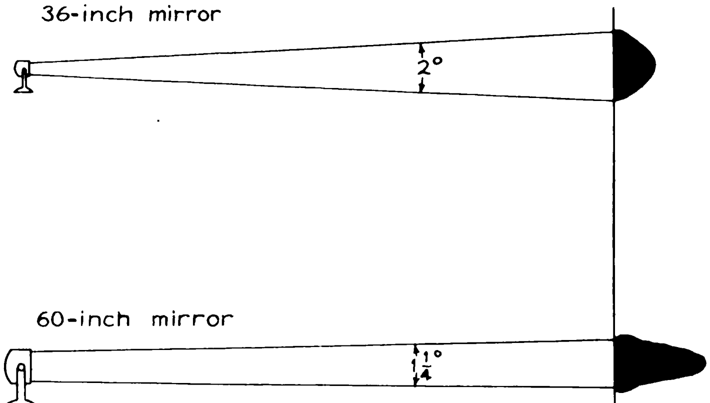



**Fig. 75. Diagram of beam divergence**

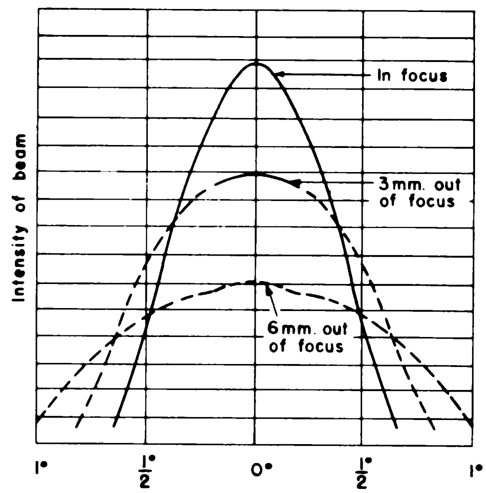



Fig. 76. Chart showing relative intensity of beam

## 86. Effect of the Position of the Source

In order to appreciate the importance of maintaining the arc at the correct focal position, refer to Fig. 76 which gives the beam intensities and widths of the beam taken from tests of a 60-inch searchlight.

**a.** From Fig. 76 it will be determined that a displacement of only 1/8 in. (3.2 mm) toward the reflector reduces the maximum intensity approximately 35 per cent and increases the beam width more than 20 per cent, while a displacement of 1/4 in. has much greater effect. The ranges of the searchlight will thus suffer tremendously when the lamp is operated with the arc "out-of-focus." Therefore, operating personnel should be instructed to give special attention to maintaining the crater at the focus of the reflector, unless, for a definite reason, a "spread beam" is desired.

## 87. Efficiency

The efficiency of the searchlight may be defined as being the ratio of the luminous flux projected by the searchlight to the luminous flux radiated by the arc and received by the reflector. The difference between these two luminous fluxes represents the actual losses. These losses are of several varieties.

**a.** The first is due to the reflector itself, which absorbs a certain quantity of the incident flux received. The mirrors used are of two kinds: mirrors of silvered glass and metal mirrors. The silvered-glass mirrors have a silver surface on the back of the glass parabolic form, the glass serving both to preserve the shape and protect the silver against tarnishing. The metal mirrors are "first-surface" reflectors, i.e., the front surface is the reflecting surface and, therefore, this surface must be of a material which will not corrode or tarnish easily. The efficiency of the reflector is taken as the ratio of the total reflected flux to the total incident flux over the visible portion of the spectrum.

**b.** In the case of the silvered-glass reflectors, the efficiency is affected by the surface reflection of the glass, the coefficient of metallic reflection of silver, the coefficient of transparency of glass, the thickness of the glass, and the condition of the surface of the reflector. The various losses will not be presented quantitatively, since only the total loss is being considered. In general, a clean silver-on-glass reflector will have an average efficiency of approximately 82 per cent.

**c.** For the metal reflector, the only factors to be considered are the coefficient of metallic reflection and the condition of the surface of the reflector. Due to the necessity of employing a nontarnishing metal, the number of usable metals is very restricted and, in each case, the coefficient of reflection is not as high as that of silver. For a clean rhodium-surfaced reflector, an average value of reflectivity of 70 per cent may be assumed.

**d.** The efficiency of either type of reflector is greatly affected by the accumulation of any deposit on the reflector during the operation of the searchlight. Hence, it is very important to maintain a clean, bright surface. However, it is equally important that damage incident to cleaning be avoided.

**e.** Other sources of loss are the shadow effects of the lamp itself, including those of the negative head on the reflector; those due to the position of support, nose cap, and operating rods in the beam; and loss due to the "front-door" glass and its condition. The loss to be assessed to shadow effects is approximately eight per cent. The losses in the front door are due to surface reflection of the glass, the coefficient of transparency of the glass, the thickness of the glass, the joints and bevels of the glass segments, and the condition of the surface. As with the reflector, the efficiency of the front door is greatly affected by the accumulation of any deposit due to the operation of the arc or to etching of the surface of the glass by chemical action when the glass is not cleaned properly. It is, therefore, very important to clean the front door thoroughly, as directed in the instruction manual.

## 88. The Principal Elements External to the Searchlight Which Affect the Efficiency and Performance Are:

**a.** The distance of the target from the searchlight.
**b.** The absorption of the atmosphere.
**c.** The dimensions and characteristics of the target.
**d.** The position of the observer.
**e.** Visual acuity and the use of glasses.

## 89. Distance of the Target

The so-called range of a target takes into effect only a part of the path which must be traversed by the luminous flux before it becomes effective in "picking up" or "finding" the target by an observer. The range of the target is the distance from the searchlight to the target, while that portion of the luminous flux which has reached the target and has been reflected must traverse the path back to the observer. The illumination on the target will be inversely proportional to the square of the distance to the target, due to the spreading of the beam. The working area of any section of the beam, taken perpendicular to the axis, increases with the spread as the square of the distance from the searchlight, and since all of these sections are traversed by the same luminous flux, the result is that the illumination of each such section, that is, the flux per unit of surface, decreases with the square of the distance.

**a.** Of the luminous flux which reaches the target, part only will be reflected or diffused in the direction of the observer. Omitting for the moment the factor of atmospheric absorption, the amount of illumination of the eye of the observer is the result of the two effects. It may be asked why the distance from the target to the observer should not likewise act according to the above law, causing the degree of illumination to decrease, as in the case of that along the path from the searchlight to the target. In order to explain what seems an anomaly, it is necessary to refer back to the theory of vision. The eye has a sensitive screen on which is formed an image of the target. As the target recedes from the eye, the angle subtended by the target diminishes. The dimensions of the image formed on the retina decrease in the same proportion. The luminous flux per unit of surface which emanates from the target and falls on the retina decreases as the square of the distance, or as the square of the angle subtended by the target. However, the surface of the retinal image also diminishes as the square of the same angle.

**b.** It is known that the sensitivity of the eye is maintained only when the retinal image is not less than a given dimension which corresponds approximately, for keen eyes, to an angle of five minutes in height and one minute in width. When this limit is reached, the eye no longer perceives the dimensions of the object, because it sees nothing more than a luminous point. Starting from this distance, the retinal illumination and the impressions resulting therefrom again begin to vary as the square of the distance, as in the observation of stars, but in the field of searchlights, the target must have sufficient size for perception, and this latter condition does not apply.

## 90. Absorption by the Atmosphere

In analyzing the influence exerted by the external elements, the effect of the atmospheric transmission is of primary importance. Accordingly, as the atmosphere is clear or misty, the luminous flux suffers small or large losses in traversing the distance between the searchlight and the target, and also the distance between the target and the observer's eye. It is found that the energy-absorbing characteristics of the atmosphere vary through very wide limits, and that they are affected by many factors for which, at present, there are no well-established standards of measurement. For example, the present meteorological determinations give the amount of moisture in the atmosphere, but do not state how this moisture is distributed. It may be in the form of a mist composed of very fine drops, or it may be in the form of a rain of relatively large drops. The mist is an almost impenetrable screen for a searchlight beam, while the rain curtain can be easily penetrated. Then again, the amount of dust in the atmosphere is an important factor tending to reduce the amount of light transmitted from a searchlight source.

**a.** A primary action in the absorption of the atmosphere is a scattering of light rather than true absorption, and a considerable part of this scattered light comes back toward the searchlight and the observer. Violet and blue portions of the spectrum of the beam are scattered more strongly than the other colors, thus accounting for the characteristic blue tone of the searchlight beam. The scattered light acts as a screen surrounding the target, and the searchlight engineer is faced with a complex problem of contrast in color and in intensity. Furthermore, the true absorption of the shorter-wavelength portion of the spectrum, such as violet or blue, is greater than that of the longer wavelengths. This accounts for the variation in the color of beams of searchlights when analyzed at different distances from the searchlights. Thus, colors of amber and red will be found to predominate at great distances.

**b.** The total absorption of the atmosphere will vary from five per cent per kilometer for very clear weather to almost absolute absorption in fog. When measured, the absorption is also found to vary greatly for different geographical locations, seasons of the year, and altitudes.

## 91. Dimensions and Characteristics of the Target

The visibility of the target is affected by many factors among which are (1) the size and angle of presentation of the target, (2) the reflecting or diffusing power of the target, (3) the color of the target, (4) the effect of contrast between its color and brightness and the color and brightness of its background or surroundings, and (5) the effect of relative illumination of the field of view.

**a.** While the dimensions of planes have increased, bombing heights likewise are greater, and this latter factor is of greater consequence, as a reference to the effect of distance will show. Since modern bombing planes are predominantly monoplanes, the maximum projected area of the plane in flight will occur when the plane is directly overhead in the beam, and the projected area will decrease to approximately 30 per cent when the plane is low and viewed directly ahead, as shown in Fig. 77.

**b.** There is a further reduction in luminous flux reflected toward the observer as the angle is decreased from 90 degrees to zero degrees, due to the fact that the percentage of the area of surface of the plane which is normal to the line of sight of the observer is diminished, and thus the power of reflecting light toward the observer is decreased.

# MODEL 1942 SEARCHLIGHT AND CONTROL STATION

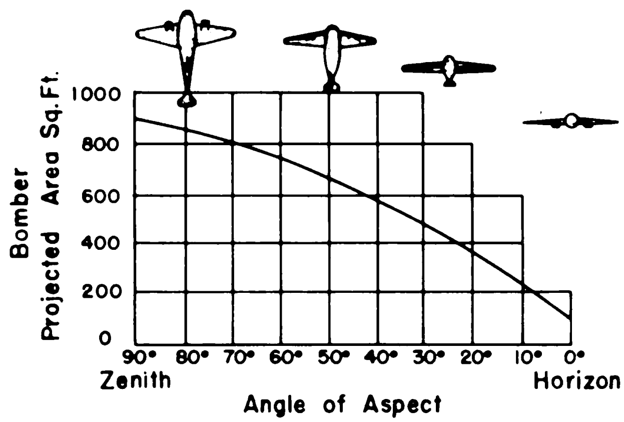



Fig. 77 Chart showing effect of angle of aspect

**c.** Certain objects on the target may possess parts having a brilliancy which reflects the light in the direction of the observer's eye. As a general rule, the parts simply diffuse the incident light. For this reason, polished and bright surfaces on the plane are avoided or covered.

**d.** Color of the target is also of importance. Light objects have a highly reflective power, while dark objects are very absorbent. The use of dark or black, soft-textured paint will reduce the reflective property of a plane to a small fraction of that of its normal covering.

**e.** The color and illumination of the target with respect to the background gives rise to an effect of contrast which greatly favors visibility. Thus, a light target on a dark background, or a dark target on a light background will be more easily distinguishable than if the tints of the two are more or less similar or the degrees of illumination are comparable.

**f.** For visibility of near objects, a difference of only a few per cent in illumination of the object and its background is necessary, while for distant objects, where the angle subtended at the observer's eye by the objects is small, a contrast in brightness between them and the background must be very great. The total luminosity of the searchlight beam giving rise to back glare and forming the background against which the target must be observed remains essentially the same for a given position of the observer. Investigations have shown that, whereas a ratio of contrast in brightness of 2:1 between the target and its background is sufficient for visibility of a bombing plane at a few thousand yards, a ratio in excess of 10:1 will be required for a distance of 10,000 yards. The range of the searchlight which is the maximum distance of visibility of the target must, therefore, be based on values of contrast which are relatively high due to the small angle subtended by the plane.

**g.** In addition, the background for the beam itself must be considered in determining the range, since brightness effects the contrast of the target illumination. Maximum ranges are secured on dark, black nights. Moonlight serves to decrease the effective range, and any atmospheric condition which increases the beam's ambient illumination will lower the range.

## 92. Position of the Observer

The relative positions of searchlight, target, and observer are of extreme importance in the rapid detection of a target. For an observer near the searchlight, the beam obscures his vision, due to highly illuminated air particles

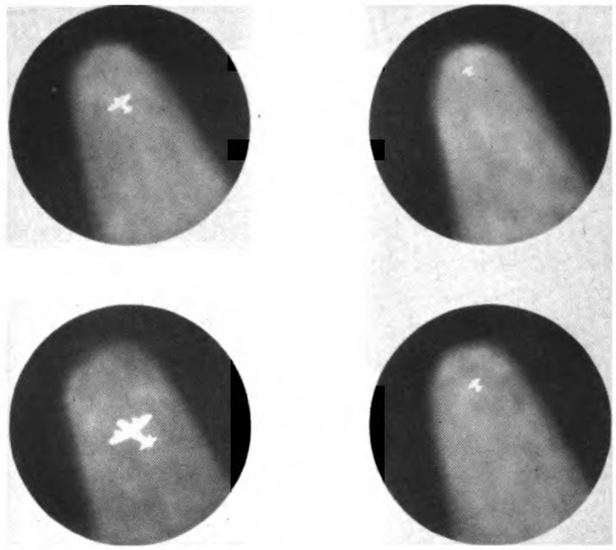


Fig. 78. Effect of distance on visibility of the target

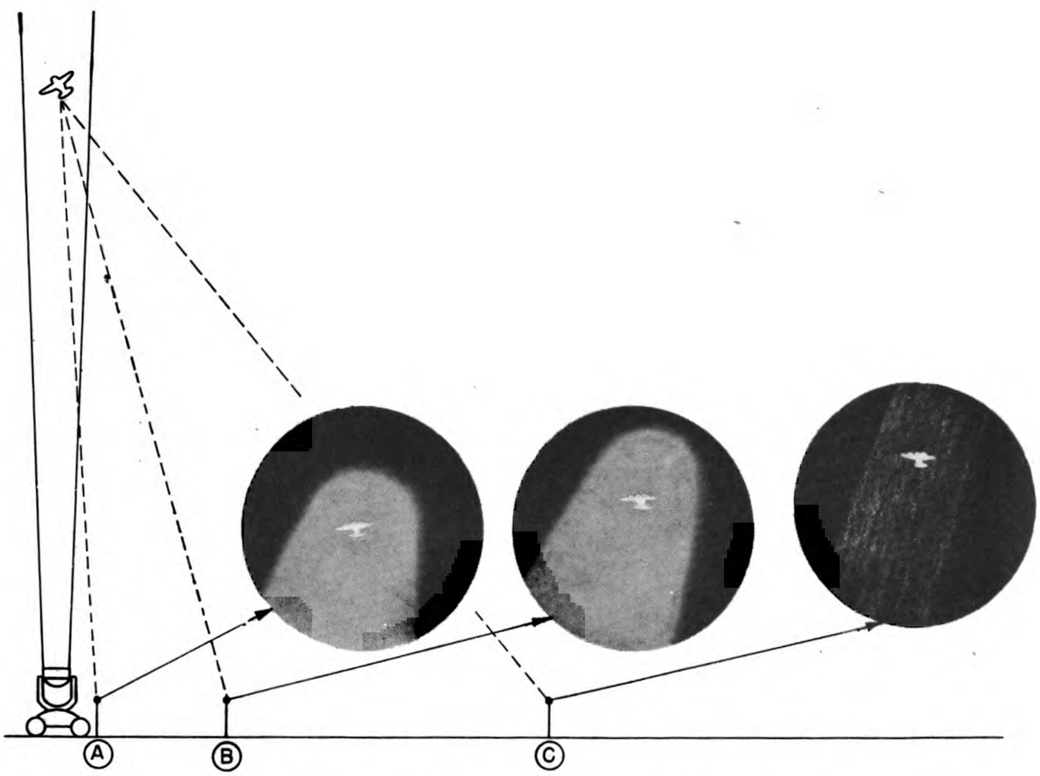



Fig. 79. Effect of observer's position with respect to arc on visibility of the target

in his line of sight. As his position is moved away from the searchlight, the amount of penetration through the beam is decreased, as shown in Fig. 79.

**a.** Furthermore, the contrast between the brightness of the target and the background is increased, due to a reduction of background illumination as shown in Fig. 79.

**b.** The advantage to be gained by increasing the distance of the observer from the searchlight cannot be fully utilized by the searchlight operating personnel. The control station of the searchlight, however, can be placed at the maximum distance permitted by the equipment assigned.

**c.** The position of the target in the beam is also of interest in determining the usefulness of searchlights for distant targets. It has been found that the intensity of illumination required to pick up a target on the far side of a beam from the observer may be two to three times that necessary when the target is on the near side. Operating personnel may make good use of this fact in following a target.

## 93. Visual Acuity and Use of Glasses

The sensibility of the eye of an observer at different illumination levels is a factor in the use of searchlights, and will be found to differ widely with different observers. This is particularly true when the size of the target lies near the threshold of vision. In this regard it is necessary to shield from the observer's eyes any stray light from near sources in order to secure the maximum acuity for the particular observer.

**a.** Since the range of searchlights depends in a great measure upon the relative size of the target to be observed, optical glasses are employed to advantage. For this use, such glasses should be chosen for low losses at the given magnifying power and also with regard to their suitability for night work.

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