(FIRST REVISION)

GUN SIGHT MARK 14

MODS 6, 7, 8, 12, 13, 14, AND 15

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ORDNANCE PAMPHLET 1040 (FIRST REVISION)

GUN SIGHT MARK 14 MODS 6, 7, 8, 12, 13, 14, AND 15

1. Ordnance Pamphlet 1040 (First Revision) covers the general theory, description, and shipboard maintenance of Gun Sight Mk 14 Mods 6, 7, 8, and 12 to 15 inclusive. Information on available training devices and training aids is also included.

2. This pamphlet supersedes OP 1040 (Preliminary), which is to be destroyed. OP 1040 (First Revision) is a shipboard maintenance manual, a general reference text, and a guide for training activities in the study and maintenance of Gun Sight Mk 14. It does not supersede OD 4369, Gun Sight Mk 14 Overhaul Manual, which is for the use of repair shop personnel.

3. This publication is RESTRICTED and shall be safeguarded in accordance with the security provisions of U. S. Navy Regulations, 1920, Article 76.

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Vice Admiral, U. S. Navy
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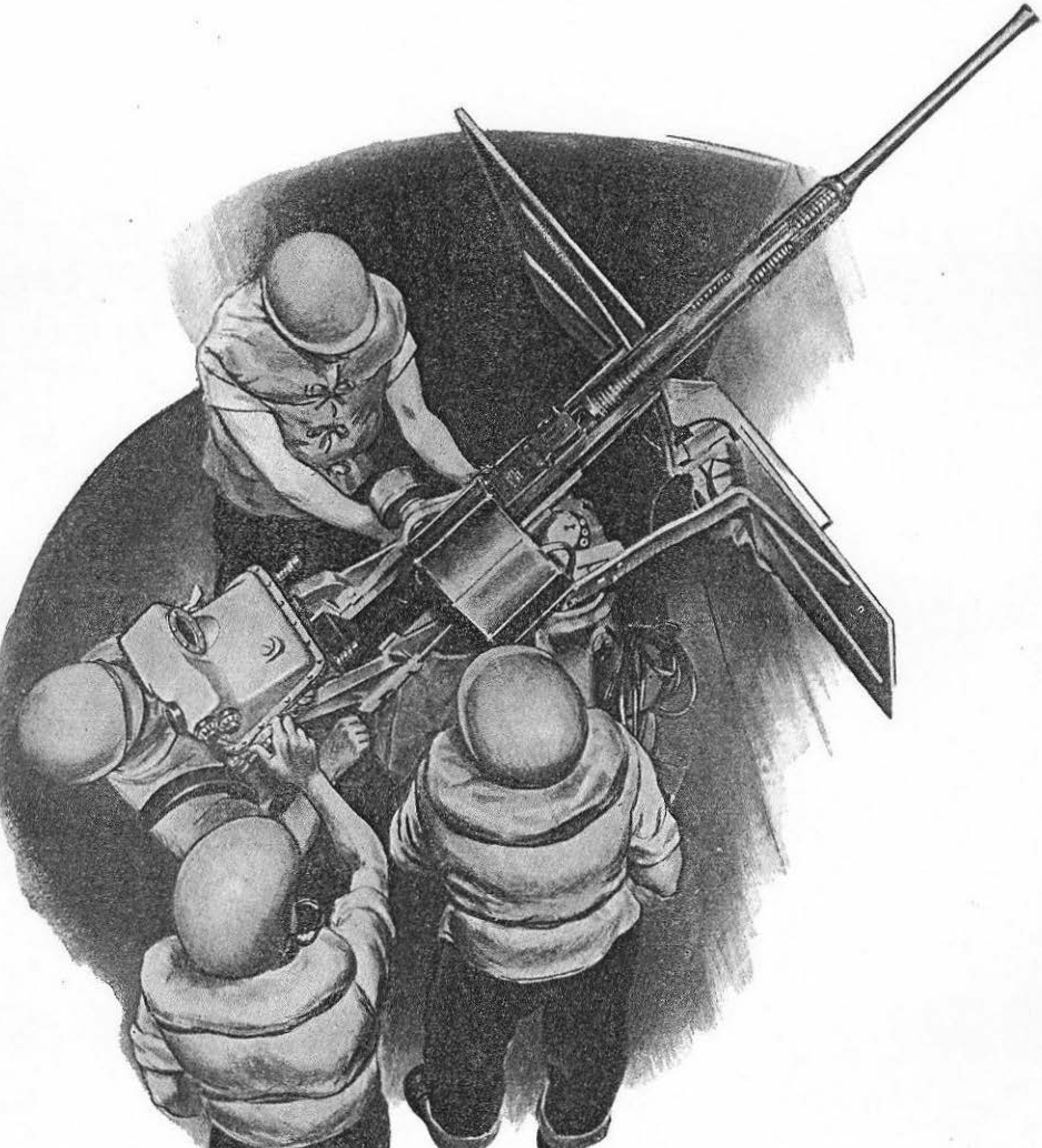

Frontispiece.—Gun Sight Mk 14 Mod 6 in Action.

CHAPTER I

INTRODUCTION

What It Is

Gun Sight Mk 14 is a simple, gyroscopic lead-computing gun sight. With no input other than manual range, this gun sight automatically develops gun train and elevation orders when a fast moving target is tracked continuously with a moving reticle, the position of which is controlled by rate-of-turn gyros. Gun Sight Mk 14 is designed to provide a rapid solution of the short range antiaircraft fire control problem. It is limited to such problems by certain approximations introduced into the solution and by its lack of optical magnification.

Installed on Gun Director Mk 51 Mod 2, it controls 1.1-in., 40-mm, 3"/25 cal., 5"/25 cal., or 5"/38 cal. antiaircraft guns. It may also be mounted directly on 20-mm antiaircraft gun mounts or on the 40-mm Single (power-driven) Mount Mk 4 Mod 3.

Official Nomenclature

All modifications of Gun Sight Mk 14, when delivered, include the following units: gun sight, boresight tube, carrying case for gun sight and boresight tube, air power unit, two air hoses, and two electrical cables. The following additional equipment is supplied with Gun Sight Mk 14 Mod 6 for use with the 20-mm antiaircraft gun mount: gun sight bracket, air power unit bracket, hose-and-cable support bracket, and three hose-and-cable clamps. The Gun Sight Mk 14 Mod 15, as delivered, includes longer hoses and cables replacing those ordinarily supplied.

Modifications

Table 1 lists the official modifications of Gun Sight Mk 14, together with pertinent installation data.

Requirements for Use

The electrical power required for operation of Gun Sight Mk 14 is the 60-cycle a-c ship's service supply at 115 volts. The gun sight circuit requires 326 watts and is fused for five amperes.

Operation of Gun Sight Mk 14, whether installed on 20-mm antiaircraft mounts or on Gun Director Mk 51 Mod 2, normally requires two men, a pointer and a range setter. Its use on the 20-mm mount or on the gun director does not increase the working circle of either.

Sizes and Weights of Equipment

The overall sizes and weights of Gun Sight Mk 14 are listed in Table 2. (For detailed list see Table 9.)

References

Definitions of the terms used in the solution of the short range fire control problem by Gun Sight Mk 14 appear for ready reference in Chapter 11. Inasmuch as certain terms, heretofore used with specific meaning for other equipment, have required significant redefinition when applied to the theory of gyroscopic lead computing sights, these definitions must be carefully studied for a thorough understanding of the functioning of Gun Sight Mk 14.

Table I

GUN SIGHT MARK 14

Official List of Modifications

Mod	Controls	Max range setting *Yards*[1]	Installed on	Notes
0	20-mm A.A.	2,000	20-mm Mount	Experimental M.I.T. design.
1	do.	2,000	do.	do.
2	do.	2,000	do.	1st production design, OD 4429.
3	1.1" A.A.	2,800	Gun Director, Mk 51 Mod 2	do.
4	40-mm A.A.	3,200	do.	do.
5				Experimental M.I.T. design.
6[2]	20-mm A.A.	2,000	20-mm Mount	2d production design, OP 1040.
7[3]	1.1" A.A.	2,800	Gun Director, Mk 51 Mod 2	do.
8	40-mm A.A.	3,200	do.	do.
9	3"/50 A.A.	3,600	do.	1st production design, OD 4429.
10	5"/25 A.A.	3,000	do.	do.
11	5"/38 A.A.	4,000	do.	do.
12	3"/50 A.A.	3,600	do.	2d production design, OP 1040.
13	5"/25 A.A.	3,000	do.	do.
14	5"/38 A.A.	4,000	do.	do.
15	40-mm A.A.	3,200	40-mm Single (power-driven) Mount Mk 4 Mod 3.	

[1]Minimum range for all Mods is 400 yards.

[2]Mod 6 also mounted on Gun Director Mk 51 Mod 2 when used with Gunnery Trainer Mk 3 Mods 0, 3, 4, 5, 6, and 7 (See OP 1200).

[3]Mod 7 also mounted on trainer gun of Gunnery Trainer Mk 1 (See Navord OD 2013 on page 10).

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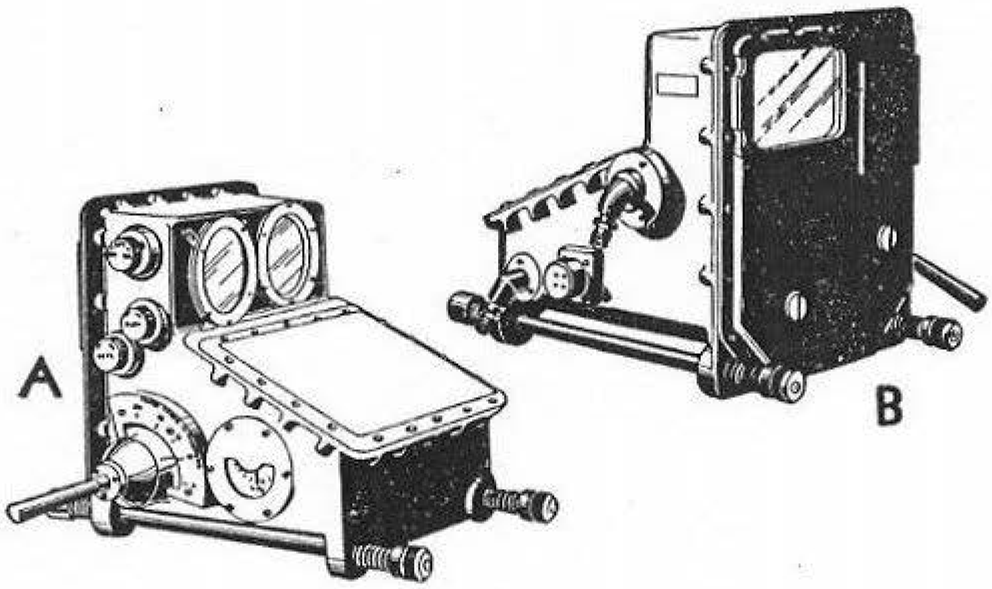

Figure 1.—Gun Sight Mk 14 Mod 2.
A. Front and Right Side.
B. Rear and Left Side.

Table 2
OVERALL SIZES AND WEIGHTS

Unit	Size (in.)	Weight (lb.)
Gun Sight	14¼ x 13⅞ x 11⅛	35
Complete Gun Sight Mk 14 Mod 6 as packed for shipment	48 x 22¼ x 21	236
Complete Gun Sight Mk 14 Mods 7, 8, 12, 13, 14, 15 as packed for shipment	38¼ x 21⅝ x 20½	172

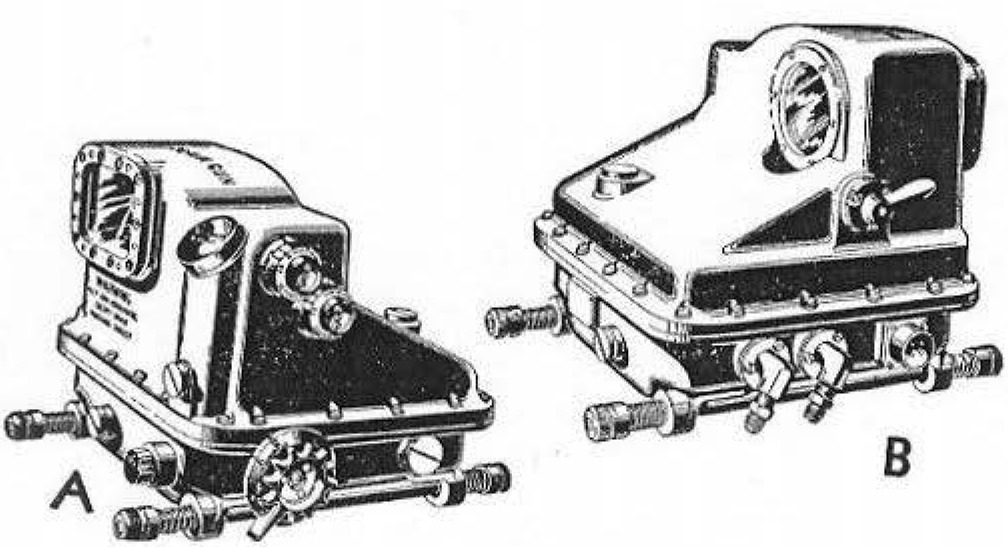

Figure 2.—Gun Sight Mk 14 Mod 6.
A. Rear and Right Side.
B. Front and Left side.

A summary of various precautions to be observed appears for ready reference in chapter 11. Before operating the equipment, these precautions should be studied and thoroughly understood.

The latest list of all applicable Ordnance publications, including Ordalts, also appears in chapter 11.

Scope of the Pamphlet

This pamphlet must serve not only as a shipboard maintenance manual but also as a general reference book and as a text for use by various training activities. Consequently, it has been organized to satisfy these needs, insofar as possible. Detailed maintenance and overhaul instructions for use by qualified repair men and shops are given in NAVORD OD 4369, Overhaul Manual for Gun Sight Mk 14 (Part 2 for Mods 6, 7, 8, 12, 13, and 14).

THEORY AND FUNCTIONAL DESCRIPTION

INTRODUCTION

Gun Sight Mk 14 is designed to permit rapid solution of the short range antiaircraft fire control problem. This rapid solution is achieved by the use of gyroscopic computing elements, by limiting the maximum effective range, and by employing a simple, compact lightweight design. Limiting the range and using gyro computing elements insure a minimum solution time.

Again, the use of gyro computing elements, together with the omission of those ballistic corrections not important in the short range problem, allows the use of a simple lightweight gun sight which can be attached to the gun mount itself, or to a nearby lightweight director.

Other than the elements of target motion which are introduced by the action of tracking the target, the only input to the gun sight is estimated range, which is introduced manually. With these inputs, the gun sight determines the lead angles necessary to establish the line of fire of the gun.

Note: In this discussion, wherever target motion is mentioned it means motion of the target relative to own ship.

A reflected reticle image is positioned by two gyroscopic computing elements in such a way that the optical line of sight determined by the reticle lags behind the axis of the gun sight housing by an angle equal to the angle of lead required to hit the target. Since the gun sight housing is directly attached to the gun or director and aligned with it, this results in positioning the gun or director along the correct gun aim axis. The fact that the line of sight lags behind the axis of the gun sight housing gives Gun Sight Mk 14 a disturbed line of sight.

The action of the gyroscopic computing elements is such that tracking the target provides all necessary inputs (except range) to provide a solution to the problem and aim the gun or director correctly.

Before considering the functional description of how Gun Sight Mk 14 utilizes the disturbed line of sight principle (given in the second section of this chapter), a review of the short range antiaircraft control problem and its theoretical solution is presented. As an aid in understanding the problem, it is recommended that the Glossary of Terms and Definitions in Chapter 11 be consulted frequently.

THE SHORT RANGE ANTIAIRCRAFT FIRE CONTROL PROBLEM

For purposes of definition of the short range antiaircraft fire control problem, the maximum effective range can be considered to be less than 3,000 yards. Within such ranges certain ballistic corrections, which would have a definite effect on accuracy of fire at longer ranges, are neglected. Solution of the problem requires, first, that the instantaneous present position of the target be determined in terms of relative target bearing, target elevation above the deck plane, and range. Relative target bearing and target elevation are continuously introduced into the final solution by tracking the target to keep the optical line of sight continuously on the target. Range may be determined by estimation or other available means.

Next, to allow for the movement of the target during the time required for a projectile to travel the distance to the target, it is necessary to determine, in advance, the future position the target will occupy relative to own ship at the expected moment of impact. In the solution under discussion, the future position of the target is determined, not as a point in space, but as a line passing through a point which the target may be expected to occupy after the time of flight of the projectile (fig. 3). This is done by adding to the angular coordinates

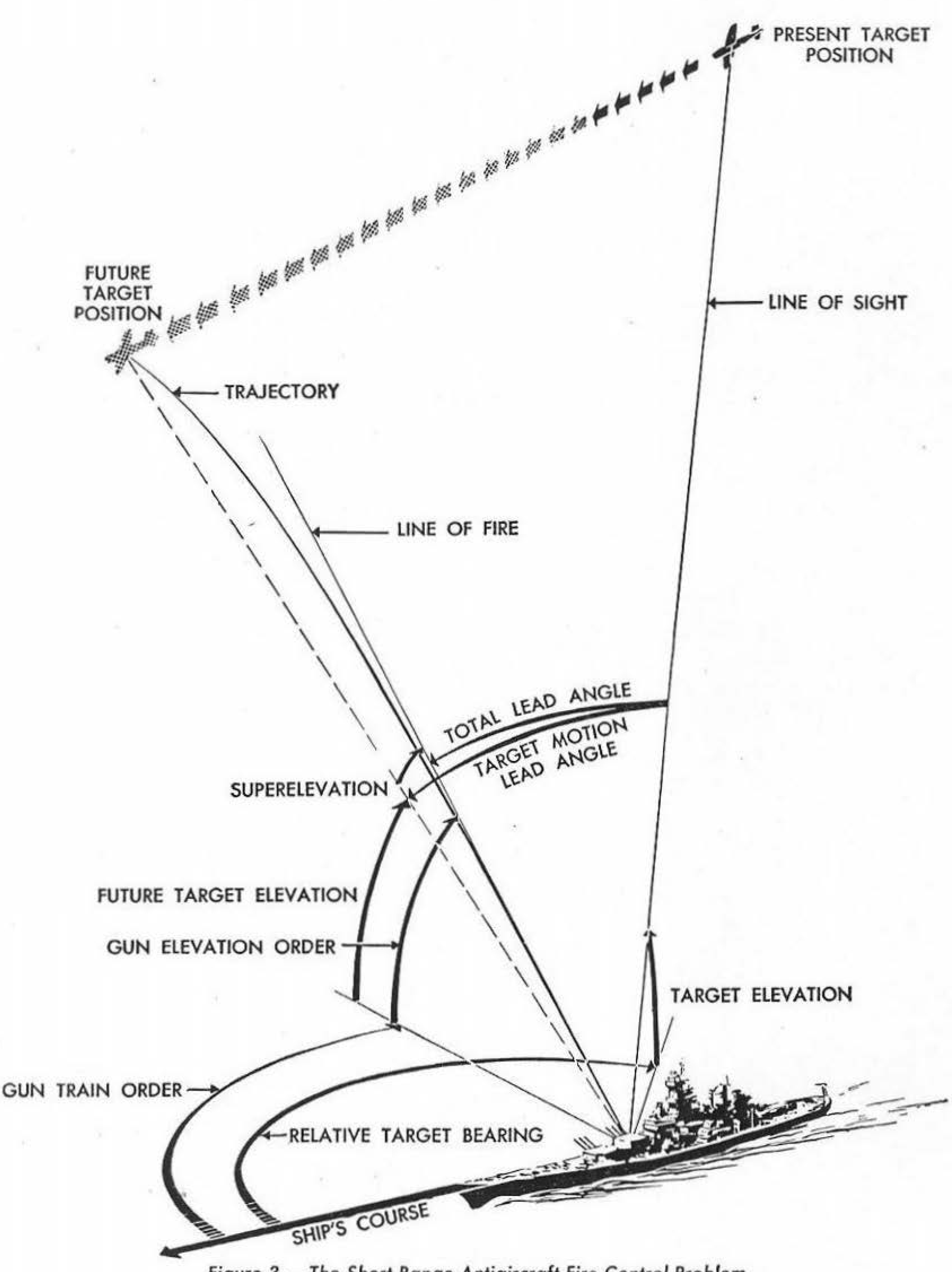

Figure 3.—The Short Range Antiaircraft Fire Control Problem.

of target present position, components of the angle through which a line from gun sight to target would pass while the target is moving from present to future position. These angles are called lead angles, and their application will establish the relative bearing and elevation of the target future position.

Except for ballistic considerations, the line between gun sight and target future position establishes the line along which the gun must be aimed.

Ballistic corrections applied, in terms of angles, to the coordinates of the target future position will give the correct line of fire required to hit the target. These coordinates of the line of fire, when referred to the deck plane, will give gun train and elevation orders (B'gr and E'g).

Elements of Target Motion: The elements of target motion in the short range antiaircraft fire control problem are illustrated in figure 3. For the purpose of this discussion it is necessary to define relative target bearing and target elevation in somewhat different terms than those generally used. Relative target bearing is the angle between the fore-and-aft line of the ship and the perpendicular projection of the line of sight into the deck plane. It is measured in the deck plane clockwise from the ship's bow. Relative target elevation is measured in a plane perpendicular to the deck plane which includes the line of sight. It is plus from zero to 90 degrees above the deck plane, and minus below the deck plane. Range is measured along the line of sight to the target and, in the antiaircraft problem, is frequently called slant range. These three coordinates fix the instantaneous present position of the target. The line of sight is the line from the gun or director to the present target position, along which the pointer looks while tracking the target. Since the target is moving constantly at a rapid rate, any present position fixed by these coordinates will be only instantaneous, yet for each instantaneous present position the solution of the problem requires that a corresponding instantaneous future position be determined. The line of fire is the line along which the gun is aimed, and is determined by the coordinates of instantaneous future position, with the addition of ballistic corrections.

The target, in moving from its present position to its future position during the time of flight of the projectile, will cause the line from gun to target to move through an angle in the plane of motion of the target. It is this angle, the result of target motion, which must be computed when the target is at its present position, to give advance information as to the target future position. This angle is the total target motion, or prediction, lead angle of the target and lies in a plane determined by the instantaneous line of flight of the target and the present line of sight. This is the Prediction Plane (fig. 4). Note that application of this angle to the coördinates of present position establishes only a line passing through the future position but does not determine range to that position. It will be shown later that, except for determination of ballistic corrections, a knowledge of future range will not be required.

It is possible to determine a line to the future position by resolving the lead angle in the prediction plane into two angles, one in a traverse plane and

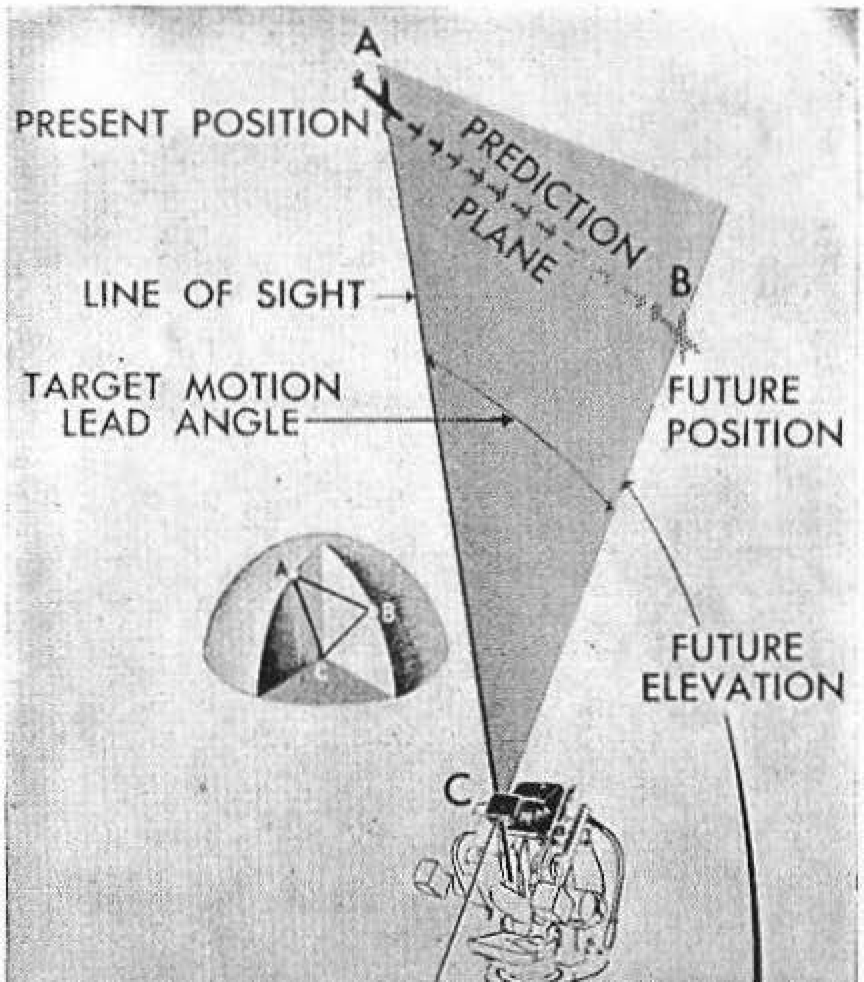

Figure 4.—Prediction Plane.

one in an elevation plane. The elevation plane may be defined as a plane perpendicular to the deck plane of the ship and including the line of fire (fig. 5). This is the elevation plane of the gun and not the elevation plane of the target. A traverse plane may be defined as any slant plane which includes the gun or director trunnion axis. The solution made by Gun Sight Mk 14 requires that the traverse plane used be the one which includes the present position

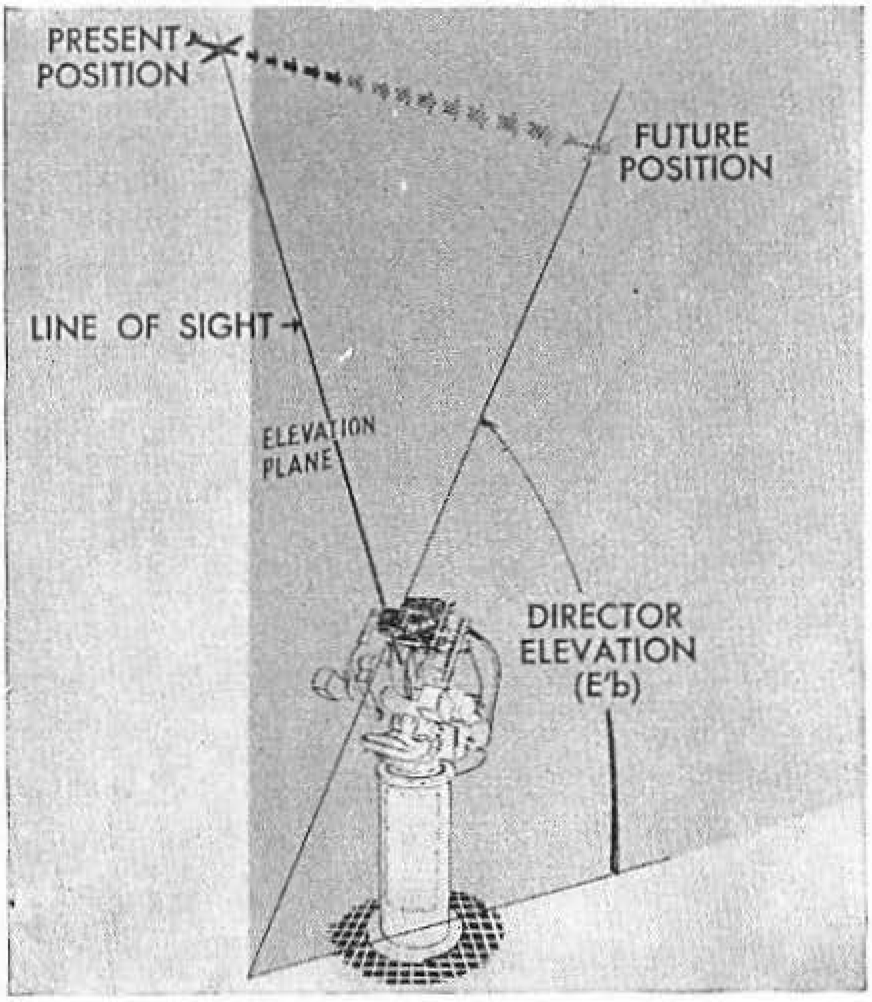

Figure 5.—Elevation Plane.

of the target as well as the gun or director trunnion axis (fig. 6).

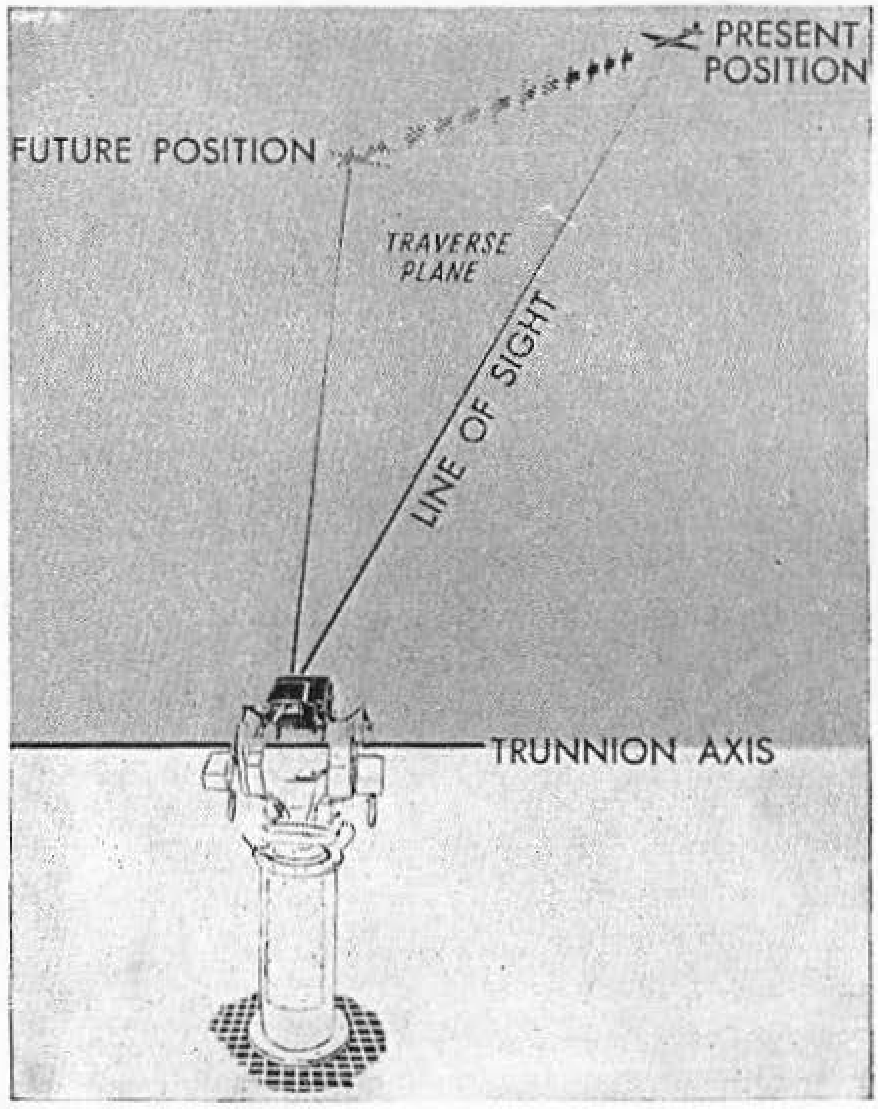

Figure 6.—Traverse Plane.

As seen in figure 7, it is possible to move the line to present target position so that it coincides with the line to future target position by moving it through an angle in the traverse plane and then through an angle in the elevation plane. The solution for these two angles is made by Gun Sight Mk 14 simultaneously, but the mechanism of the optical system of the gun sight is such that, in effect, the line of sight lags the line of fire, first in elevation and then in traverse.

Computation for these angles is made on the basis of the present range from the angular rates of tracking in elevation and traverse.

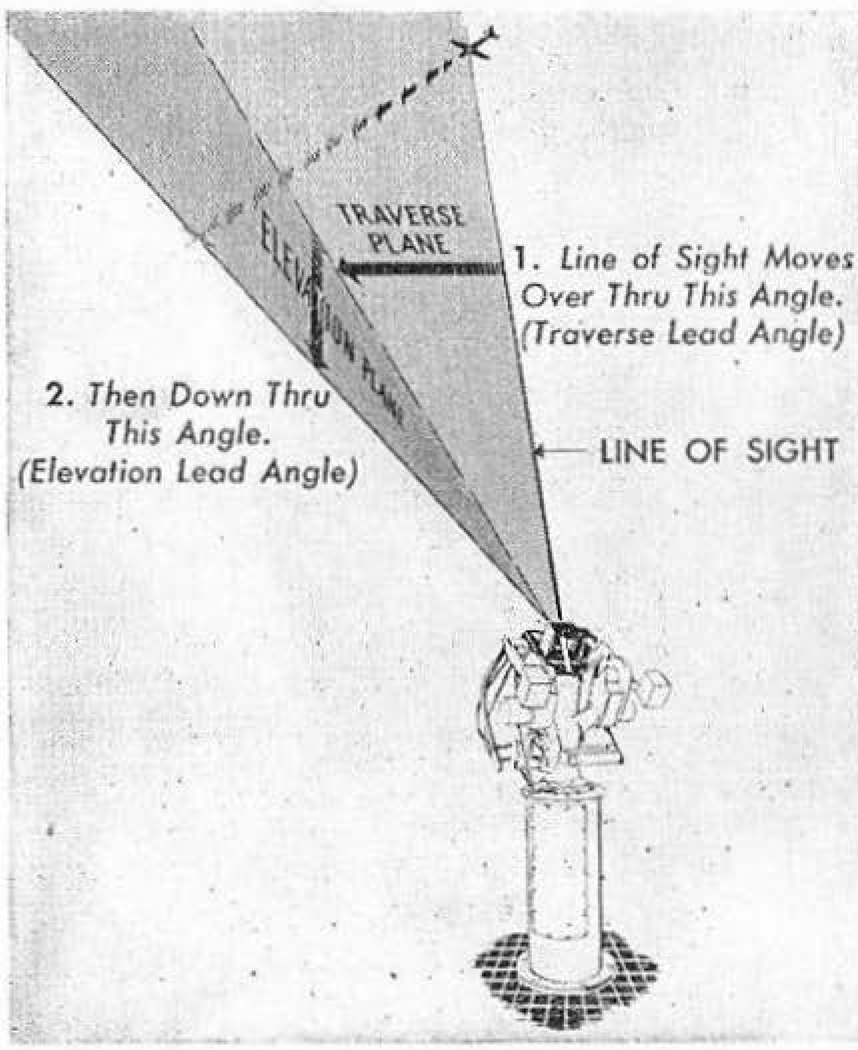

Figure 7.—Elevation and Traverse Lead Angles.

Solution of the Problem by Angular Rates: The simplest demonstration of the solution of the short range antiaircraft fire control problem by angular rates is illustrated in figure 8. Here the target is flying a circular course about the gun at a constant bearing, so that target elevation is the only coordinate of present position which is changing.

The range is such that the time of flight to any position on the target course is 3 seconds, and the target is changing its elevation at the rate of 5° per second. During the 3 seconds of projectile time of flight the target will reach an elevation which is 15° above the present elevation (angular rate multiplied by time of flight). If the gun is fired at this future position, the times of flight of the projectile and the target are equal, and both will reach the future position simultaneously. The angle of 15° through which the line from the gun sight to the target moves during the time of flight is the lead angle due to target action.

The above solution for lead angle (angular rate times time of flight) will be correct only for targets flying circular courses about the gun, and consequently having a constant angular rate and range. Targets flying other courses will have continuously changing angular rates, as in figure 9, depending upon their course, speed, and range, and will have components of motion in both elevation and traverse planes. To use the instantaneous present angular rates for the computation of lead angle for such targets, it is possible to multiply each angular rate by a value, having the dimension of time, which takes into account the effects of target course, speed, and range, and thus arrives at instantaneous elevation and traverse target motion lead angles. This time value is called Prediction Time.

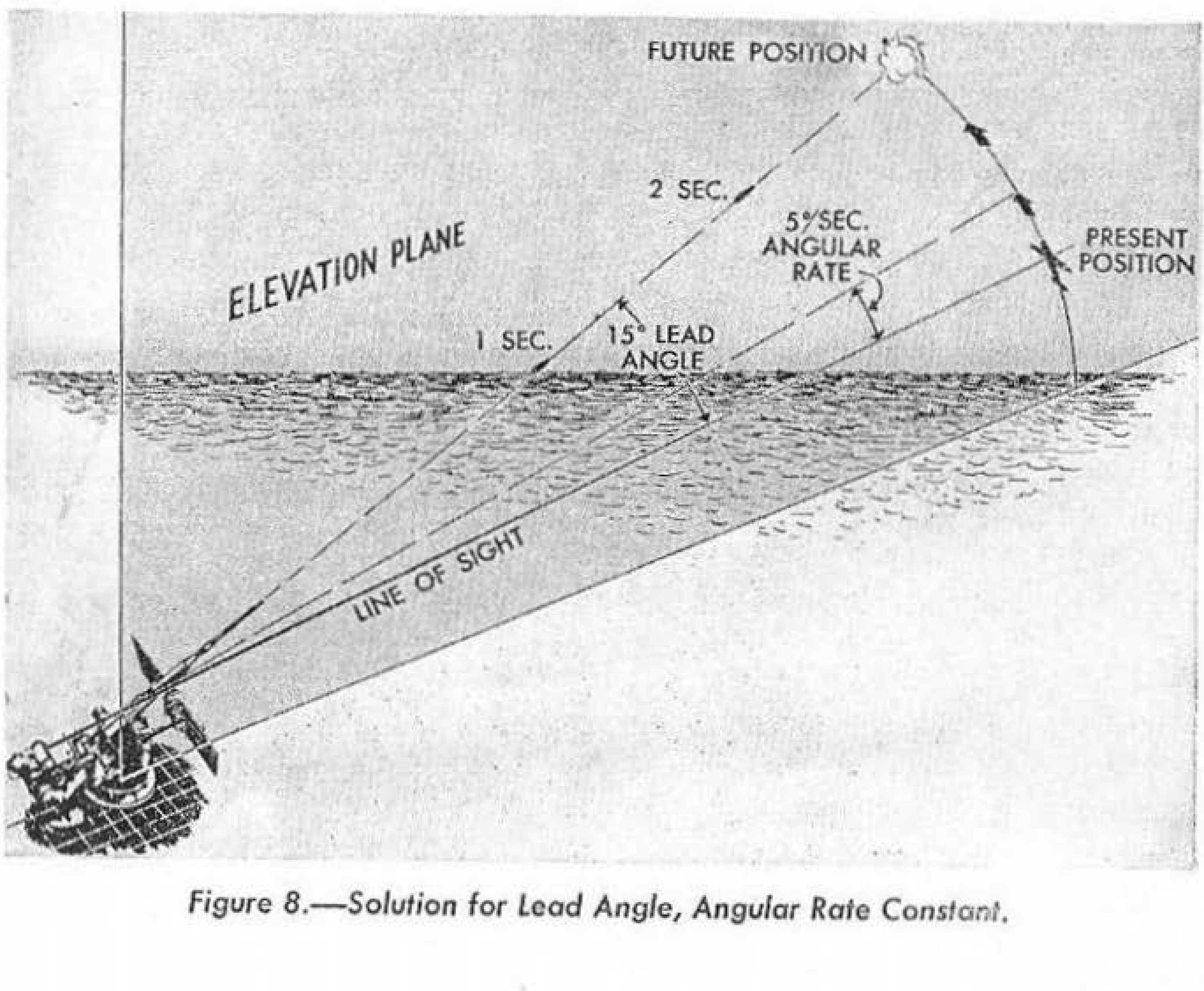

Figure 8.—Solution for Lead Angle, Angular Rate Constant.

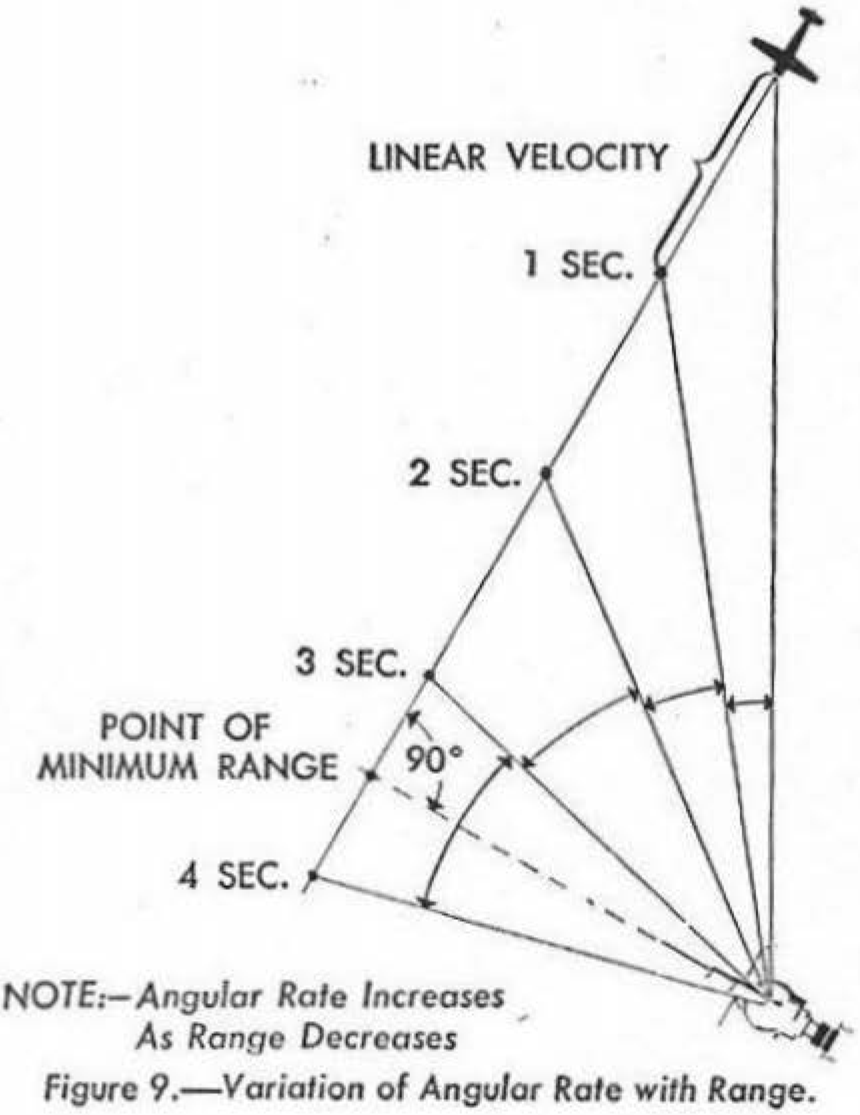

Figure 9.—Variation of Angular Rate with Range.

Computation of Prediction Time: Lead angle and prediction time can be determined graphically by the method shown in figure 10. Assuming a target present position at any given range, the path of the target is plotted along its course, showing its position at various times. From the gun position a movable scale shows the position of the projectile plotted against time. The movable scale is adjusted to such a position that it crosses the path of the target at a point where the projectile's time of flight and the target's time of flight are exactly the same. The angle between the line of sight to present target position and the line to the established point of intersection is the target motion lead angle. Prediction time can be established by dividing this lead angle by the instantaneous angular rate of motion of the target.

It is possible that several targets on widely different courses will pass through the same points at speeds which vary so that their angular rates at that point are equal. Their computed prediction times (and consequently the required lead angles)

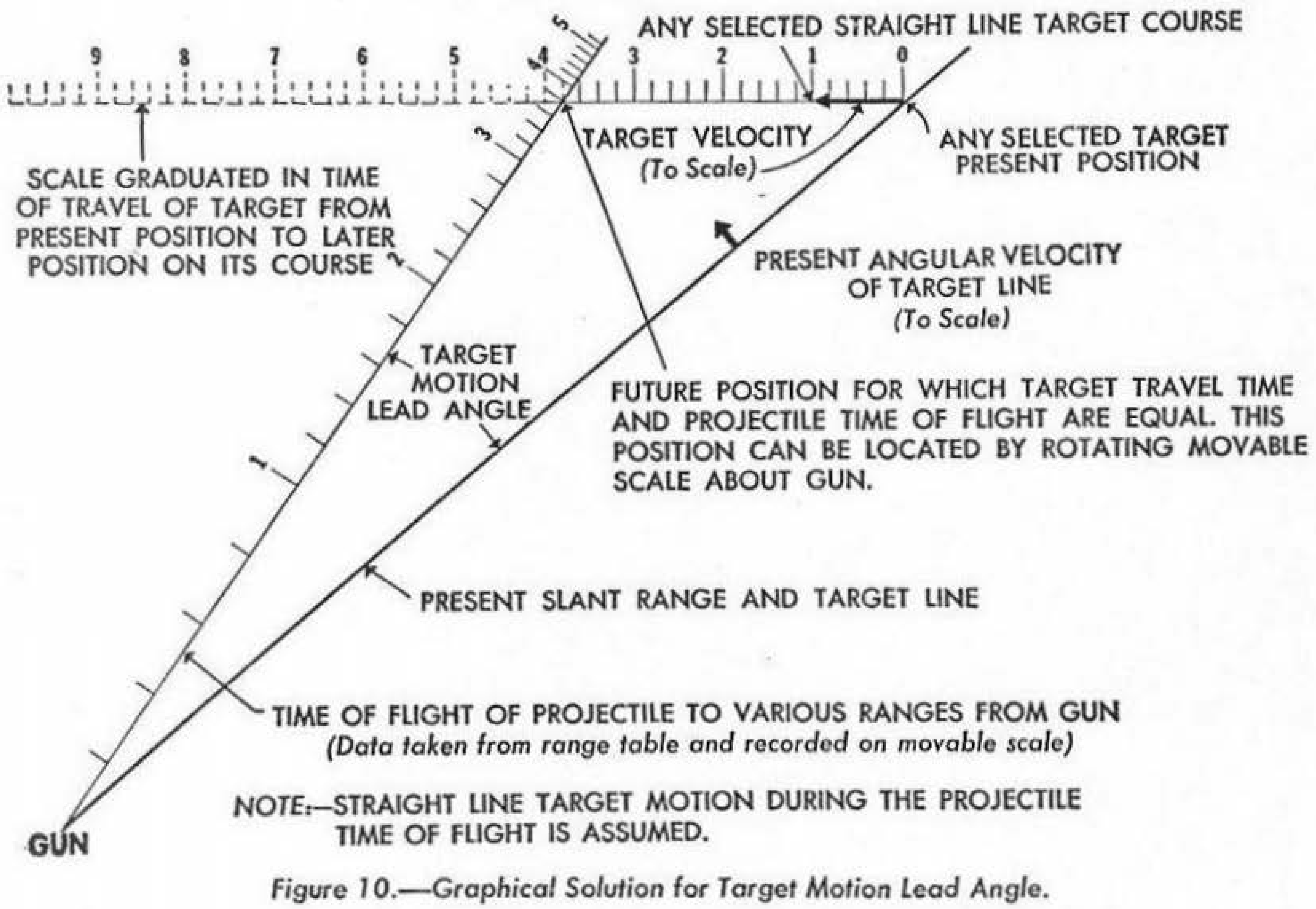

Figure 10.—Graphical Solution for Target Motion Lead Angle.

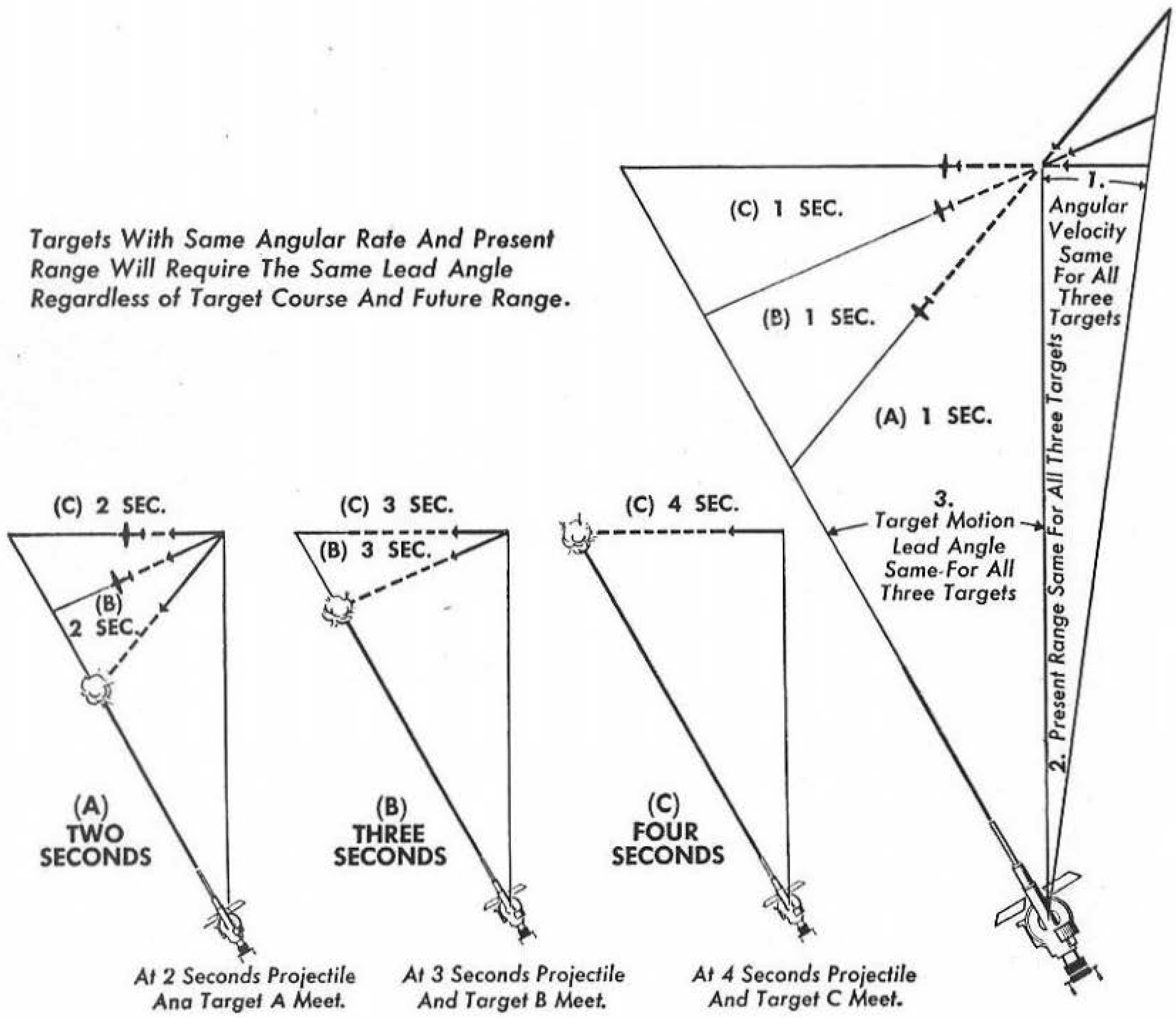

Figure 11.—Same Lead Angle on Targets Flying Different Courses.

will be somewhat different because of their different courses. However, the difference will be small, because of the different times of flight involved. The three targets shown in figure 11 would each be hit when the same lead angle is used, because the time of arrival of projectile and target at the line to future position will be approximately equal for each course, because of the different speeds required for each target to have the same instantaneous present angular rate. By computation of prediction times for a number of target courses and speeds with the same range and angular rate, it can be found that the required lead angles will lie so close together for all courses that any error introduced can be expected to lie within the probable dispersion of the gun and is to be ignored.

From this it can be concluded that, for all targets with the same range and angular rate, the same prediction time and lead angle will be correct, regardless of course and speed. For this reason, it is unnecessary to know future range to determine target motion lead angle.

The above conclusion is based on the assumption that the flight of the target is level and on a straight line. For targets flying under other conditions, the error in lead angle will be considerably greater.

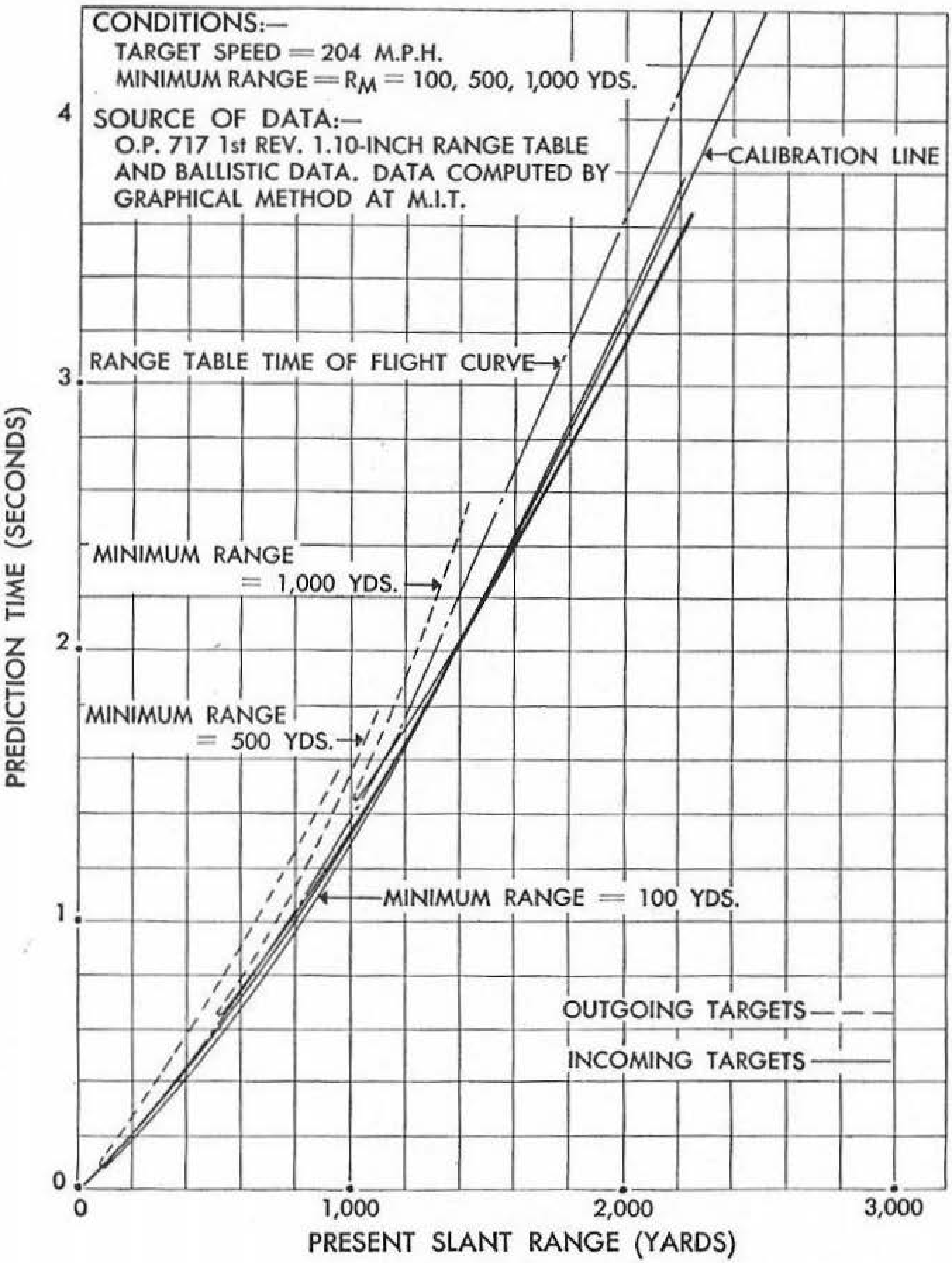

Figure 12.—Prediction Time Versus Range.

Design of Gun Sight Mk 14 is based on this assumption and, therefore, no correction is made for this possible error.

If a series of curves, figure 12, is plotted showing prediction time against range for a number of representative courses, the curves for these courses will lie close enough together so that a single calibration curve can be used for all. Therefore, if the angular rate of motion of target is established for any instant by tracking, and its present range is known, its prediction time (taken from the calibration curve) can be multiplied by the angular rate to determine the computed lead angle.

The above discussion is based on a target having an angular rate in only one plane, either traverse or elevation. Normal targets will be moving so

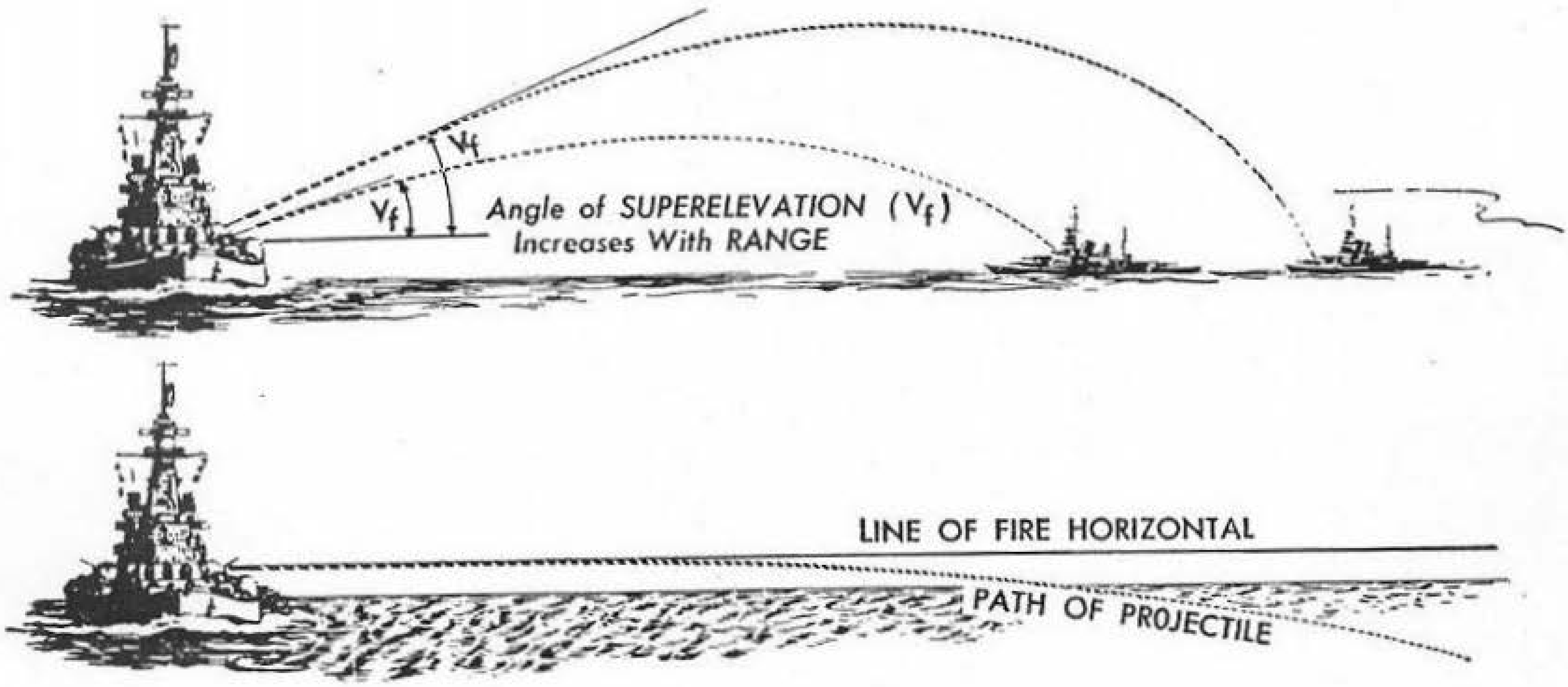

Figure 13.—Variation of Superelevation with Range.

that they have angular rates in both planes simultaneously. From a knowledge of the angular rate in each plane, the solution just described can be made for the lead angle in each plane. These lead angles, when applied to the coordinates of target present position and the result related to the deck plane, will establish gun train and elevation orders.

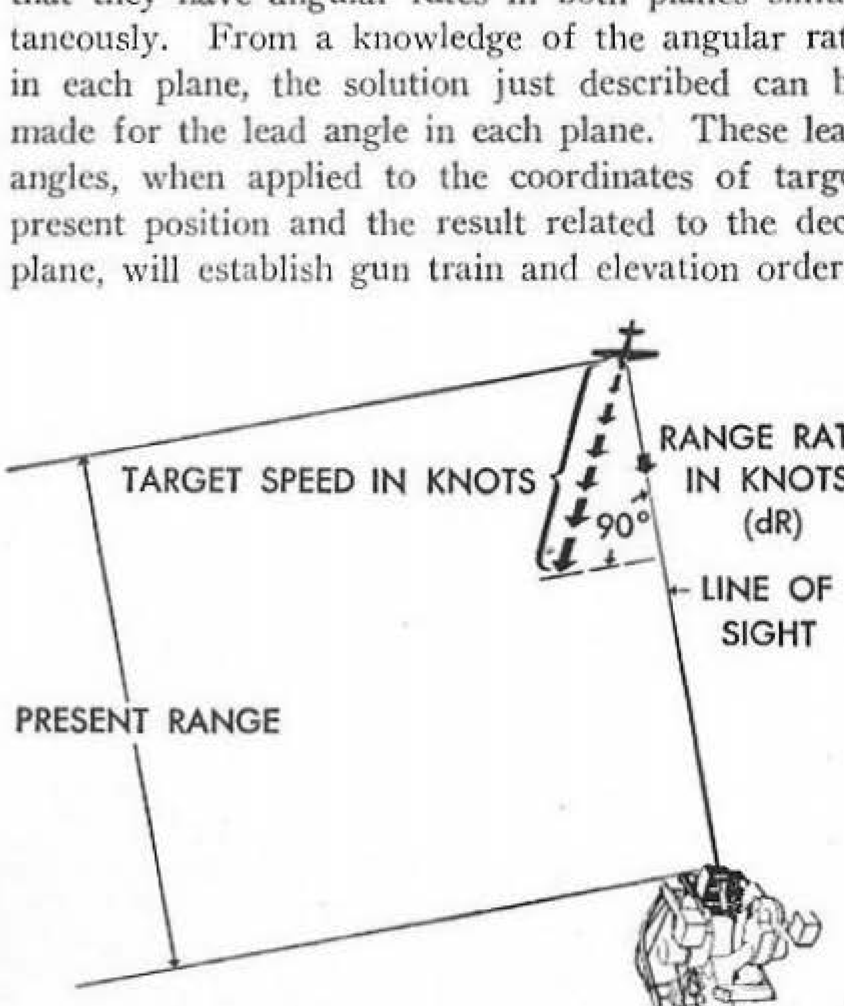

Figure 14.—Range Rate.

Ballistic Corrections: In addition to the application of target motion lead angle, correction should be made to the line of fire for superelevation, wind, drift, initial velocity loss, and atmospheric density. Since, in the solution of the problem by Gun Sight Mk 14, the effect of all but the first is considered negligible compared to other factors, superelevation is the only correction made to the solution.

Superelevation (Vf) is the correction angle included in the angle of elevation of the line of fire to allow for the effect of gravity upon the projectile in flight. It is dependent upon the range to the target future position, and upon the cosine of the angle of gun elevation.

The effect of range on superelevation is shown in figure 13. With increasing range, the time available for the force of gravity to work upon the projectile is greater and the path of the projectile drops farther toward the earth, thus following a curved line. It is necessary to know the range to the future position before superelevation can be determined accurately. This can be found through a knowledge of range rate (dR) which is defined as the rate of change of range along the line of sight (fig. 14). It is minus for incoming targets, and plus for outgoing targets. In the solution of the problem by Gun

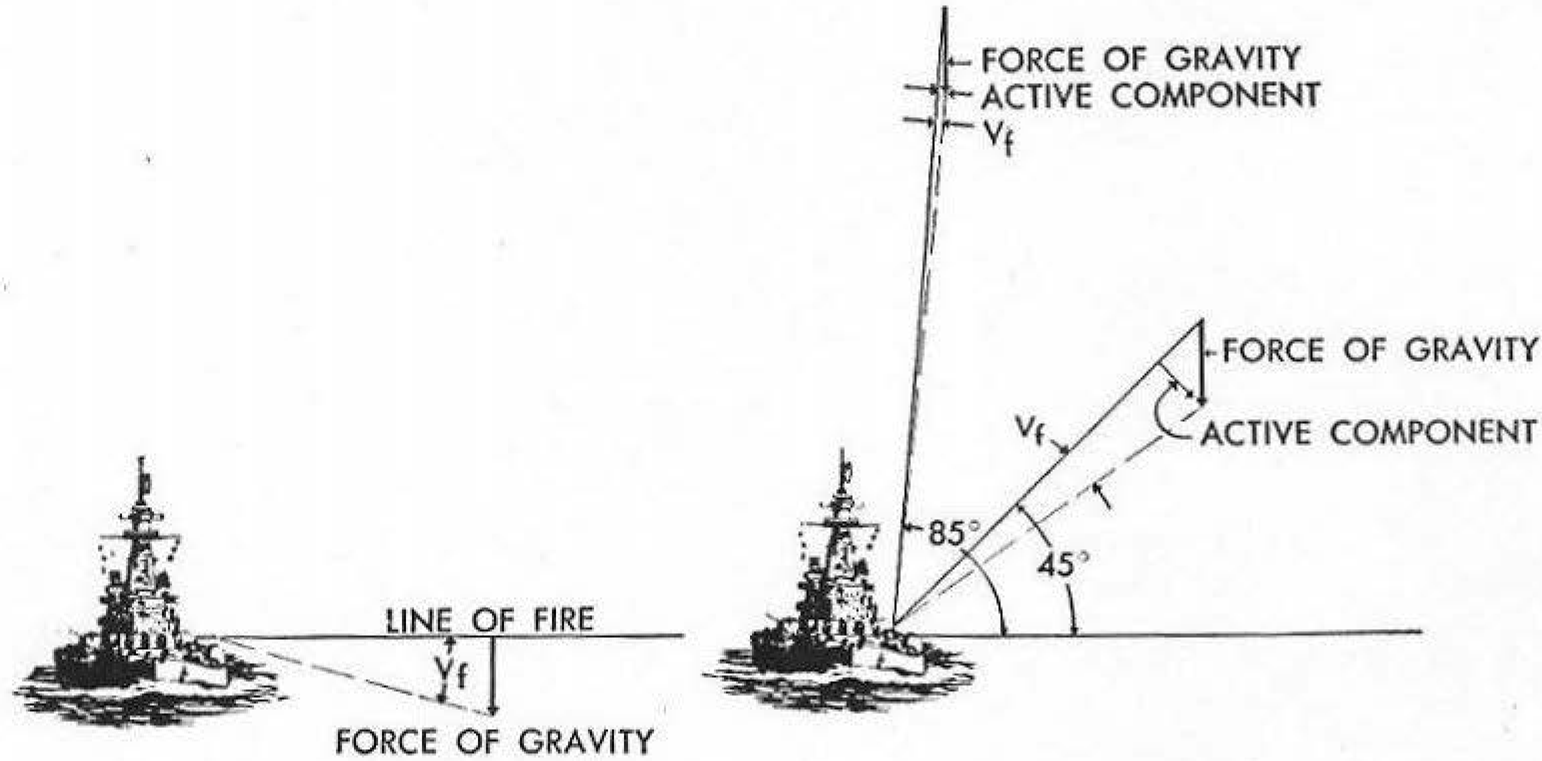

Figure 15.—Variation of Superelevation (Vf) with Elevation

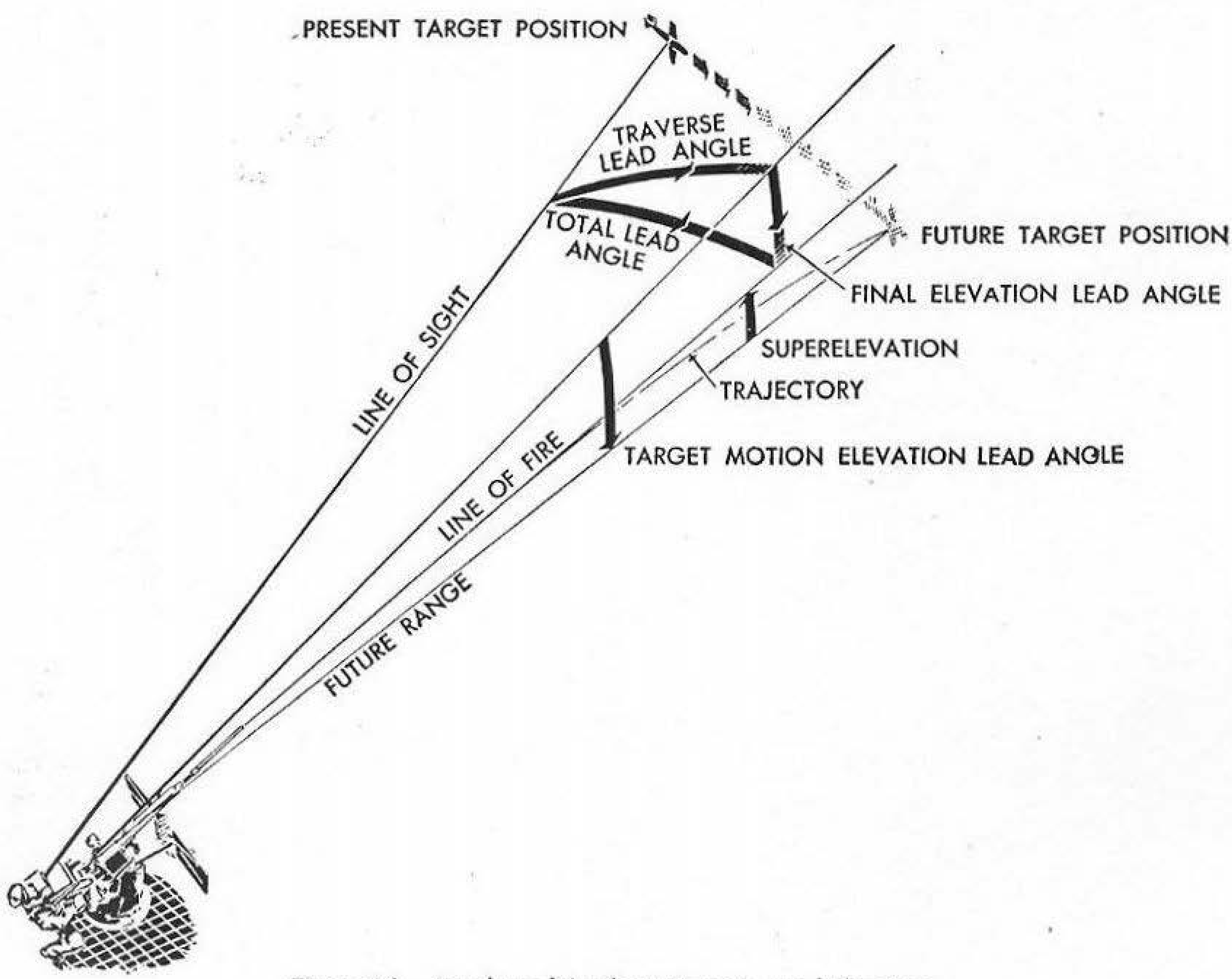

Figure 16.—Total Lead Angles in Traverse and Elevation.

Sight Mk 14, a fixed range rate of minus 180 knots is used. This gives rise to an error in superelevation when targets operating at other rates are encountered, but the error will not exceed two mils for any incoming target, or five mils for any outgoing target.

The amount of the force of gravity which tends to draw the projectile from a straight line is that component which works at right angles to the line of fire of the gun. With the line of fire horizontal, the full force of gravity is exerted (fig. 15). If the line of fire is elevated, this component of the total force decreases, and as the elevation approaches 90 degrees it becomes smaller and smaller, finally disappearing altogether at 90 degrees. Here the full force of gravity tends only to reduce the velocity of the projectile but not to pull its trajectory from a straight line. In other words, the superelevation correction varies as the cosine of the angle of gun elevation. For a mathematical solution of the short range antiaircraft problem, superelevation for any range and elevation can be determined from the ballistic tables for the gun in use. Adding superelevation to the elevation target motion lead angle will give the elevation lead angle from which gun train and elevation orders are determined (fig. 16).

Note: In the previous theoretical discussion of the short range problem, the determination of target motion lead angle has been based upon the instantaneous angular rates of target motion. In the actual solution by Gun Sight Mk 14, because of the orientation of the axes of the computing elements, lead angles in traverse and elevation are based upon the line of fire rather than the line of sight. They are applied in such a manner that the line of sight lags the line of fire, first in elevation and then in traverse, thus effectively placing the traverse plane so that it includes the present target position.

HOW GUN SIGHT MK 14 SOLVES THE PROBLEM

Gun Sight Mk 14 solves the short range antiaircraft fire control problem by angular rates as outlined previously. Its computing mechanisms (rate-of-turn gyros) convert the angular rates of target motion into tilts of the gyro rotors which are representative of the target motion lead angles, taking into account the effect of range. To these angles of tilt, ballistic corrections are made for the effect of superelevation, assuming a fixed range rate. Instantaneous present target position, represented by the position of the line of sight when on the target, is continuously fed into the sight by tracking the target with a reticle. Rates of target motion are established by the angular tracking rates in traverse and elevation. Since the reticle position is controlled by the gyros in proportion to their tilt, the line of sight will lag behind the gun or director position in each plane by an amount equal to lead angle in that plane, thus automatically positioning the gun sight housing so that it indicates gun train and elevation orders. Since this is so, instantaneous values of present position cannot be read directly from either the gun director or the mount.

Optical System: The optical line of sight is determined by a reticle pattern which consists of two concentric circles. To demonstrate the action of the reticle the line of sight, target, and gun (fig. 17A) are initially considered to be stationary. Here the line of fire and the line of sight coincide. In figure 17B the target starts to move, and the line of fire and line of sight move with it. A lead angle is now required because of the target motion, and the computing mechanisms cause the reticle to lag behind the gun barrel. The line of fire then leads the line of sight. As the target approaches its final velocity (fig. 17C), the computing mechanisms will cause the reticle (and consequently, the line of sight) to lag behind the line of fire by an amount equal to the computed lead angle.

In this manner the gun director is caused to move directly to the computed train and elevation, while the line of sight remains on the target. A gun sight operating in this manner has a disturbed line of sight.

Since the line of fire of the gun is positioned in

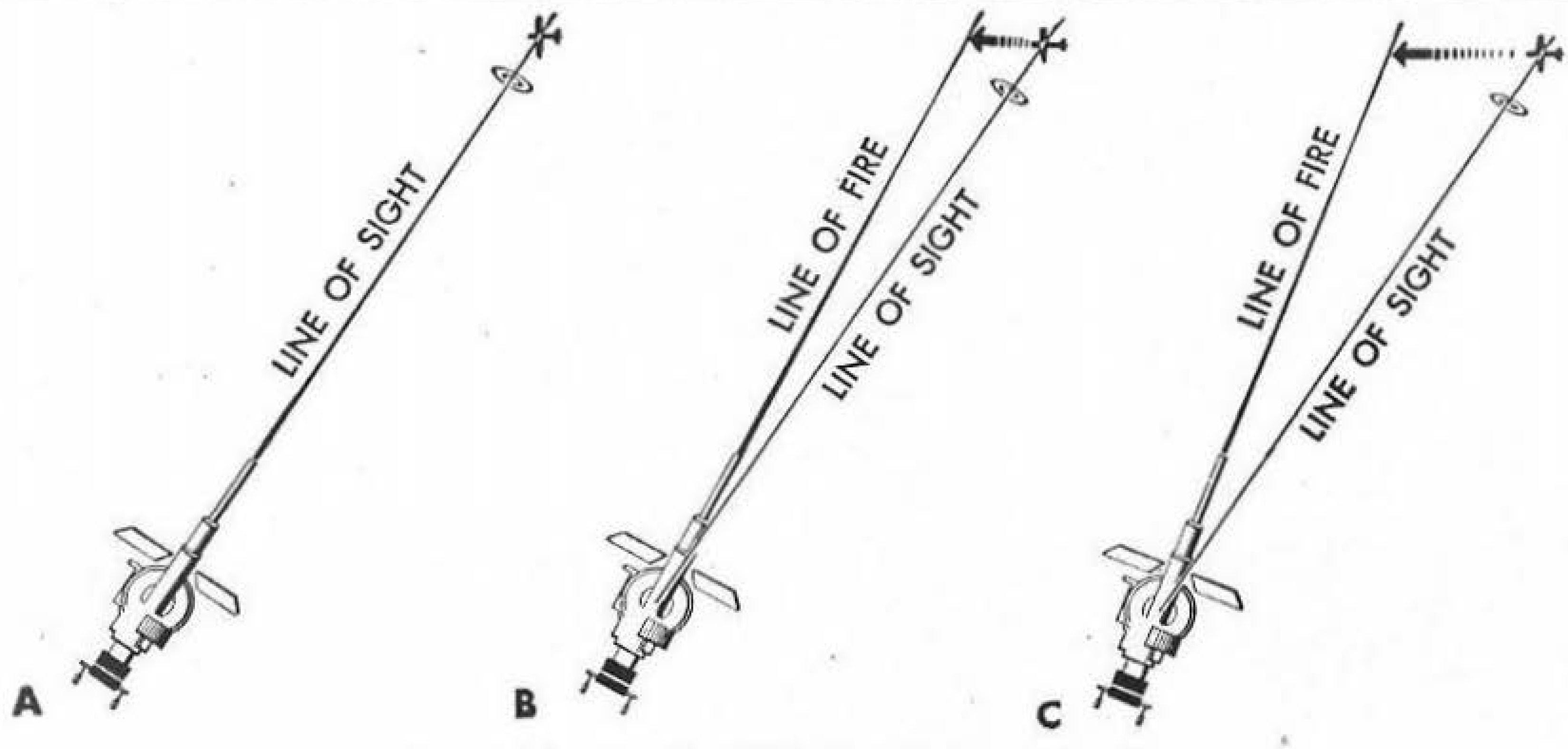

Figure 17.—Tracking With Disturbed Line of Sight.

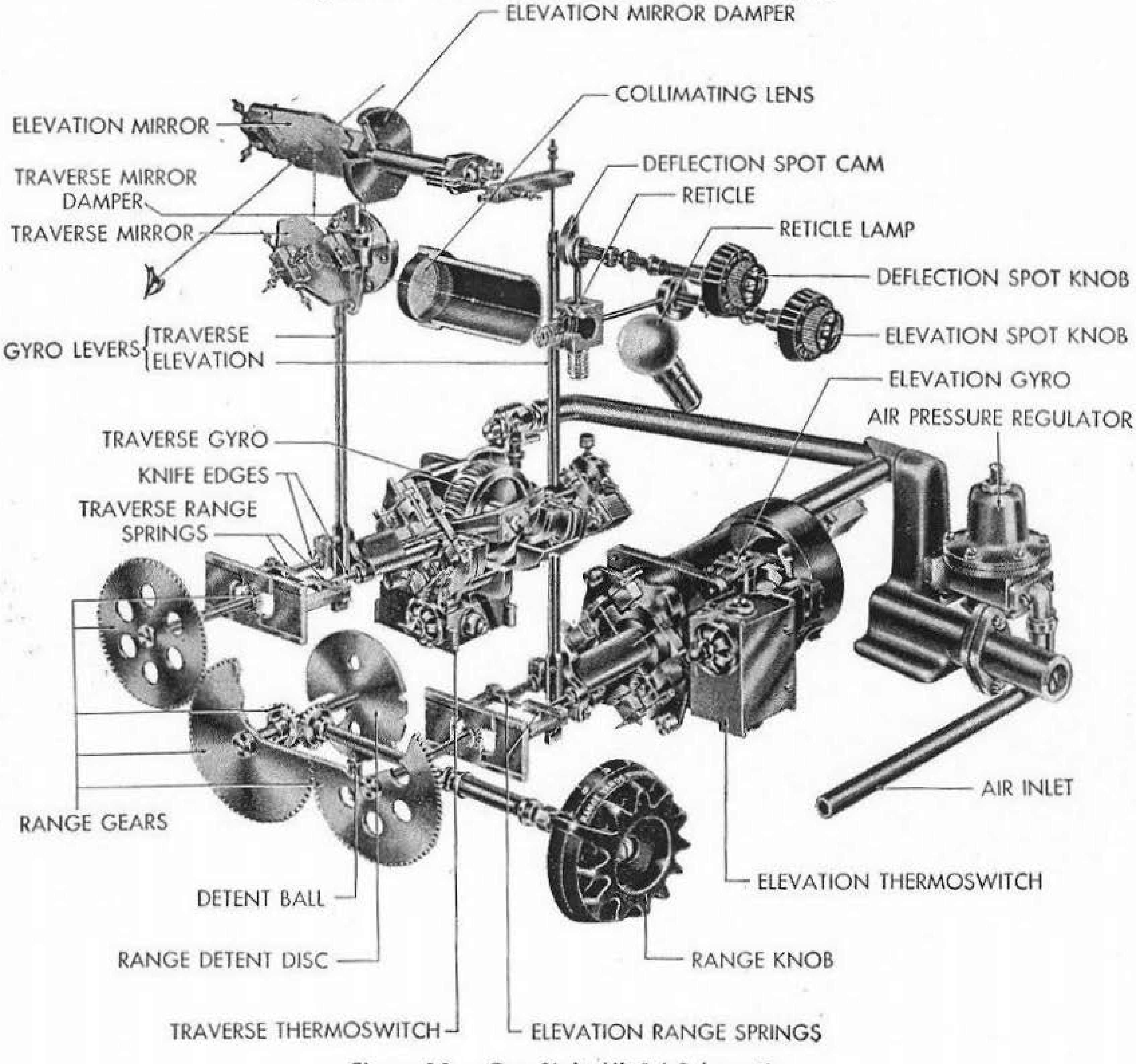

Figure 18.—Gun Sight Mk 14 Schematic.

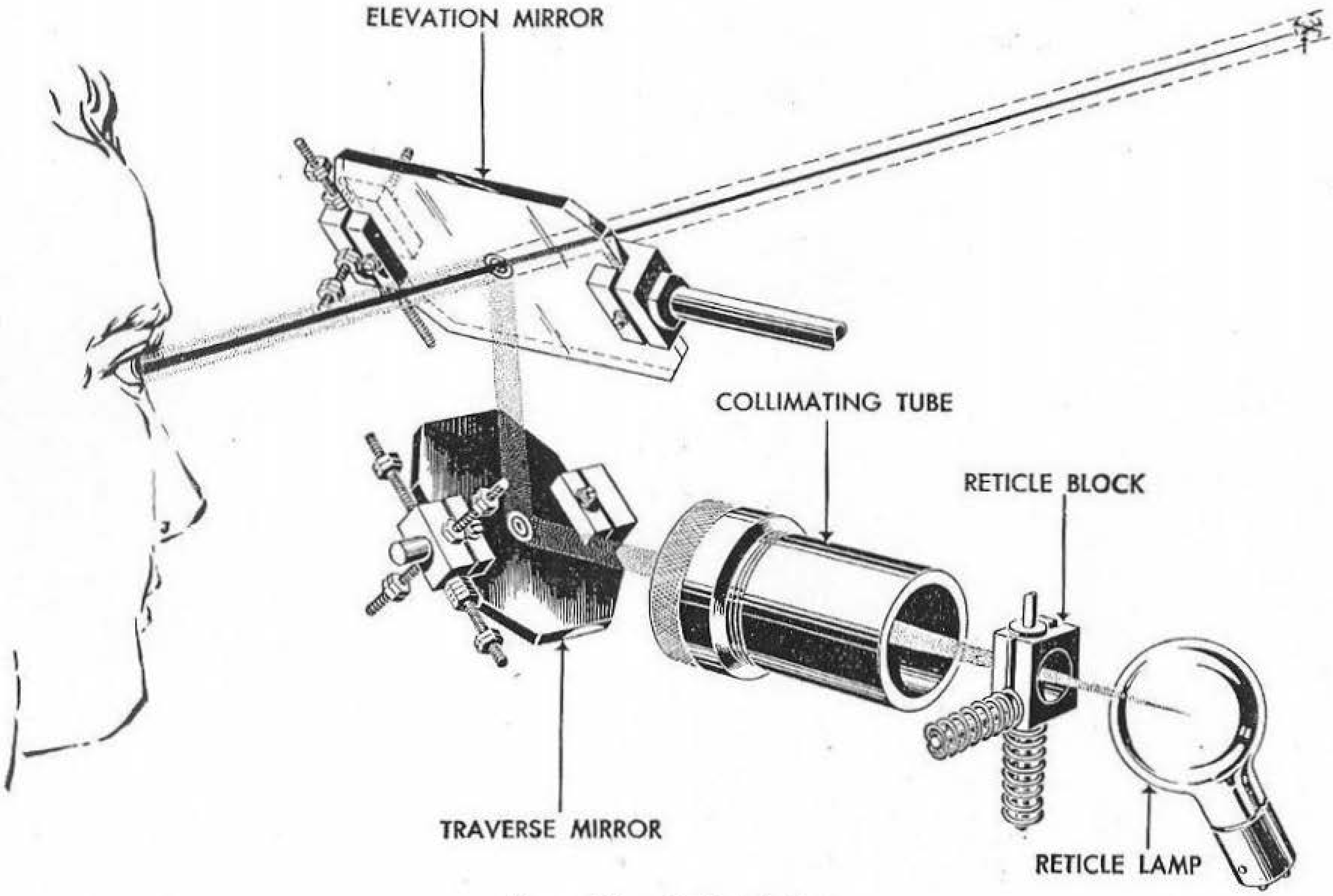

Figure 19.—Optical System

accordance with the imposed angular rate, it is essential that the target be tracked smoothly and continuously. It is not sufficient to get on the target momentarily and fire, nor is it sufficient to follow the target erratically with the reticle. In neither case will the correct lead angles be established.

To bring the reticle image into the pointer's field of view so that it will appear to lie in the same plane as the target, light from a reticle lamp is produced through the reticle and then through a collimating lens which renders the rays of light from the reticle parallel to each other. The parallel beam of light is reflected upward from a silvered mirror (traverse) (fig. 19) to a transparent mirror (elevation) and then to the pointer's eye. Because rays of light from a distant source (the target) are very nearly parallel, the collimated reticle image appears to lie in front of the sight at the same distance as the target. Thus, there is no parallax between the reticle image and the target, and movement of the pointer's eye will produce no relative movement between the reticle and target.

The angle of tilt of the silvered mirror is controlled by the traverse gyro in proportion to the required traverse lead angle, and the angle of the transparent mirror is controlled in the same manner by the elevation gyro.

Tilting the traverse mirror will cause the reticle beam to fall on the elevation mirror to one side or the other of center, depending upon the direction of tilt. However, the reticle image will appear to the pointer to move in the opposite direction, as illustrated in figures 20 and 21, because of the angle of reflection away from the elevation mirror. The change in angle is equal to twice the change in angle of tilt of the traverse mirror. Fig. 22 shows that the angle of reflection has moved through 20 degrees, while the mirror was tilted only 10 degrees. The final change in angle of the beam is the lead angle in traverse.

The elevation mirror, being controlled in the same manner by the elevation gyro, will act to shift the angle of reflection of the reticle beam in elevation in the same manner (figs. 23 and 24), causing the reticle image to move through the lead angle in elevation. For a target having a component of motion in both planes, each mirror is tilted to produce its proper component of lead angle; the resultant lag of the reticle image produces the total lead angle.

To permit the gyro to compute the proper lead angle for any instantaneous angular rate, the pointer

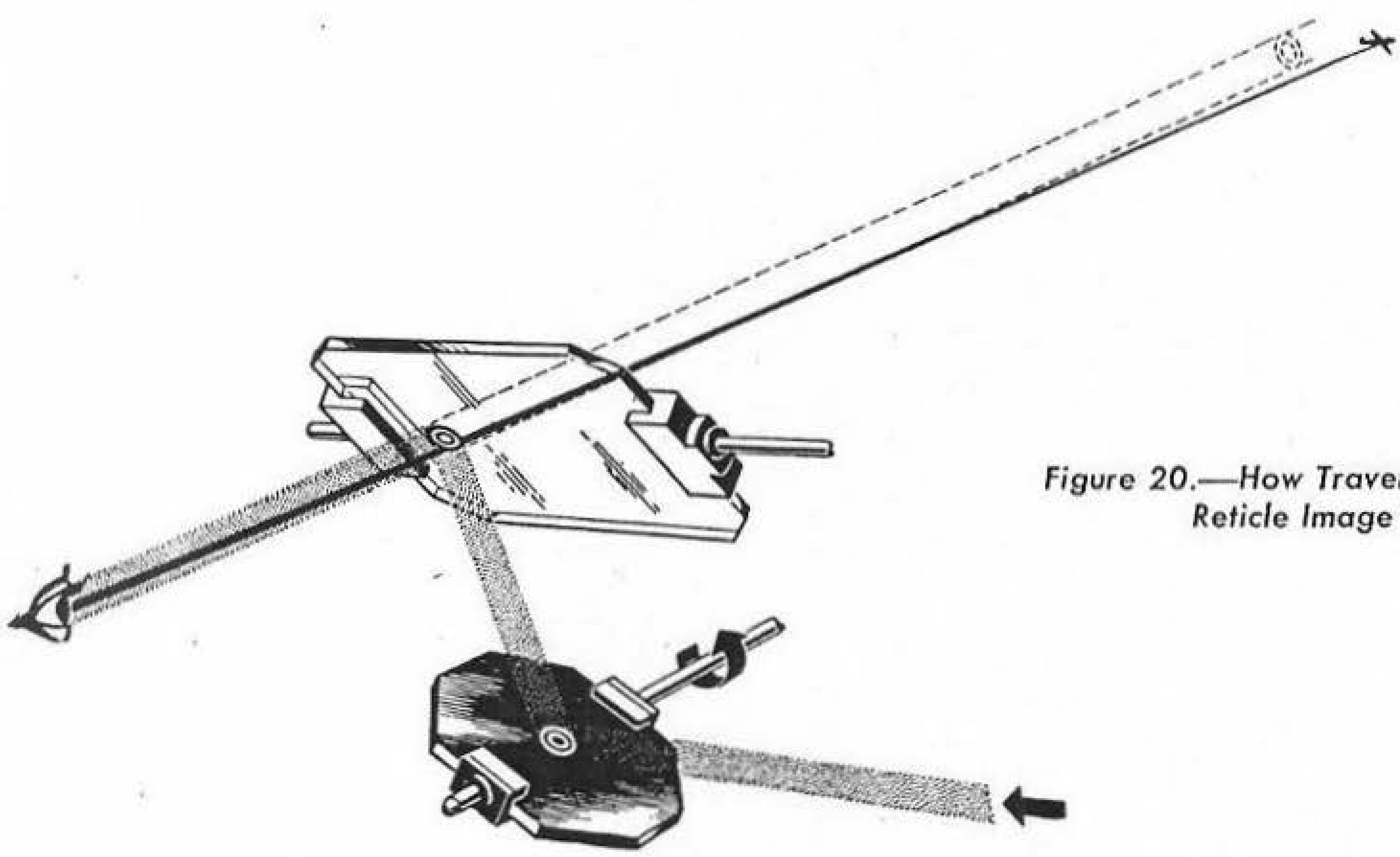

Figure 20.—How Traverse Mirror Moves Reticle Image to Left.

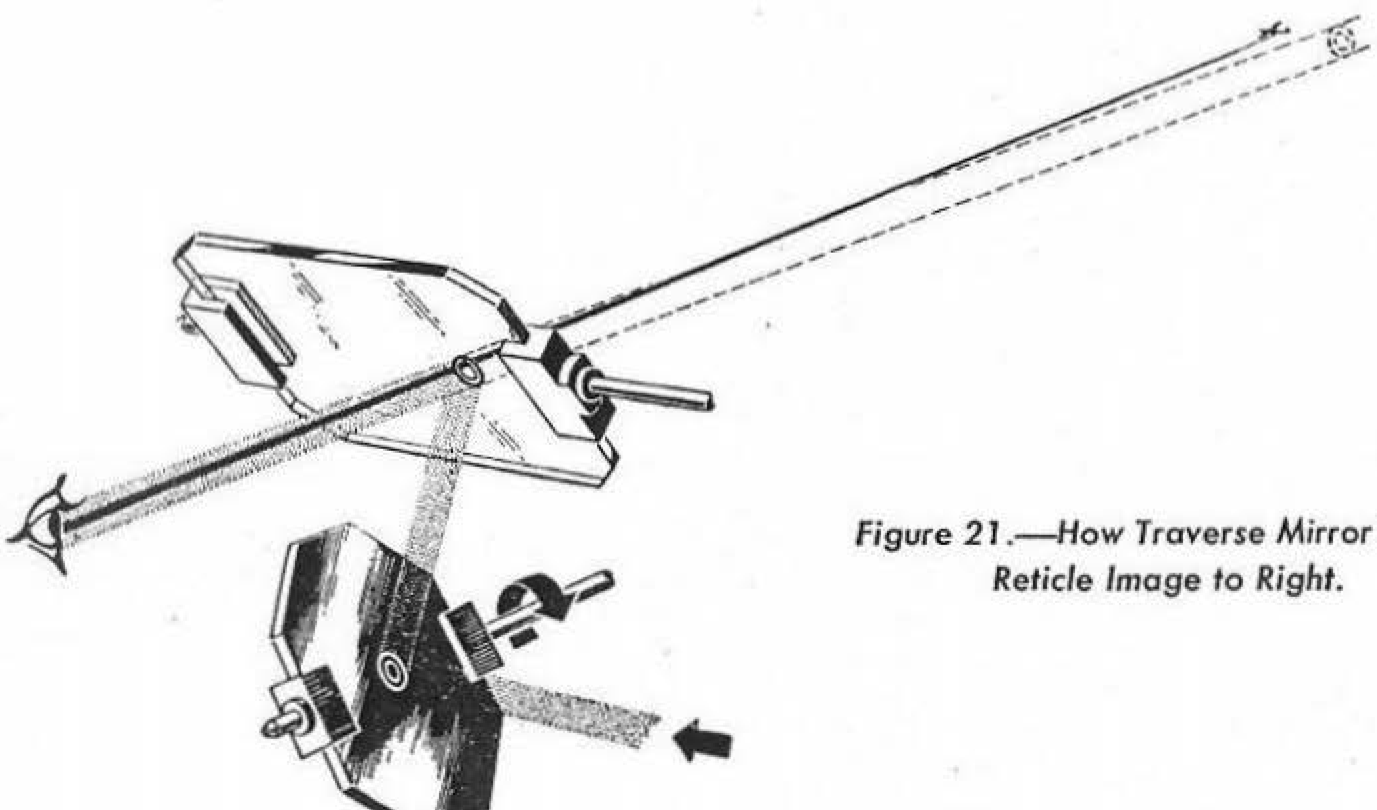

Figure 21.—How Traverse Mirror Moves Reticle Image to Right.

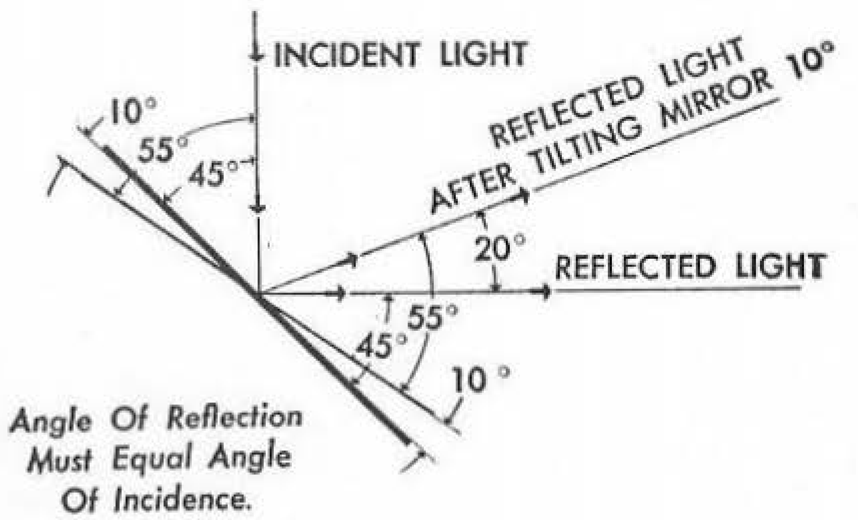

Figure 22.—Optical Mulitplication of Angles.

must track the target smoothly and accurately for a sufficient length of time to insure the correct solution. The time required for this is the solution time, and will be slightly less than the time of flight to present position. Solution time can be defined as the time required for any error, which may exist at the beginning of steady tracking, to fall to two percent of its initial value

After a solution has been established, the pointer must continue to track the target accurately, throughout the firing run, so that correct instan-

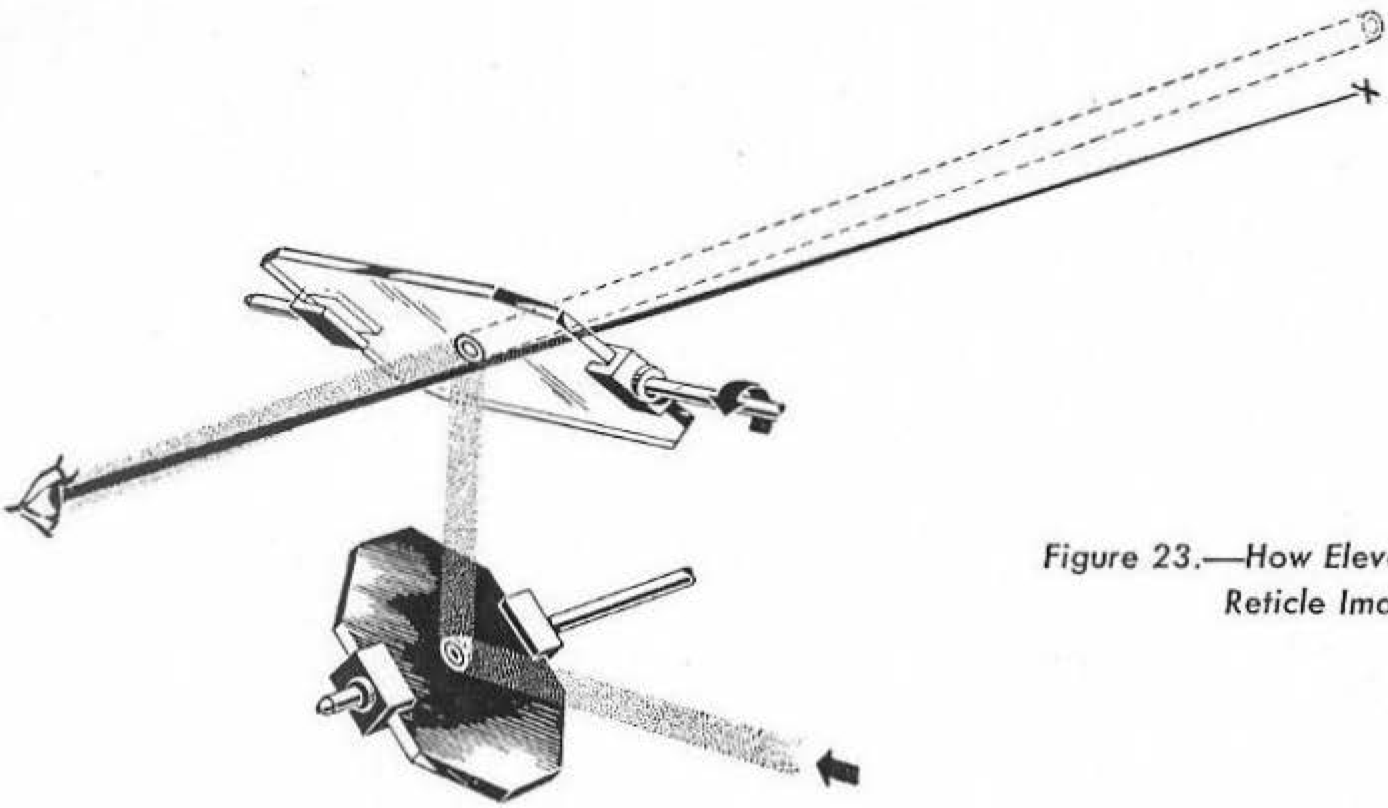

Figure 23.—How Elevation Mirror Moves Reticle Image Up.

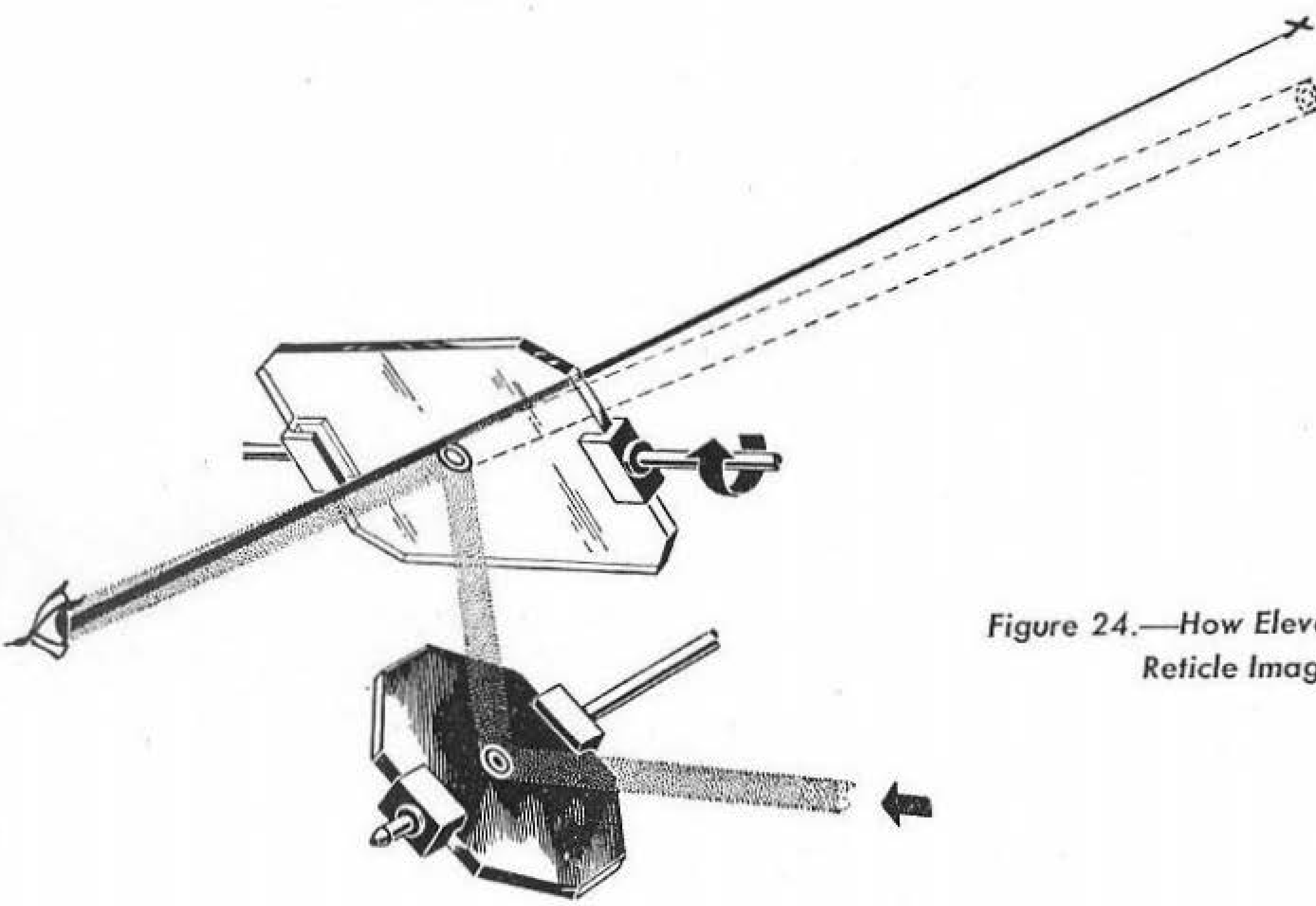

Figure 24.—How Elevation Mirror Moves Reticle Image Down.

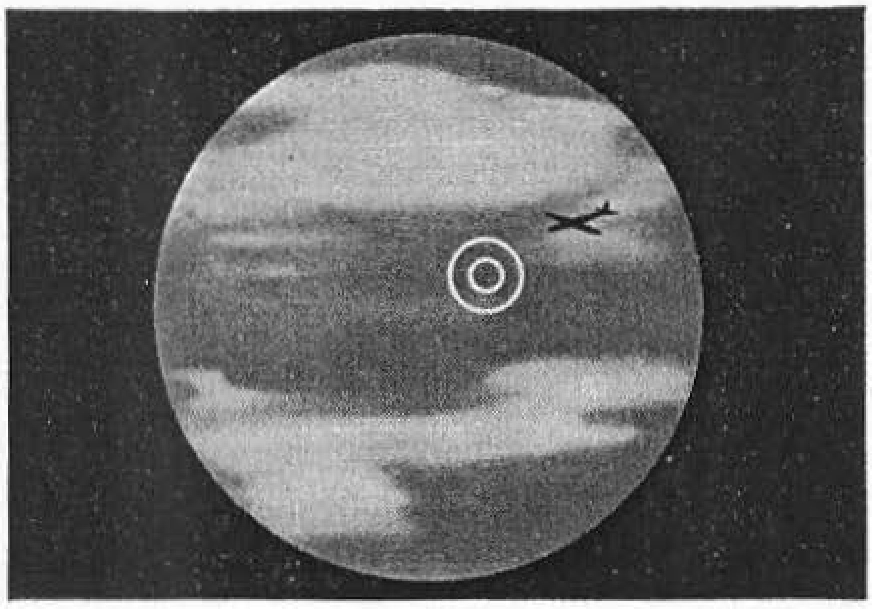

Figure 25.—Reticle Leading Target.

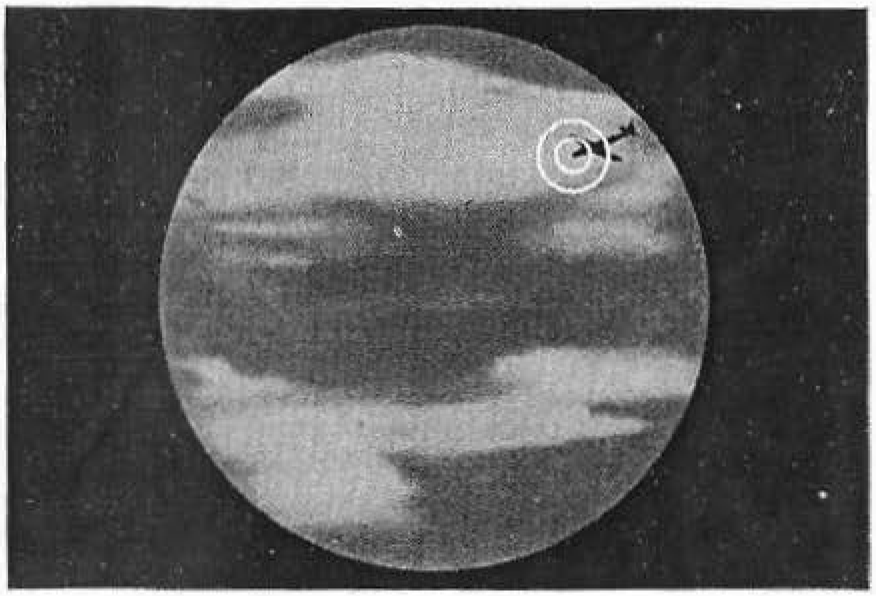

Figure 26.—Reticle on Target.

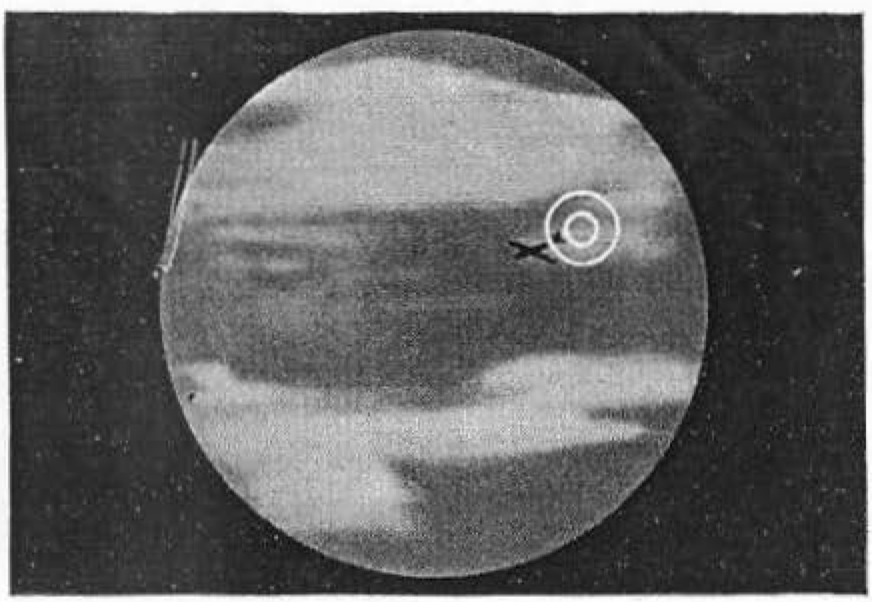

Figure 27.—Reticle Lagging Target.

taneous angular rates will continue to be established and the correct line of fire determined.

By tracking, it is possible to establish the correct angular rates of target motion but still not score hits, because the coordinates of target present position are not correct. This condition would occur if the line of sight were leading or lagging the target by a constant amount, as in figures 25 and 27. The reticle must be on the target, as in figure 26.

Errors in tracking will result in errors in the line of fire, with a consequent reduction in the probability of hits. Motion of the ship will definitely affect the accuracy of tracking. Aboard a rolling and pitching ship, to keep the reticle on target it is necessary to move the gun or director in relation to its mount and the deck plane, thus increasing the probability of tracking error. The average (nonfiring) tracking error, with normal motion of the ship, is about three to five mils for the director, and about five to eight mils for the 20-mm mount.

The Computing Mechanisms: The Gun Sight Mk 14 computing mechanism consists of two rate-of-turn gyroscopes (rate gyros) which receive (as inputs) the angular rates of tracking, and deliver (as outputs) angles which are in proportion to lead angle. The output angles are multiplied by linkage between the gyros and the traverse and elevation mirrors, so that with the optical multiplication (fig. 22) the position of the reticle image indicates lead angle. The gyro output angles are multiplied 5 times by the mechanical linkage, and two times by the optical system, so that the resulting indicated lead angles are 10 times the gyro output angles. The output angle of the gyros is controlled by a range adjustment system and by superelevation weights, so that the final lead angle generated is sufficiently close to the correct total lead angle. The gyro computing mechanism is damped to introduce a time delay, or lag, in response of the mechanism to motion of the gun sight. This prevents instantaneous reticle response to minor rapid changes in the tracking rate caused by tracking errors. It not only smooths out tracking errors but also makes slewing practicable when getting on a target.

Theory of the Rate Gyro: The rate gyro is enabled to act as the computing element of Gun Sight Mk 14 because of the gyroscopic phenomenon of precession, by which a spinning gyro tends to orient itself in a specific manner when torque is applied to its mounting. An elastic restraint system limits the angle of precession in proportion to the effect of range, so that, with additional torques applied by the superelevation weights, the final angle of precession is proportional to lead angle.

A restrained (rate-of-turn) gyro located in the gun sight housing, with the housing attached to a 20-mm mount, is shown schematically in figure 28. For comparison, a universally mounted gyro, restrained by springs, is shown in figure 28A. The gyro rotor spins about an axis called the output axis, about which the gyro gimbal can rotate. The third axis of the universally mounted gyro is the axis of the outer gimbal, and is called the input axis. The entire gyro assembly can be rotated about this axis. The gyro, as mounted in the gun sight, does not have its input axis located as in the universally mounted gyro, but the assembly can still be rotated about a third, or input axis, which is the gun mount pivot. This actually makes the gyro, as mounted in the gun sight, universally mounted.

In normal operation the gyro rotor will be spinning rapidly about its spin axis at a constant speed. **The application of torque about the input axis, to cause a rotation of the entire system about that axis, will cause the spin axis to rotate about the output axis in an attempt to align itself in the same plane with the input axis.** This action, illustrated in figure 28B, is called precession.

The gyro is prevented from precessing its spin axis into line with the input axis by the restraining springs shown. These springs appear as flat cantilever springs (supported at only one end) against which knife edges, attached to the output axis, press. As the gyro precesses, the force applied by the springs causes a torque about the **output** axis. This causes the spin axis to try to precess about the input axis and align itself with the output axis. When the input torque has caused the gyro to precess about the output axis to a point where the torque exerted by the springs is equal to the precessional torque, the entire system will be in a state of equilibrium. At this point the gyro will have tilted about the output axis an amount proportional to the input torque applied. An increase in the rate of rotation about the input axis requires that additional torque be applied about the gun pivot. The added torque about the input axis causes the gyro to precess further until the increasing spring restraint torque again equals the precessional torque. Thus, a change in the angular rate of tracking a target is reflected in a proportional change in the precession, or tilt, of the gyro. A gyro, spring restrained as above, is called a rate-of-turn gyro or, simply, a rate gyro.

The gyro, illustrated in figure 28, is affected only by rotation of the gun in elevation about the gun trunnions. Since rotation in traverse will cause a torque to be applied through the output axis and in the same plane as the spin axis, no precession occurs. The output axis of this gyro is fixed in the gun sight so that it is at all times parallel to the gun barrel, and therefore lies always in the elevation plane of the gun. Rotation of the gun about its trunnions will cause the gyro to precess. Therefore, it is called the elevation gyro, and generates lead angles in elevation.

The traverse gyro is shown in figure 29. The plane of spin of this gyro rotor is vertical, and the axis is parallel to the gun barrel (as is that of the elevation gyro), thus lying always in the traverse plane of the gun. However, the orientation of the input axis has been changed, as shown in figure 29A. This new input axis is perpendicular to the line of fire at all times. Therefore, any rotation about the train axis of the gun mount will have a component about the input axis. The gyro reacts to rotation about its input axis in the same manner as the elevation gyro. Thus, when the gun is trained while following a target, the angle of output generated by the traverse gyro is proportional to the angular rate of tracking in traverse.

This gyro is not affected by rotation in elevation. Any torque applied will be through the output axis and in the plane of the spin axis, and no precession will occur.

The elastic restraint system of this gyro also consists of cantilever springs (figs. 30A and 30B), against which the knife edges attached to the output

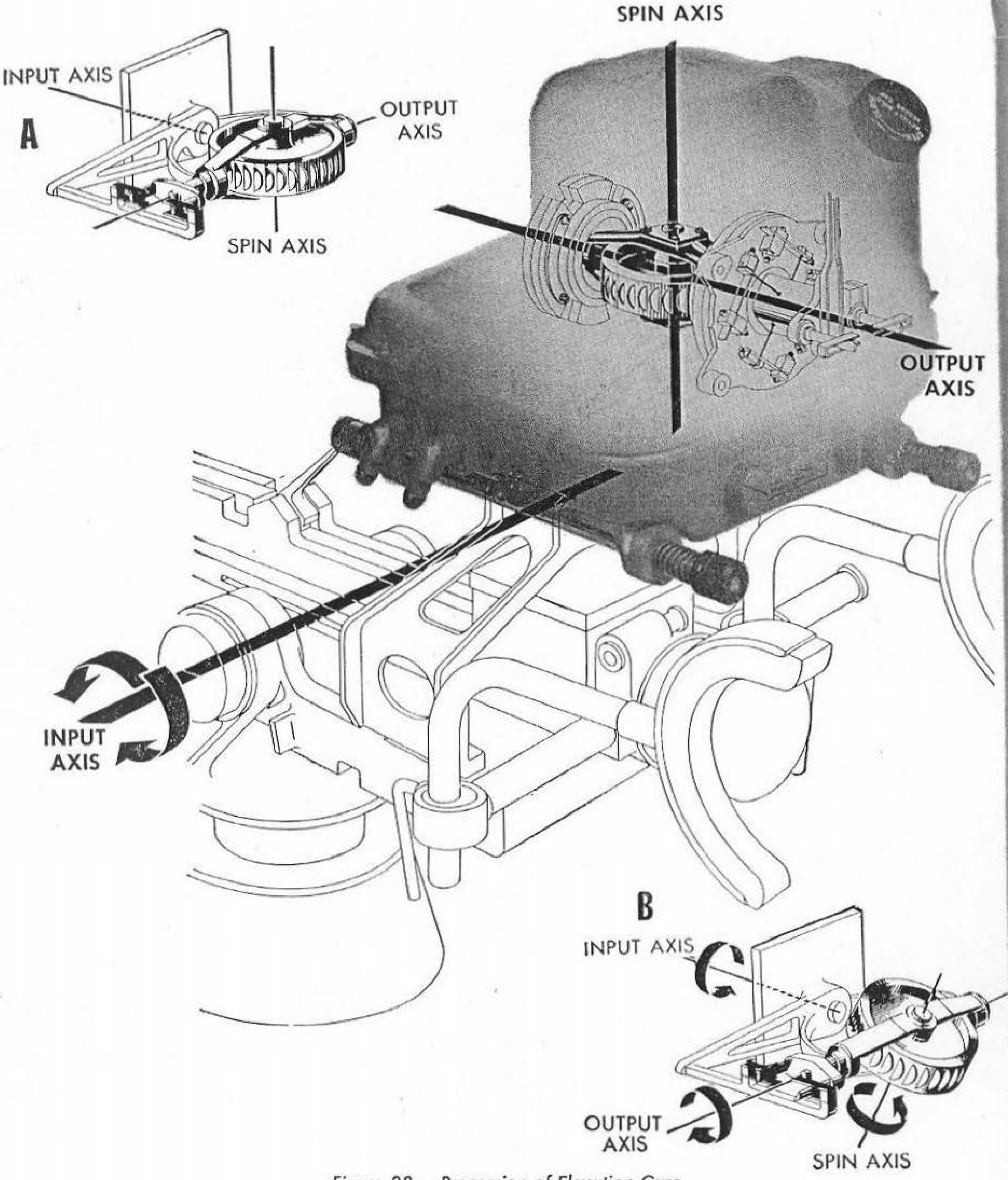

Figure 28.—Precession of Elevation Gyro.

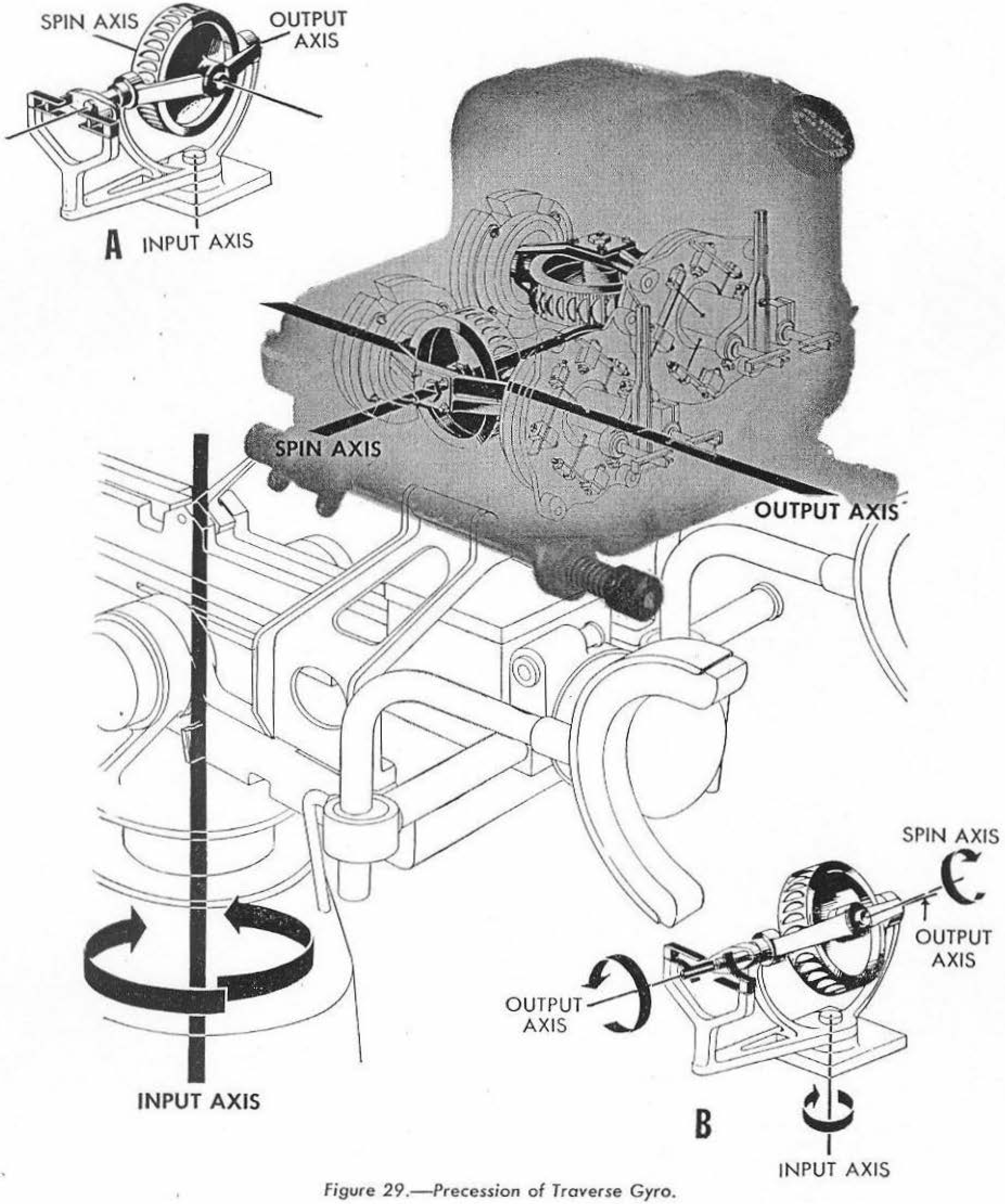

Figure 29.—Precession of Traverse Gyro.

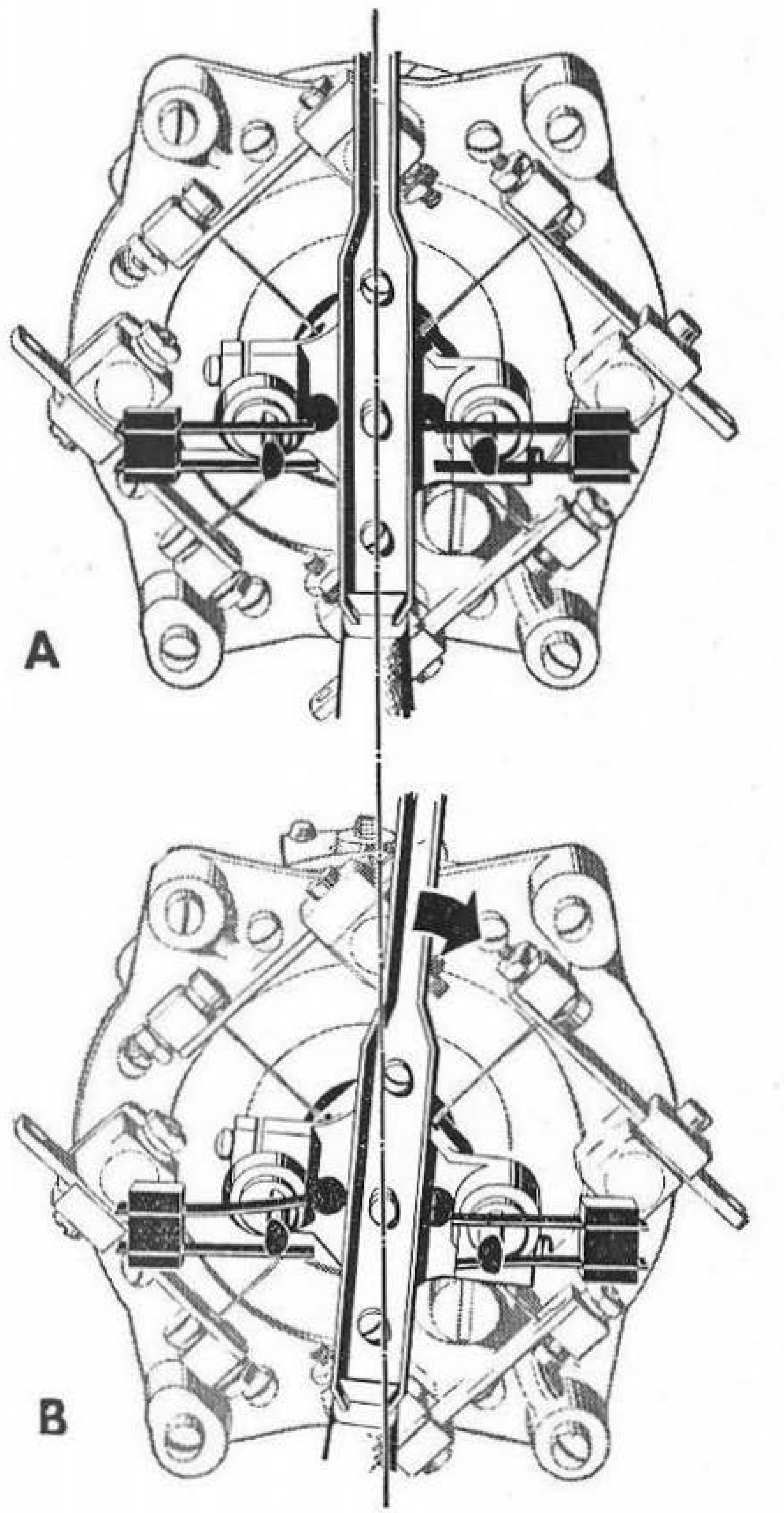

Figure 30A.—Spring Restraint, Zero Precession.
B.—Spring Restraint, Gyro Precessed.

axis press. The springs of both gyros can be moved closer together or farther apart by the range adjustment system to vary the stiffness of spring restraint. The greater the stiffness, the smaller will be the angle of precession of the gyro to establish equilibrium.

Thus, one input to the gyro is the angular rate of rotation of the gun sight (angular rate of target motion), and the other is the stiffness of the spring restraint system. Since lead angle equals angular rate multiplied by prediction time, both required factors for computation of lead angle are introduced into each gyro. It has been shown previously that a calibration curve showing range against prediction time can be determined for all target courses. Therefore, if the adjusting knob for the stiffness of spring restraint is graduated in range from the calibration curve, the problem can be solved by Gun Sight Mk 14 from knowledge of angular rates and range.

Superelevation Correction: The only ballistic correction made by this gun sight in the solution of the short range antiaircraft fire control problem is superelevation. This correction is made by the application of an unbalanced weight to the output axis of each gyro. Figure 31 shows these weights as attached to the elevation and traverse gyros. As shown, the one on the traverse gyro exerts its weight through the output axis, and therefore has no effect on the angle of precession unless the ship is rolling or pitching.

Superelevation varies with range, and, since the amount of deflection given the gyro by the superelevation weight depends upon the stiffness of the spring restraint system, the same setting of range

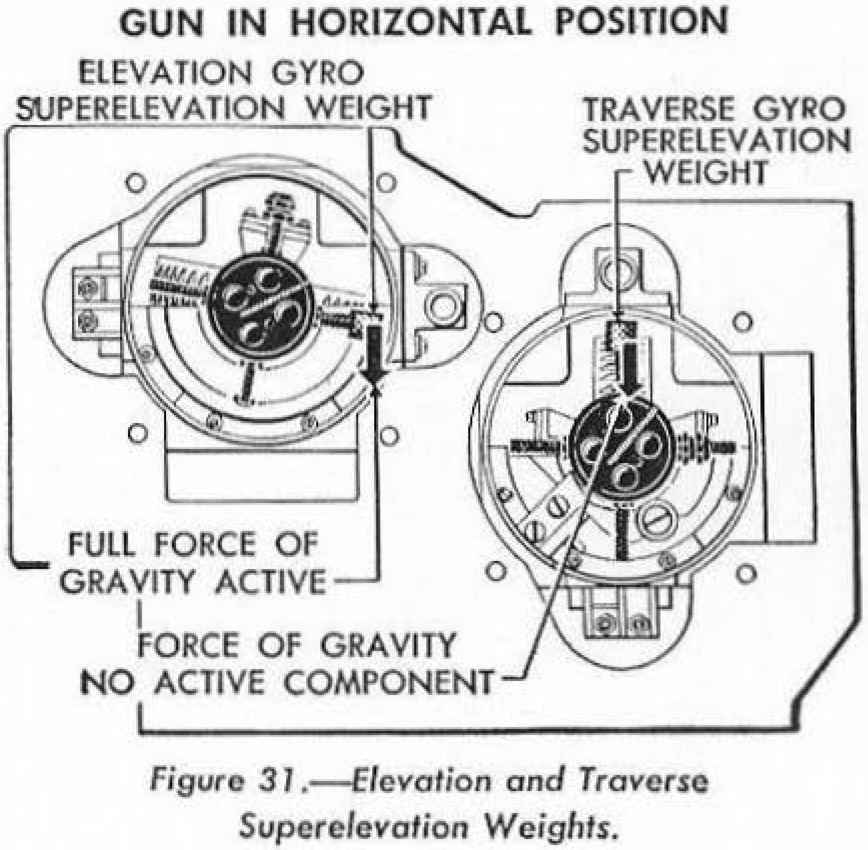

Figure 31.—Elevation and Traverse Superelevation Weights.

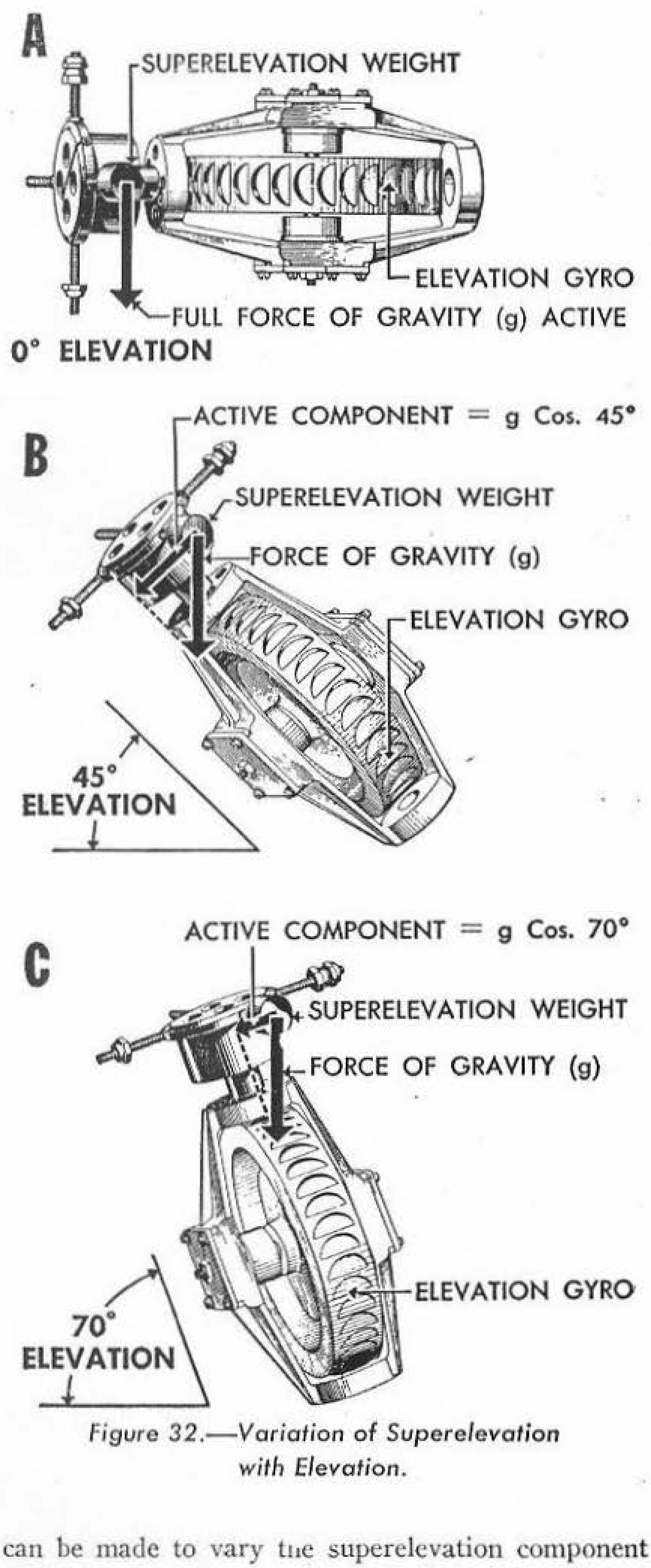

Figure 32.—Variation of Superelevation with Elevation.

can be made to vary the superelevation component of lead angle. Range, as set, is the present range, while superelevation depends upon future range. The size of the weight and the length of the lever arm are adjusted to give correct superelevation, assuming that a fixed ranged rate exists, thus making the superelevation component correct for future range. The use of a fixed range rate will introduce an error in the solution of problems involving other range rates, but will not cause great inaccuracy of fire at the ranges involved.

Superelevation also varies with gun elevation. With the output axis of the gyro horizontal, as in figure 32A, the full force of gravity is exerted upon the superelevation weight, and produces a torque about the output axis. As the output axis is elevated with the gun, the component of gravity working upon the weight to cause a tilt of the gyro (that component perpendicular to the lever arm) becomes less and finally disappears at 90° (figs. 32B and 32C) in the same manner as superelevation. In other words, the force acting on the superelevation weight varies as the cosine of the angle of elevation, exactly as does superelevation.

With the sight horizontal, only the elevation gyro will be affected by its superelevation weight. However, when the ship rolls and pitches, the active component of the force of gravity on that weight may become less because of the angle of roll (fig. 33), and, at the same time, a portion of the lead angle generated by the elevation gyro may be in the traverse plane. Therefore, the superelevation

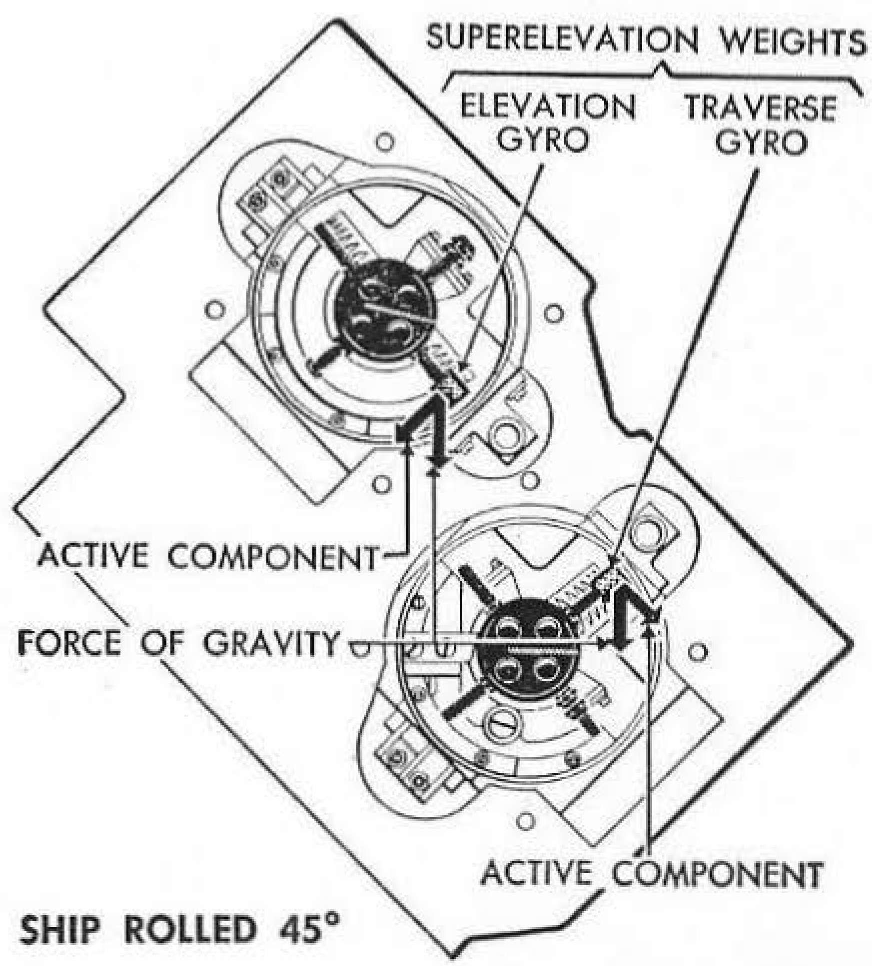

Figure 33.—Action of Traverse Superelevation Weight.

component of the elevation gyro will be smaller, although the same amount of superelevation is required. On the same roll, a portion of the lead angle generated by the traverse gyro will be in elevation. The superelevation weight on the traverse gyro will now no longer be directly over the output axis but will be thrown to one side by the roll, and a component of the force of gravity will apply a torque to the output axis (fig. 33), thus causing the generation of that portion of superelevation which was not produced by the elevation gyro. In this manner, the correct superelevation correction is applied to the output angles of the gyros, regardless of the roll and pitch of the ship.

At this point a review of the solution of the short range antiaircraft fire control problem by angular rates may aid in relating the theoretical solution to that made by Gun Sight Mk 14. For aircraft targets flying circular courses which involve a rate of change of only one coordinate of present position, a line to the future position can be determined by multiplying the angular rate of change of the coordinates by the time of flight of the projectile. The angle between this line and the line of sight to target present position is known as the target motion lead angle. If the target is flying a course other than circular, it is necessary to multiply by a time value other than time of flight to compensate for the effect of target course and speed. This different time value is the prediction time. Prediction time is determined graphically and plotted as a function of range. Using a single calibration curve for all courses, lead angles can be determined from a knowledge of angular rate and range. If the angular rates are in two planes simultaneously, separate solutions can be made for each and the results combined to obtain final target motion lead angle. To obtain total lead angle, ballistic corrections must be applied to the target motion lead angle. In the problem, as solved by Gun Sight Mk 14, superelevation is the only ballistic correction made. Adding superelevation to the components of target motion lead angle will give correct gun lead angles, which, if applied to the coordinates of target present position, will establish gun train and elevation orders.

Damping: The action of the gyros of Gun Sight Mk 14 is damped to cause them to lag behind the angular rate as established by tracking. This prevents instantaneous response to tracking errors, and consequent inaccuracy in solution. Thus damping provides a degree of smoothing which tends to average out the effect of tracking inaccuracies. Further, slewing at high rates causes the reticle to move toward the target instead of remaining stationary or moving in an opposite direction.

Damping in Gun Sight Mk 14 is accomplished by discs, one attached to each end of the output axis of each gyro. These discs are enclosed in a housing filled with a viscous fluid. When precession of the gyro causes the output axis (and, consequently, the damping discs) to rotate, the fluid, in which the discs must turn, provides a restraining force. Because the restraining medium is a fluid, it does not provide a constant restraint. The restraint reduces to nearly zero as the fluid rearranges itself within the housing. Damping resists a change in lead angle in an amount proportional to the rate of the change. This resisting effect varies with the rate of change. If the angular rate becomes constant so that there is no change in lead angle, the damping effect decreases exponen-

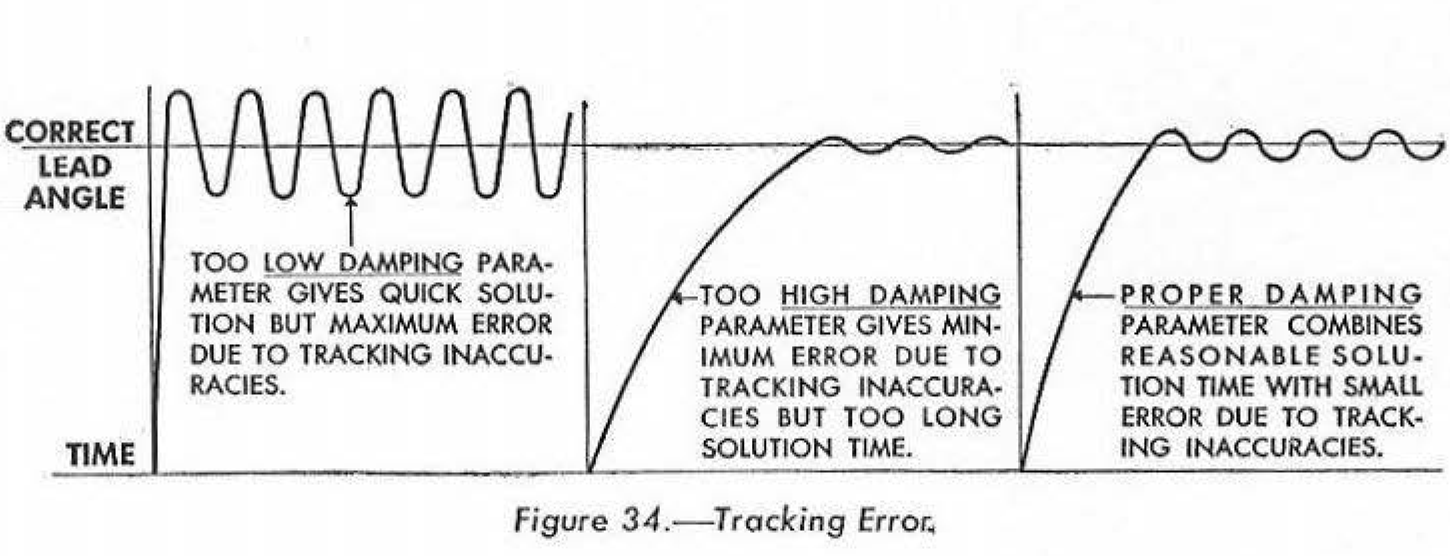

Figure 34.—Tracking Error.

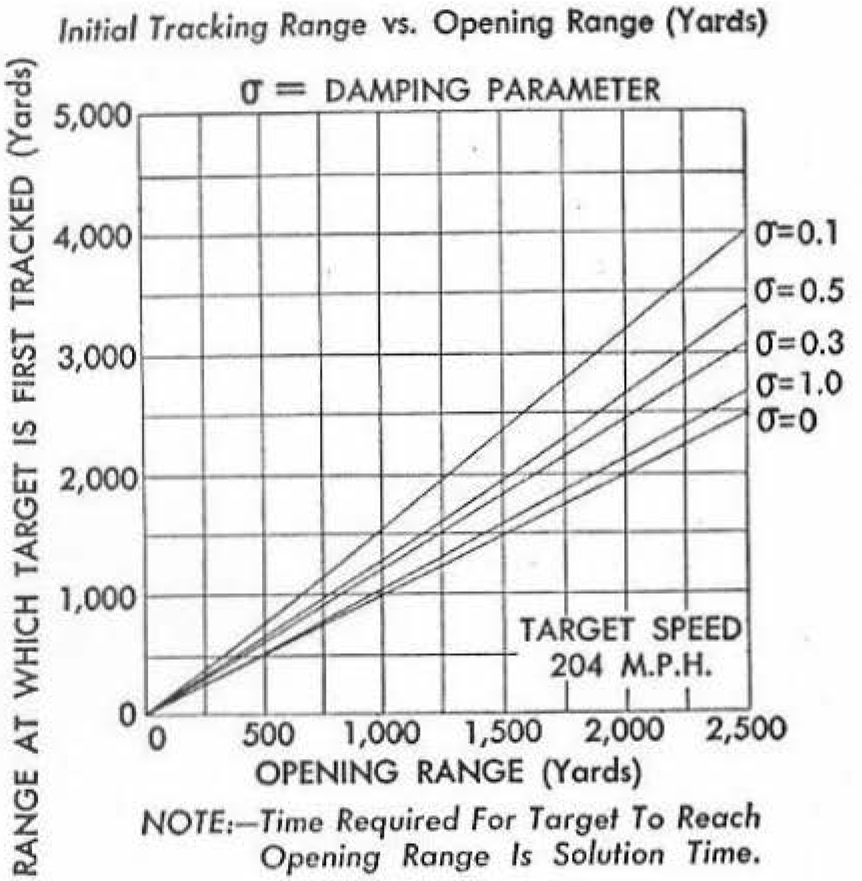

Figure 35.—Damping Curves.

tially with time. The time required for 98 percent of the initial error (hence, of the damping effect) to disappear is the solution time. If the initial error were small, it could effectively disappear in much less time.

If a tracking error is introduced after a solution has been reached, damping would resist the lead angle changes caused by this error. If the direction of the error is reversed before the solution time has elapsed, the error in indicated lead angle would be decreased. Normally, the tracking error will appear as an alternating error across the correct angular rate, as shown in figure 34. Thus, the reciprocating tracking error may be damped out, and the lead angle generated represents the average angular rate.

If no damping were provided when the gun or director is slewed toward the target, the angular rate established would cause the gyros to be affected instantly, and the reticle would move away from the target because of its generated lag. If this happens, the gun or director pointer tends to reverse the direction of slewing to bring the reticle onto the target. Damping makes the reticle move toward the target when slewing, even though a lead angle is being developed at the same time.

In other words, the amount of damping in the gun sight can be expressed in terms of a smoothing parameter. The effect of the smoothing parameter on solution time and lead angle is illustrated by the curves in figure 34. If the smoothing parameter is less than zero (minus), the sight is said to be unstable and underdamped. In this condition the reticle will be acted upon instantly by any change in the angular rate, and will not follow the gun when slewing. If the smoothing parameter is greater than zero, the sight is said to be overdamped. If it is zero, the sight is said to be critically damped. If the smoothing parameter is made too great, the lead angle will not follow the changing angular rate soon enough to give a small enough solution time; if it is made too small, errors in tracking will have too great an effect on the generated lead angle. Values of smoothing of the order of 0.2 to 0.3 will make accurate and easy tracking possible, and, at the same time, will give moderate values for solution times.

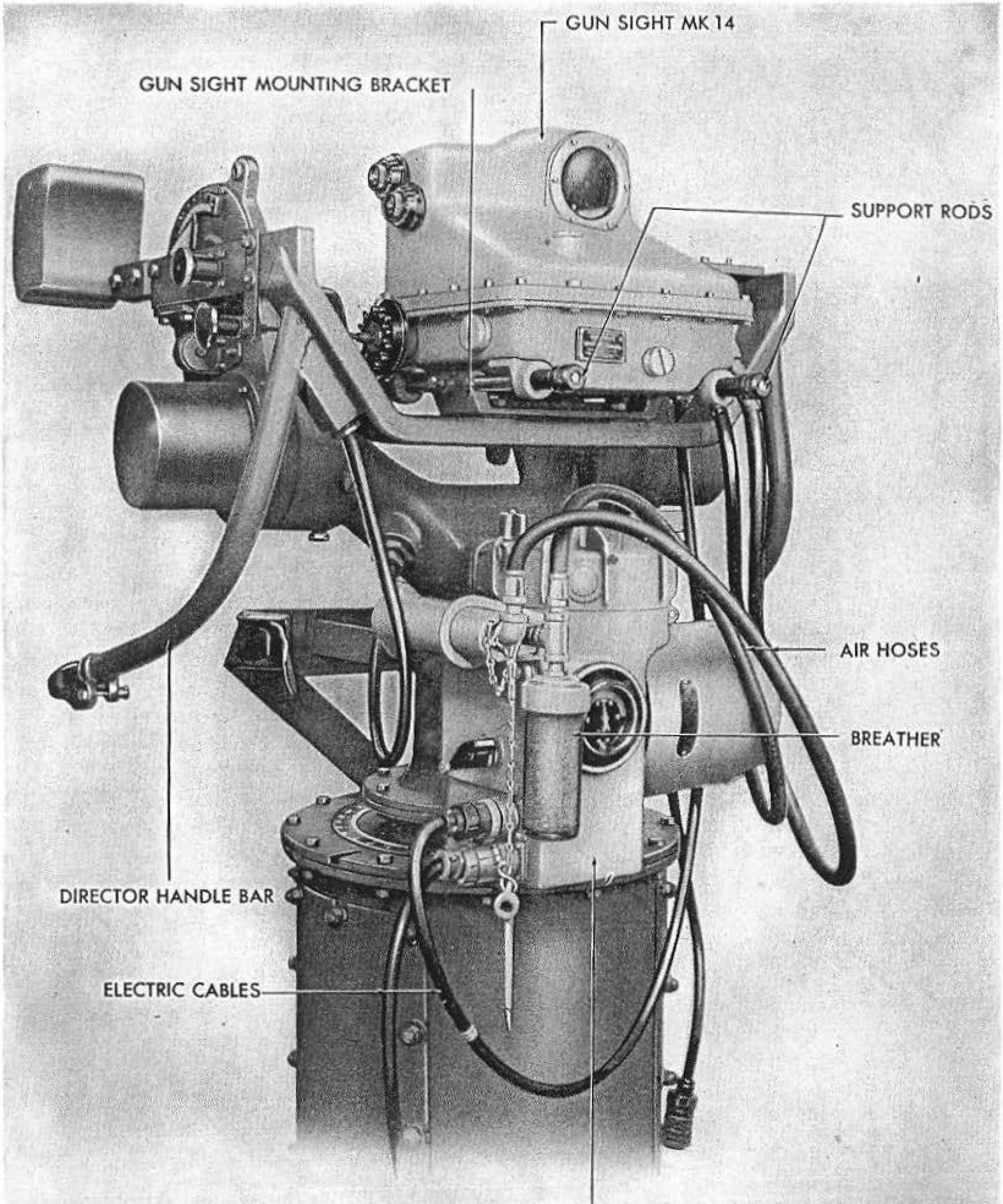

Figure 36.—Gun Director Mk 51 Mod 2 with Gun Sight Mk 14.

Chapter 3

PHYSICAL DESCRIPTION

Introduction

The complete Gun Sight Mk 14 consists of two separate assemblies: the gun sight itself and the power unit which provides air to drive the gyro rotors within the gun sight. Both units may be installed directly on the 20-mm antiaircraft gun mount (fig. 37). For use with 1.1-in., 40-mm, 3"/40 cal., 5"/25 cal., and 5"/38 cal. antiaircraft guns, both units are installed on Gun Director Mk 51 Mod 2 (fig. 36).

Gun Sight Mk 14 Mod 15, used on the 40-mm Single (power driven) Mount Mk 4 Mod 3, is described in chapter 7.

The gun sight is attached to the gun mount or director by means of two support rods and a bracket furnished with the sight (fig. 36). The support rods are adjustable within the bracket, permitting the operator to move the sight nearer to, or farther away from, his eye. After adjustment, the rods are locked in position in the bracket by means of set screws. Springs are fitted at the ends of the support rods to act as shock absorbers for Mods 6 and 15. For Mods 7, 8, 12, 13, and 14, spacers are provided instead of springs.

The air power unit is attached to the air power unit bracket which is located for minimum interference with the operation of the gun or director.

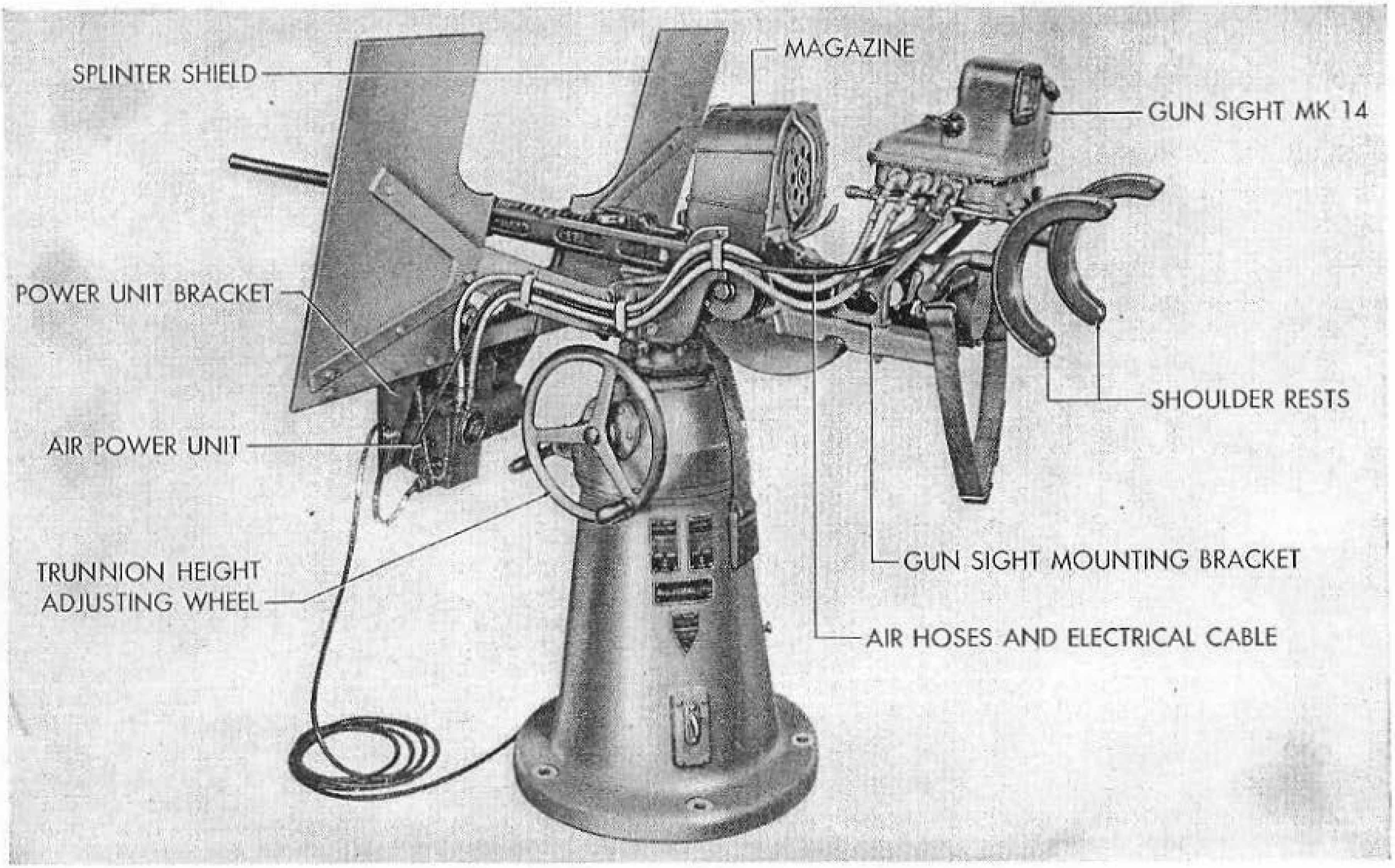

Figure 37.—20-mm Gun with Gun Sight Mk 14 Mod 6.

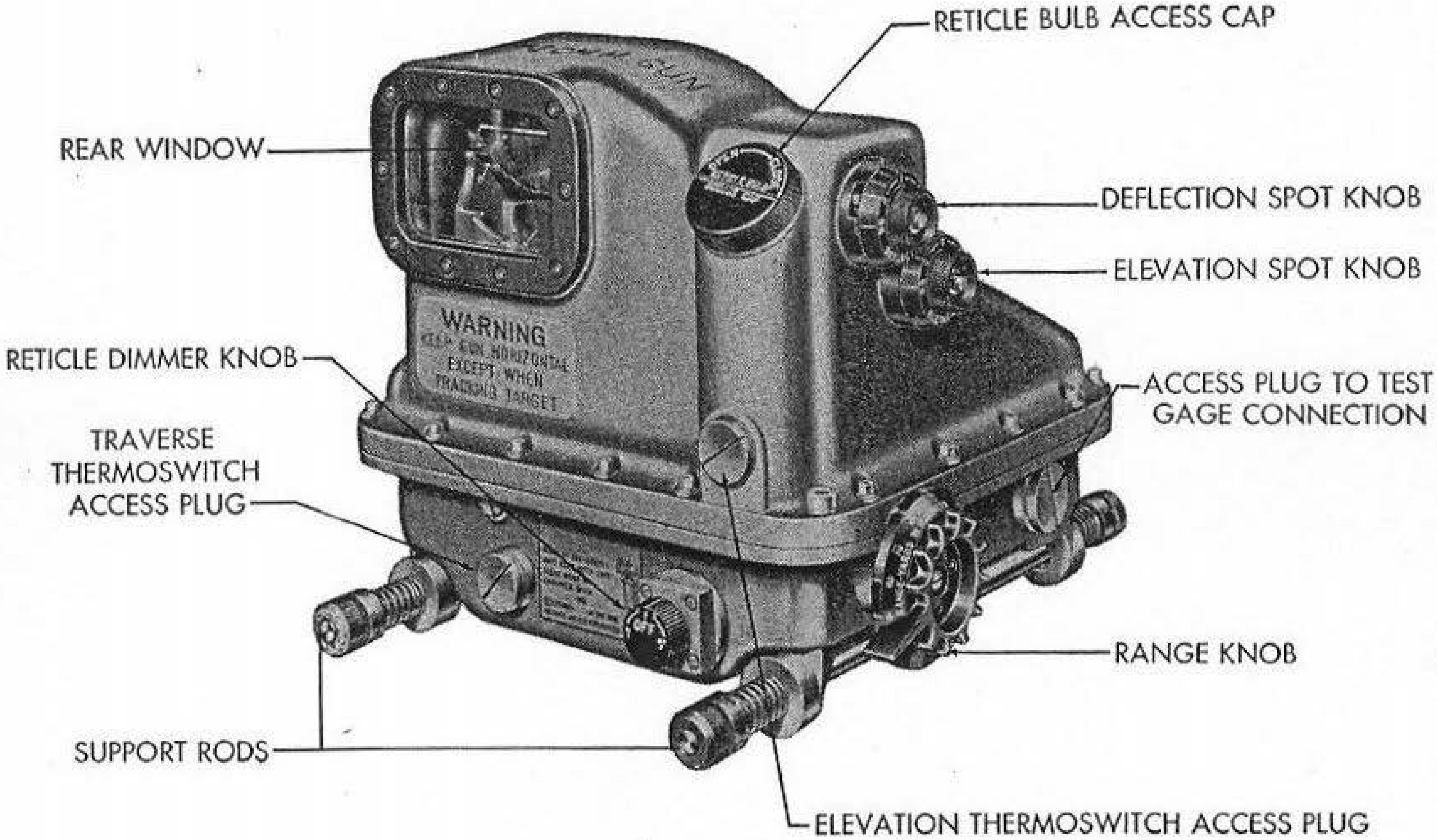

Figure 38.—Gun Sight Mk 14 Mod 6, Rear and Right Side.

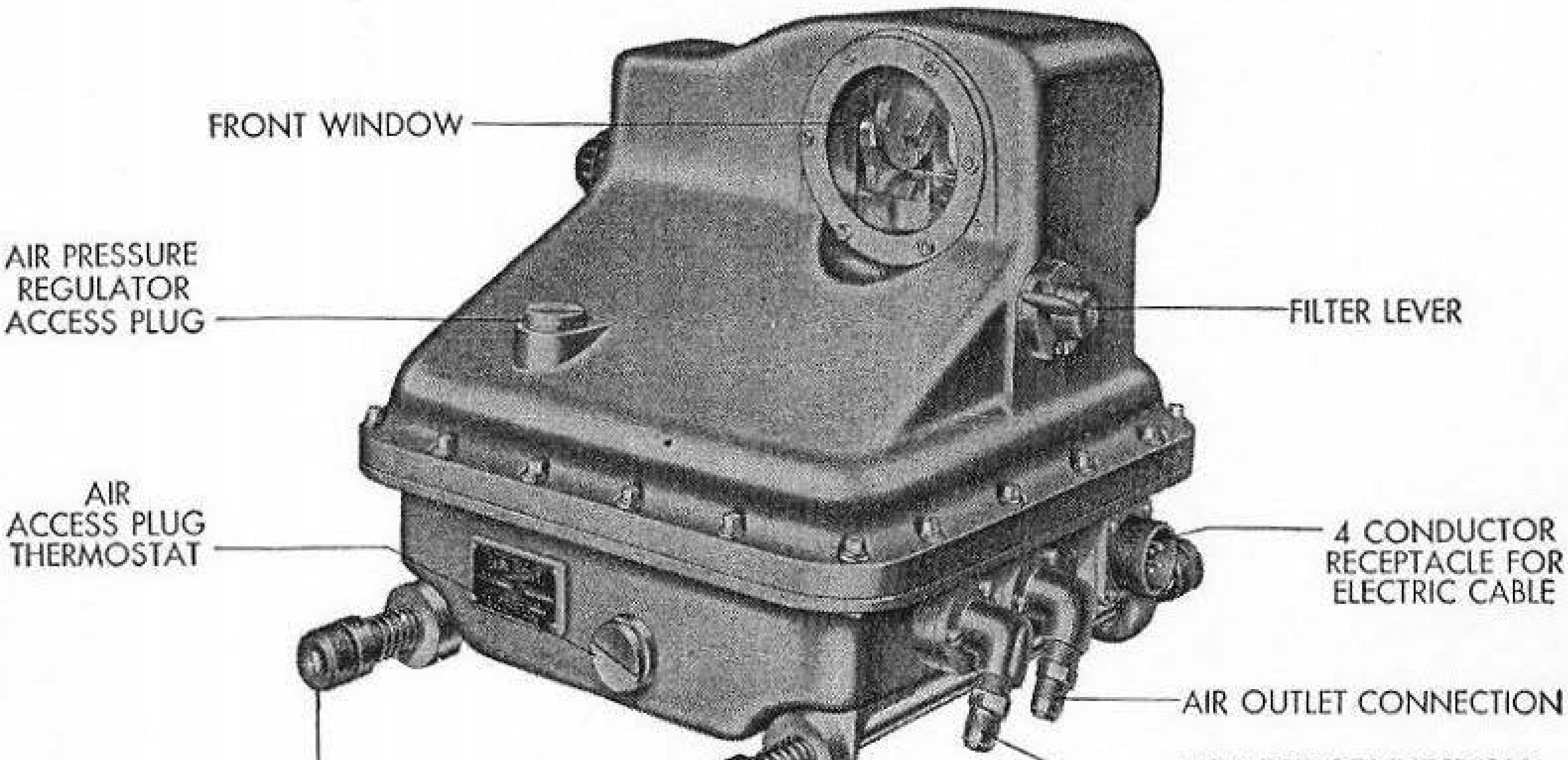

Figure 39.—Gun Sight Mk 14 Mod 6, Front and Left Side.

Gun Sight

The right side and rear of the gun sight are shown in figure 38, and its left side and front are shown in figure 39. The operator sights the target through the two windows seen in the upper section of the assembly. Between these two windows is the transparent elevation mirror from which the reticle image is refleected to the pointer's eye.

On the right side of the sight is the range knob, graduated in yards (figs. 40 and 41). The only external difference between Mods 6, 7, 8, 12, 13, and 14 is in the maximum range calibration on this knob; the maximum range for each Mod is given in table 1 (p. 8).

The knob is graduated in increments of 400 yards for all Mods, with a common minimum range of 400 yards.

The range knob is fitted with detents which engage at each graduation, so that changes in range setting can be made by feel without looking at the scale.

Note: On Mod 6, a small lever on the range knob at the 400-yard graduation facilitates operation when the knob is turned directly by hand, as it is when used on the 20-mm mount. Should range knobs with this lever be supplied for use on directors (where the range knob is controlled by an extension), the lever should be sawed off to prevent interference at extremes of elevation.

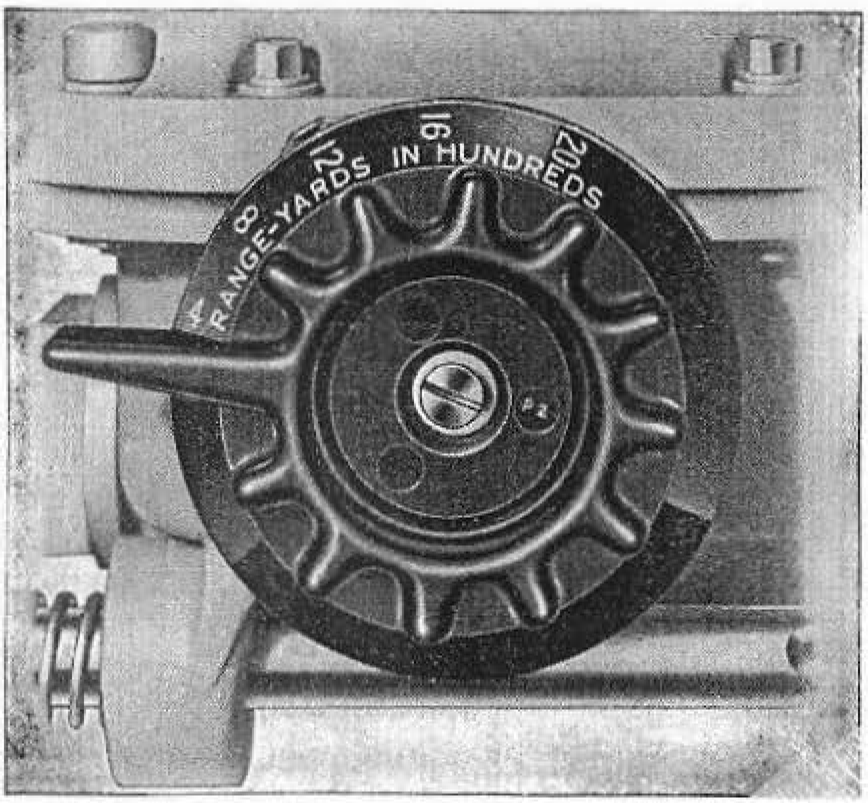

Figure 40.—Mod 6 Range Knob.

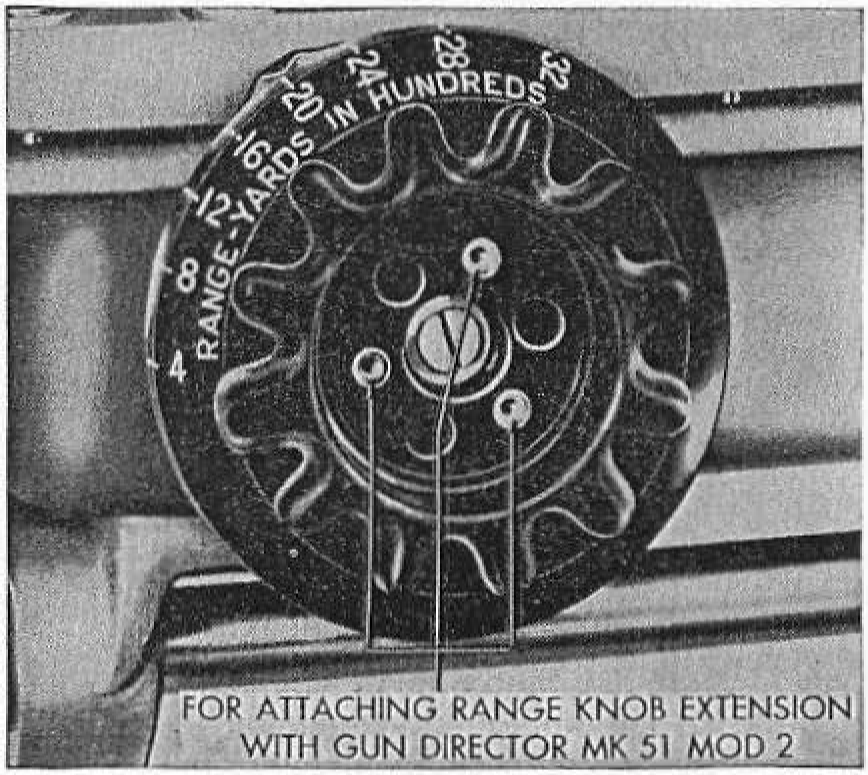

Figure 41.—Mod 8 Range Knob.

Also on the right side of the gun sight are the two spot knobs (figs. 38 and 42), one for deflection and one for elevation, used primarily for boresighting purposes. These knobs are graduated in increments of five mils to a total of 25 mils in each direction, "up" and "down" for elevation, and "right" and "left" for deflection.

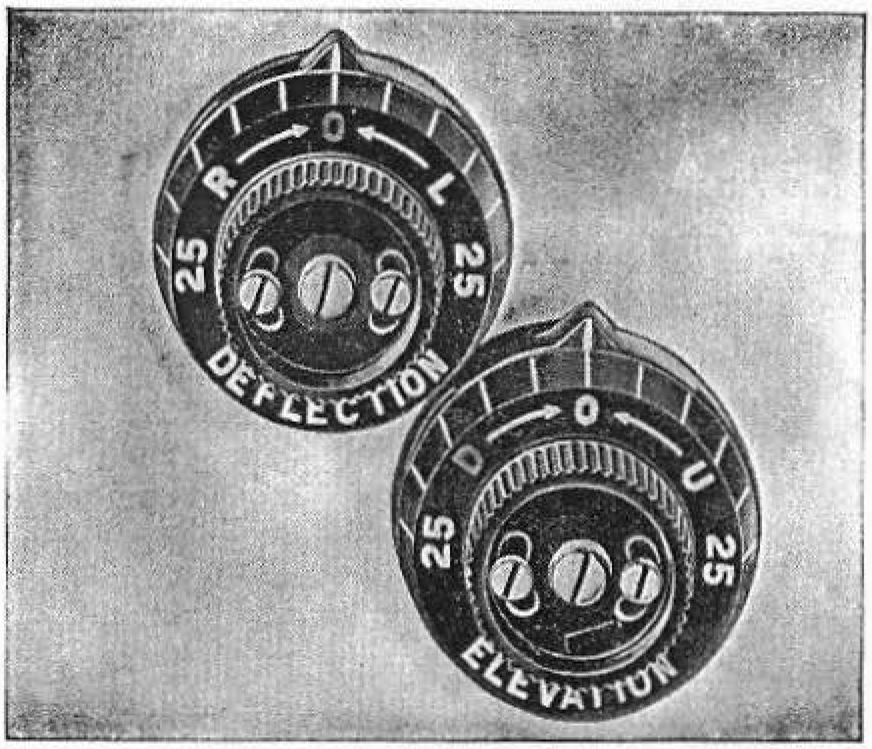

Figure 42.—Spot Knobs.

At the rear of the sight, in its lower section, is the reticle dimmer knob (figs. 38 and 43) which controls the intensity of the reticle image by varying the current through the reticle lamp filament. The reticle lamp has two separate filaments, either one of which can be turned on if the other should fail

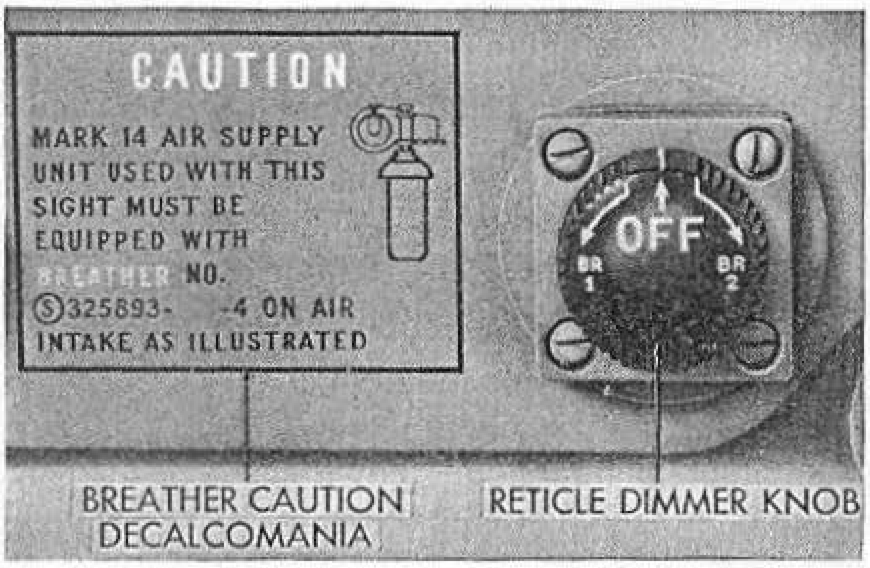

Figure 43.—Reticle Dimmer Knob.

during firing. For this purpose, the OFF position of the reticle dimmer knob is in the center, permitting it to be turned either to the right or to the left, depending upon the filament used. Turning the knob farther from the OFF position in either direction increases the brightness of the reticle image.

On the left side of the gun sight is a lever (fig. 39) which, when turned, shifts a neutral density polarizing filter into the line of sight inside the front window. Use of the filter minimizes glare and reduces the intensity of bright backgrounds.

On the left side of the lower section of the sight housing are air inlet and outlet connections and a four-pole electrical receptacle (figs. 39 and 44). Connected to the power unit by air hoses and cable, they provide air supply to spin the gyros, air return, and electrical power for the heaters in the sight.

Various access plugs are located on the sight case to permit adjustments to be made inside the sight. Their use is described in chapter 9.

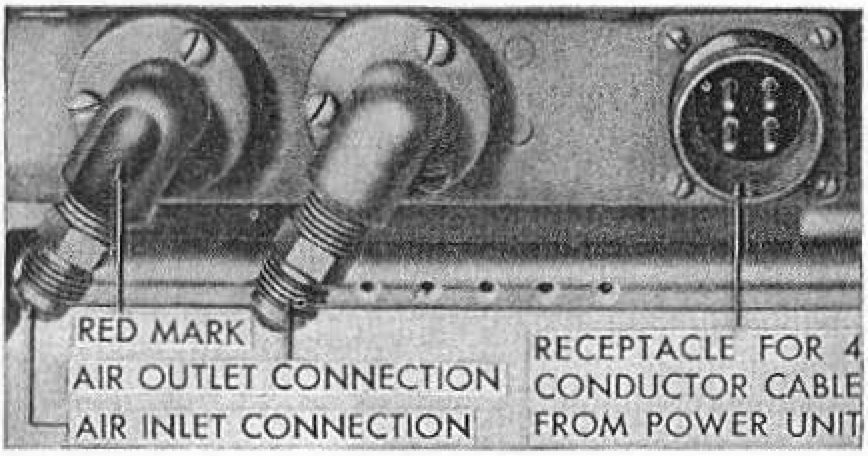

Figure 44.—Gun Sight Air and Electrical Connections.

Air Power Unit

The power unit with breather attached is shown in figure 45. Basically, the unit consists of an electrically-driven air compressor which provides air, under pressure, for the two gyros, and the ten-volt transformer which supplies the electric current for the reticle lamp filaments.

A pressure gage registers the air pressure delivered to the gun sight in pounds per square inch above atmospheric pressure. The central sector of the scale (6 to 10 p.s.i.) is colored green. When the needle is within the green sector, the compressor is delivering air at the proper pressure.

The section of the power unit case below the pressure gage contains the fuses and the transformer. On one side of this section are two electrical receptacles and the ON-OFF cut-out switch (fig. 45). When in use, the lower receptacle receives ship's service power at 115 volts, 60 cycle, A.C.; the upper receptacle delivers power to the electrical receptacle on the gun sight.

Air power units are now being provided with "standby" wiring. This allows current to flow to the gun sight heaters as long as the ship's service connection is energized, even though the cut-out switch is OFF. In this way the sight is kept warm and ready for rapid use, even though the compressor and gyros are not in operation. Power units provided with standby wiring are clearly marked.

The air inlet and outlet connections are located at the left of the compressor. At the outlet is an air drier, consisting of a cylinder filled with silica gel, a water absorbent material. Moisture in the air passing through this cylinder is absorbed by the silica gel and the air is delivered, dry, to the sight unit. The silica gel must be activated, or dried, at regular intervals by qualified personnel (See chapter 9).

Late power units are delivered with "breathers" attached to the air inlet connection. These breathers are transparent plastic cylinders filled with silica gel (fig. 45). Their purpose is to insure that the air leaving the sight housing is maintained approximately at atmospheric pressure.

Whenever a power unit is installed without a breather, one must be provided in the sight housing. Such breathers consists of porous plugs fitted in the bottom of the housing.

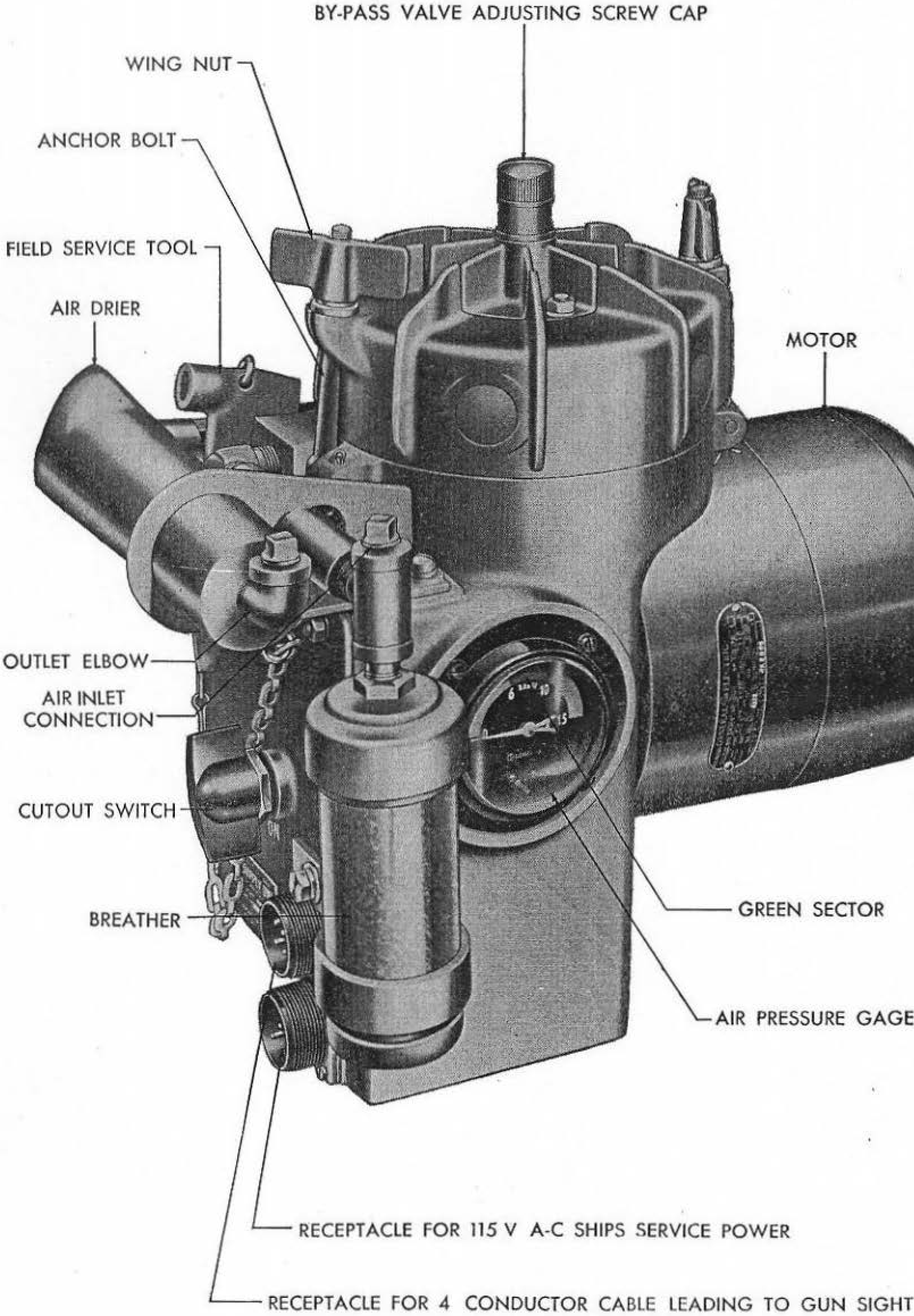

Figure 45.—Air Power Unit, Gun Sight Mk 14.

Caution: When replacing sights, make sure that at least one breather is in place, either in the sight or on the power unit.

A "Caution" decalcomania (fig. 43) located on the lower section of the sight case identifies gun sights which do not have integral plugs. These sights must be used with power units in which a breather is installed.

Use of the bypass adjusting screw cap shown at the top of the compressor (fig. 45) is described in chapter 9. The bypass adjusting screw cap should be removed only by authorized maintenance personnel.

The field service tool attached by a chain to the power unit is to be used only by authorized personnel, as described in chapter 9.

Chapter 4

OPERATION

Introduction

Operation of Gun Sight Mk 14 is described in this chapter primarily as an aid to understanding the functioning of the sight. It is not intended to establish any tactical doctrine.

Whenever reference is made to the use of the gun sight on the director, the discussion applies to its use directly on the gun as well, unless otherwise noted.

Gun Crew: The gun crew of the 20-mm antiaircraft gun normally consists of three men, as follows:

Gunner. The gunner aims and fires the gun while tracking the target with the gun sight.

Range Setter. The range setter receives or estimates range to the target and sets it on the range knob of the gun sight. He may also make necessary corrections to the range, as determined by observation of the tracer stream, or by other means.

Loader. The loader changes magazines and keeps the gun loaded.

Trunnion Operator (on mounts with adjustable trunnion height). The trunnion operator raises and lowers the gun column maintaining the shoulder rests at proper height. Since this motion directly affects the accuracy of the gun sight, a fixed trunnion height should be maintained, unless otherwise specifically required by doctrine.

Gun Director Crew: The crew of the Gun Director Mk 51 Mod 2, on which Gun Sight Mk 14 is installed for the control of power-driven automatic weapons and antiaircraft guns of larger caliber, normally consists of two men, as follows:

Director Pointer. The director pointer aims the director by tracking the target through the gun sight, and fires the gun by pressing the firing key on the director handlebar.

Range Setter. The range setter receives or estimates range to the target, and sets it on the range knob of the gun sight. When necessary, he may also make corrections to the range, as determined by observation of the tracer stream or by other means.

Standby Condition

When Gun Sight Mk 14 is secured, the gyro damping fluid is cold and a 30-minute warm-up period is required to bring the fluid to its proper temperature (140° F.) so that the sight can be operated accurately. When on standby, it is essential that the gun sight be capable of operating with full accuracy within a few minutes. To permit this, standby condition may be either of the following:

1. Gun sights without standby wiring must have all electrical connections made and energized, and air hoses connected. The air power unit must be in operation; the gyros must be operating, and the gyro unit and air heaters energized. The reticle lamp should be off until the sight is to be used. In this condition, the sight is continuously ready for instant operation.

2. Where standby wiring is provided, the air power unit is stamped STANDBY. In this case, all electrical and air connections are made but only the ship's service supply cable to the power unit is energized, and the power unit switch is turned OFF. The standby wiring within the power unit permits the gyro unit heaters to be energized, keeping the damping fluid at the proper temperature. Before the sight can be used with full accuracy in this condition, it is necessary to turn the power unit switch to ON and then allow about three minutes for the gyros to come up to speed.

Note: The connection box from which the ship's service supply connection is led may be fitted with a switch. If so, this switch must be ON, either to operate the gun sight or to energize standby wiring.

Caution: While on standby, the gun director should be left secured in its normal position, in train and at zero degrees elevation, with range set at its minimum figure. The 20-mm gun should be secured at five degrees elevation.

Preparing For Action

If the sight has been disconnected for securing, the first step in preparing it for action is to connect the 115-volt ship's service supply to the power unit. The junction box from which the current is led may be provided with a switch. If so, it must be turned to the ON position. Next, the power unit cut-out switch must be turned to the ON position.

The gyro rotors will reach proper speed three minutes after the cut-out switch has been turned on, but the damping fluid will not reach proper temperature until the heating units have been in operation for 30 minutes.

In an emergency, it is possible to use the sight ten minutes after the heaters have been in operation, but it will not give accurate solutions until the full warm-up period of 30 minutes has passed.

In the above, it is assumed that the system has not been left in STANDBY condition. If the system is equipped with standby wiring and the power cable has been left connected, the sight may be used with maximum accuracy three minutes after the cut-out switch is turned on, this 3 minutes being required for the gyro rotors to reach operating speed.

The conditions of the air hose and electrical connections should be checked.

Before tracking with the gun sight, operation of the following elements should be checked:

Power Unit Pressure: The power unit pressure gage should be inspected to see that the needle points to the green sector of the dial. If it does not, the sight must be checked by a qualified maintenance man. (See chapter 9 for maintenance procedures.)

Reticle Lamp: Operation of both filaments of the reticle lamp should be checked by turning the reticle dimmer knob to bright position (BR) for each filament and observing reticle brightness in the sight.

Neutral Density Filter: The movement of the neutral density polarizing filter should be checked by operating the filter lever.

Reticle Movement: After the gyro unit has been allowed to warm up for at least 30 minutes, movement of the reticle should be checked. This is done by swinging the gun rapidly in one direction in train, bringing the reticle to its limit of travel. Then the movement of the gun is stopped and the reticle is observed as it returns to its neutral position. Its movement should be smooth and steady. This test is made in both directions in train and in elevation. If the reticle appears to move jerkily or irregularly in returning to its neutral position, the sight is faulty and should be replaced. The faulty sight must be returned to a qualified repair station for adjustment.

Cycling: Cycling is the final step taken before placing the sight in operation. Its purpose is to settle the reticle on its true zero position in both directions and to check it for smoothness. Cycling in train can be accomplished immediately after checking reticle movement in train; and cycling in elevation can be accomplished immediately after checking reticle movement in elevation.

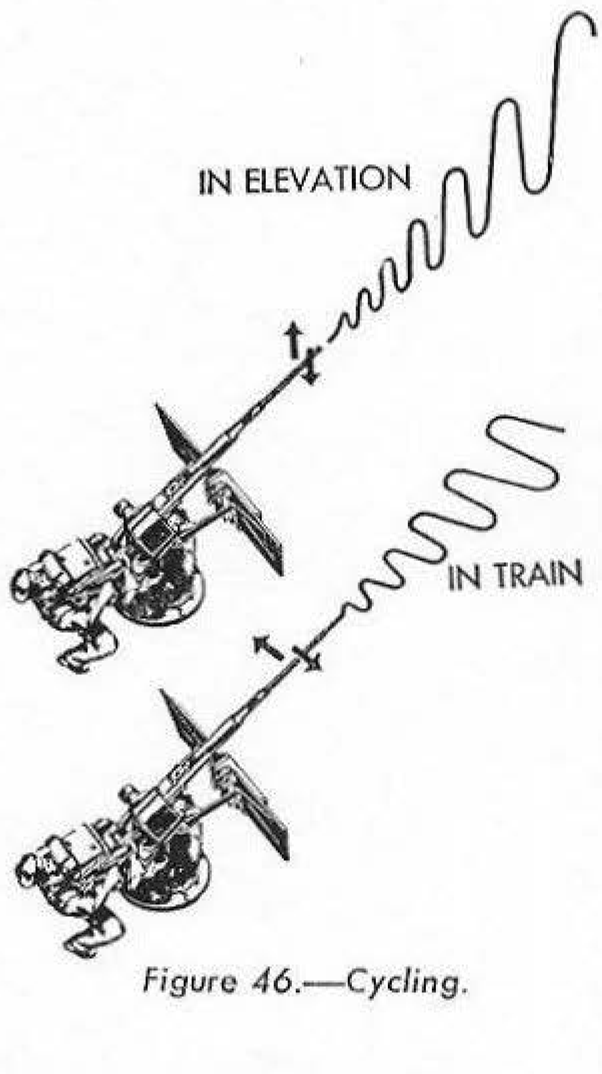

Figure 46.—Cycling.

Cycling is accomplished in the following manner:

Set the range knob at maximum range. Holding the mount in a horizontal position, swing it rapidly from side to side in train (fig. 46).

Continue swinging the mount, but reduce the speed of swing so that the reticle moves through successively small arcs, finally coming to rest. This will be its true zero position in traverse.

Holding the mount steady in train, repeat the above procedure in elevation (fig. 46), allowing the reticle to settle finally to its true zero position in elevation.

Reticle Brightness: Before actually tracking a target with the sight, it is desirable to adjust the reticle brightness so that when on the target, any further change to be made will be slight. This is done by adjusting the reticle dimmer knob so that the reticle is visible against the brightest portion of the sky, but not so intense that it will detract from vision. Reticle brightness should be adjusted only if the sight is to be used immediately; otherwise the reticle lamp is left OFF. If necessary to reduce the brightness of the background, the light filter may be shifted into position.

If the reticle is too bright, it will tend to obscure the target, and poor tracking will result. If the reticle is too dim, relative to the tracking background, the reticle will be obscured, also resulting in poor tracking.

Action

The preceding paragraphs describe normal procedures for putting the equipment into operation or getting ready for action. The following paragraphs decribe the typical procedures for handling the equipment during action, but should be considered as illustrating function and not as advancing specific doctrines of operation.

Slewing: When the gunner first sees the target, he turns the mount rapidly in the target's direction. This rapid swing, called slewing, creates a false lead angle, since the rate of swing usually is much greater than it will be after the gunner has begun tracking the target.

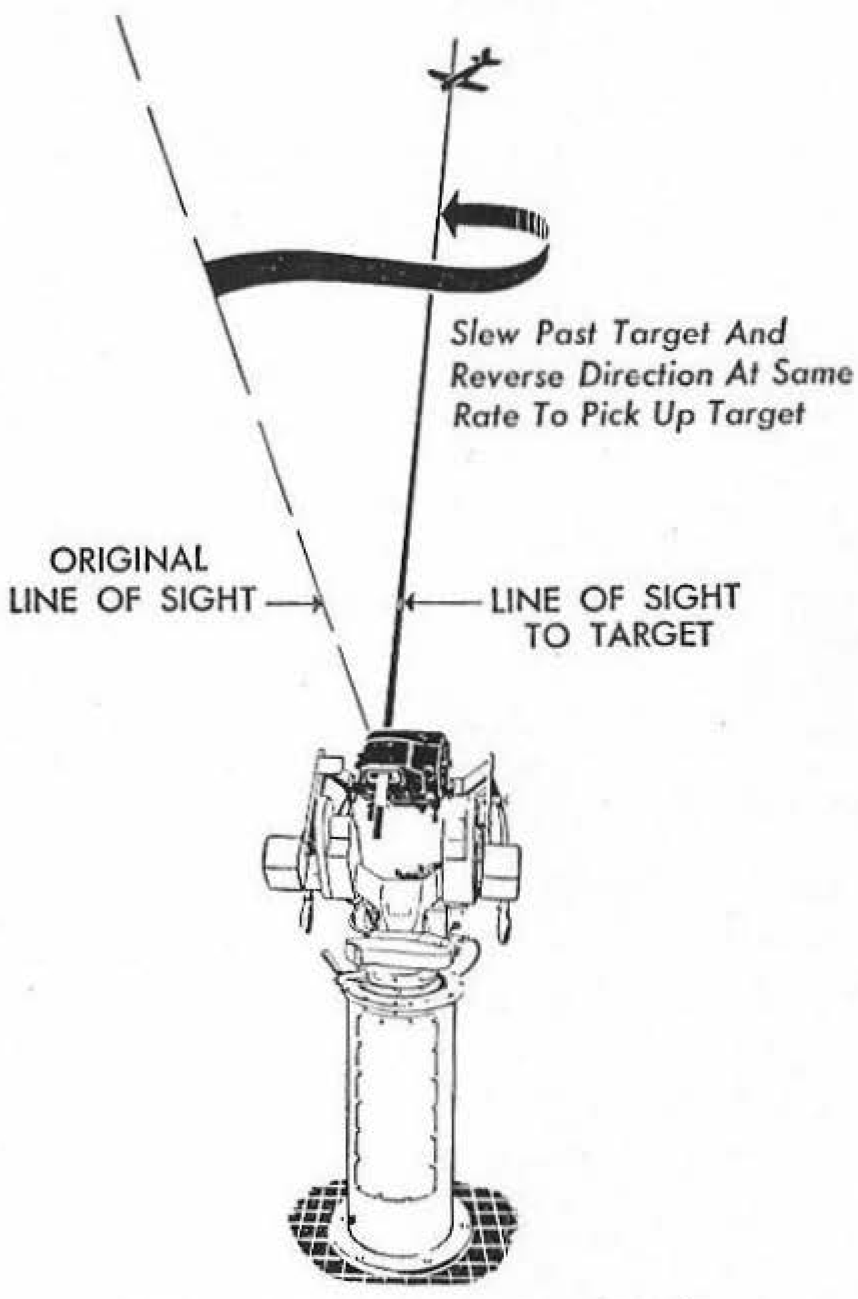

Figure 47.—Collapsing Lead Angle.

Means of correcting, or holding this false lead angle to a minimum, are as follows:

1. The gunner can swing the mount past the target, then bring it back on the target by turning or slewing the gun in the opposite direction (fig. 47). If the reverse swing is made at the same rate as the original swing, the effect will be to collapse the false lead angle.

2. While the gunner is slewing, in his attempt to pick up the target, the range knob should be set at its minimum range (400 yards), thus restricting movement of the reticle. The range setter does not set the range until the gunner is on the target.

3. NAVORD OD 2298 provides means for equipping Gun Sight Mk 14 with a "caging" device so that the gyros can be held without movement until the gunner is on the target. Caging the gyro nullifies the effect of slewing on the lead angle.

The above paragraphs pertain to the movement of the gun required to bring the sight on the target. Even after accurate tracking has begun and with the gyros caged, several seconds must elapse before the gyro units can pick up the exact angular velocity and deliver the correct lead angle.

The time for the system to adjust to any change in range setting also must be considered.

Immediately upon picking up the target, reticle brightness should be adjusted so that it is perfectly clear but not too bright to obscure the target.

As the target is picked up, the range setter must shift the range knob from its 400-yard setting to this estimated range.

Tracking: Smooth, accurate tracking is the most important factor in obtaining hits when using Gun Sight Mk 14. As demonstrated in chapter 2, the correct lead angle depends upon the angular velocity of the target as seen from the gun sight. If the angular rate of motion of the gun is not the same as that of the target, an incorrect lead angle is generated by the sight. Additionally, if tracking is done in a jerky manner, constantly changing lead angles will be generated, none of which will be correct.

The following should be remembered by the gunner or director operator while he is tracking:

Keep the reticle dimmed so that it will not obscure the target but can be seen comfortably.

If the background behind the target is very brilliant, use the light filter.

Concentrate on seeing the target, not on watching the reticle.

It is impossible to keep the head in a fixed position behind the sight. Move the head whenever necessary to keep the reticle in view.

When it is necessary for the trunnion operator to change the height of the gun, he must so do only at times when it will not interfere with the gunner's tracking. He should effect the changes only by immediate or prearranged agreement with the gunner.

Range Setting: Smooth range setting is another factor which will aid the gunner immeasurably in tracking.

Any abrupt change in range setting will make a sudden change in reticle position. This may easily throw the gunner off in tracking. Therefore, any change in range during tracking or firing must be made with a smooth motion of the range knob.

In general, there are two methods of applying range settings to the sight. In one, the range is purposely set short; in effect, the target flies into the tracer path. After the target has passed through, the range is changed by a previously established amount, and again the target approaches and flies through the tracer path.

In the other method, rather than underset or overset, the range setter attempts to obtain the exact range of the target in its present position (by visual estimation, tracer observation, or other means), and sets and adjusts the range control accordingly.

The range setter must be thoroughly familiar with the action of the gun sight as well as with fire control problems.

Incoming Target: If the tracers pass ahead of an approaching target, the lead angle is too great. Assuming accurate tracking, too great a range is set on the sight. If the tracers pass below or behind the target, the lead angle is too small, and the range setting too low. The first condition requires a definite change in range setting (400 or 800 yards) to bring the tracer stream to the target. If the tracer stream passes behind, the approaching target will fly into the set range. This may require an increase in range, depending on the amount of the error.

The range should be reduced each time the tracer stream appears to pass ahead of the target. Decreasing the range too soon causes fire to fall continuously below and behind the target. Inversely, if the range is too great, the fire will fall ahead or above the target, and will not hit an incoming target. (Accurate tracking is assumed in all cases.)

Outgoing Target: With an outgoing target the range is continuously increasing instead of decreasing. In this case, if the range is too great the tracers will still pass ahead of the target, but the target will fly into the correct range. If the tracer stream passes behind and below the target, the range is too short and must be increased to catch up with the target. In this case, the range should be increased when the tracer stream appears to fall behind the target.

Dispersion of fire, tracking error, and target size all enter into the possibility of making hits. For this reason, the gun may score hits at ranges which vary several hundred yards from the range set on the target.

Spotting: If the range is properly set on the sight, and if tracking is accomplished smoothly and accurately, the correct lead angle will be generated, and spots will not be necessary. A number of minor errors enter into the flight of the projectile. These include drift of the projectile, wind velocity (which tends to drive the projectile from its normal trajectory), errors in boresighting the gun, and errors in the roller path plane of the gun. The normal dispersion of fire of the automatic weapons controlled by the gun sight should be larger than the total of all these errors. Therefore, spotting to correct such errors is unnecessary, and can be harmful.

The range setter should avoid applying spots while the gunner is firing. Applying spots causes sudden movement of the reticle, and may throw the gunner off the target. For the same reason, range must be changed smoothly. Spots should seldom be applied and then only to correct for a known consistent error.

Securing

The gun sight should be secured in the following manner:

1. Shift range knob to minimum range (400 yards).

2. Bring gun mount or director to secured position in train, and lock.

3. Bring gun mount to 5° elevation, and insert locking pin. (Gun director is locked at 0°.) Release elevation locking pin from its stop, and move gun slowly at low elevation until pin slides into place.

4. If standby wiring is not provided, and gun is not to be left in a "ready" condition, turn power unit cut-out switch OFF.

5. Disconnect 115-volt ship's service power supply **only if so ordered.**

Caution: It is important to secure the sight in an approximately horizontal position to allow the damping fluid in the gyros to settle in the proper position. The action of the gyros would be faulty and incorrect lead angles would be generated if the fluid were to settle incorrectly.

If the sight is inadvertently left in a highly elevated position, the following should be done before placing it in service:

Bring sight to a horizontal position and allow it to warm up for from two to three hours. Then check the performance of the sight by making the following performance tests as detailed in chapter 8: Dead Zero Test, Range Shift Test, Characteristic Time Test, and Deflection (Sensitivity) Test. When these tests show the sight to be operating satisfactorily, it is ready for service.

Notes and Safety Precautions

The following safety precautions and notes relating to operation of Gun Sight Mk 14 are listed here for reference:

1. If standby wiring is provided and is in use, allow three minutes for gyros to reach proper speed.

2. Whenever the sight is not actually in use, it must be kept in an approximately horizontal position (0° for director, 5° for 20-mm mount).

3. If air pressure from the power unit is not correct, or if reticle movement is uneven, use the sight only in an emergency. Have the sight checked by a maintenance man at the earliest opportunity.

4. Always cycle the sight in train and elevation before placing it in use.

5. When slewing, always set the range knob at its minimum setting (unless gyros are caged).

6. When slewing at a high rate, it is recommended that target be picked up by "overshooting" (unless gyros are caged).

7. If a caging device is installed, always cage the gyros when slewing.

8. Never change trunnion height when firing, and only change it carefully when tracking.

9. Always make changes in the range setting with a smooth motion of the range knob.

10. Never reduce range on an incoming target until the tracer stream appears to pass ahead of the target.

11. Never increase range on an outgoing target until the tracer stream appears to fall behind the target.

12. Apply spots only when necessary. If undecided, do not spot.

13. When firing has ceased and gunner is searching for another target, immediately set range at minimum (400 yards).

14. Always secure gun mount at 5° elevation (gun director at 0°) with range set at 400 yards.

15. If gun has inadvertently been secured vertically, have performance tests made before placing sight back in operation.

16. If standby wiring is NOT provided and sight is to be used again within 30 minutes, leave power unit cut-out switch ON. If standby wiring is provided, cut-out switch can be turned OFF.

DETAILED DESCRIPTION

Introduction

This chapter is a detailed description of the mechanical and electrical elements of Gun Sight Mk 14 and their functions. The elements are divided into four systems as follows:

1. The optical system in which the reticle image is projected to the pointer's eye.

2. The gyro mechanism, which measures angular rates of target motion, and computes lead angle.

3. The air system, which provides air under pressure to drive the gyro units.

4. Electrical connections, which provide the power to operate the air compressor in the power unit and the heaters in the gun sight.

Optical System

The optical system of the gun sight provides the means by which the reticle image is projected into the line of sight so that the image may be used by the gunner as a reference point while tracking the target.

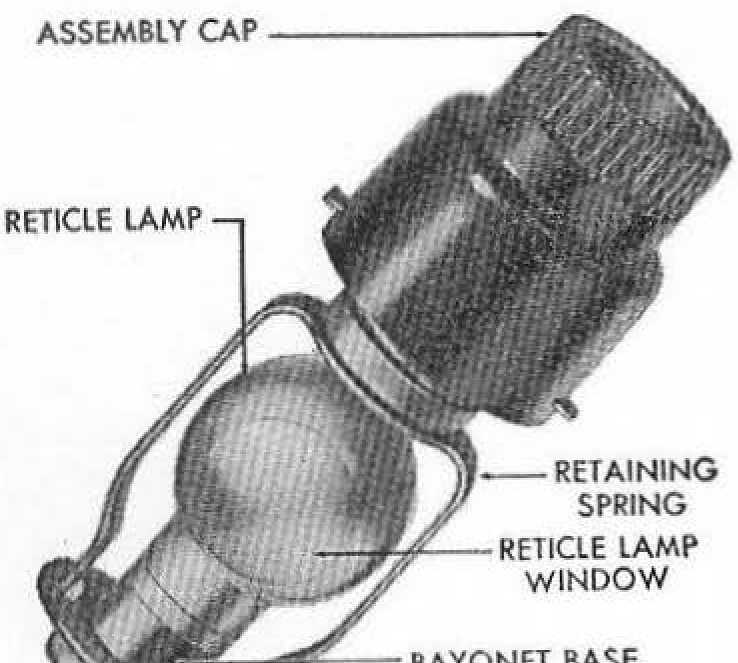

Figure 48.—Reticle Lamp Assembly.

Reticle Lamp: A double-contact, bayonet-base, reticle lamp (Mazda No. 842) provides the light by which the reticle image is projected into the optical system (fig. 48). This lamp has an external, aluminized reflecting coating which covers most of the glass bulb, leaving only a frosted circular window through which the light is directed onto the reticle. The frosted window and metallic coating deliver a maximum amount of evenly distributed light. Either of the two filaments can be illuminated instantly if one burns out.

An external knob having an OFF position when centered and two BR (bright) positions at full rotation left and right operates through a rheostat to select one filament and control its intensity of light (fig. 49). The two filaments have one common terminal which is connected directly to one side of the 10-volt a-c stepdown transformer in the power unit. The other terminal of each filament is connected to each side of a 60-ohm rheostat. Current flows from the rheostat slider, through 30 ohms resistance, to both filaments when the external knob, which controls the slider, is in the center position.

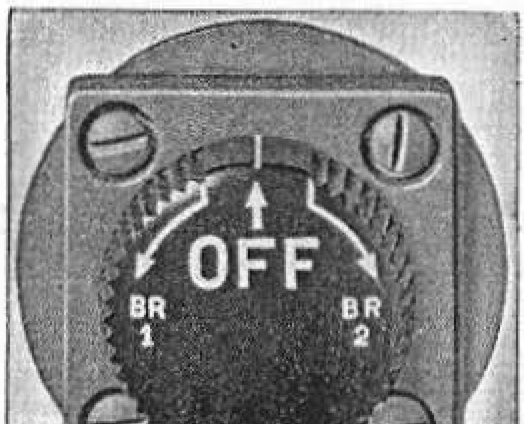

Figure 49.—Reticle Dimmer Knob.

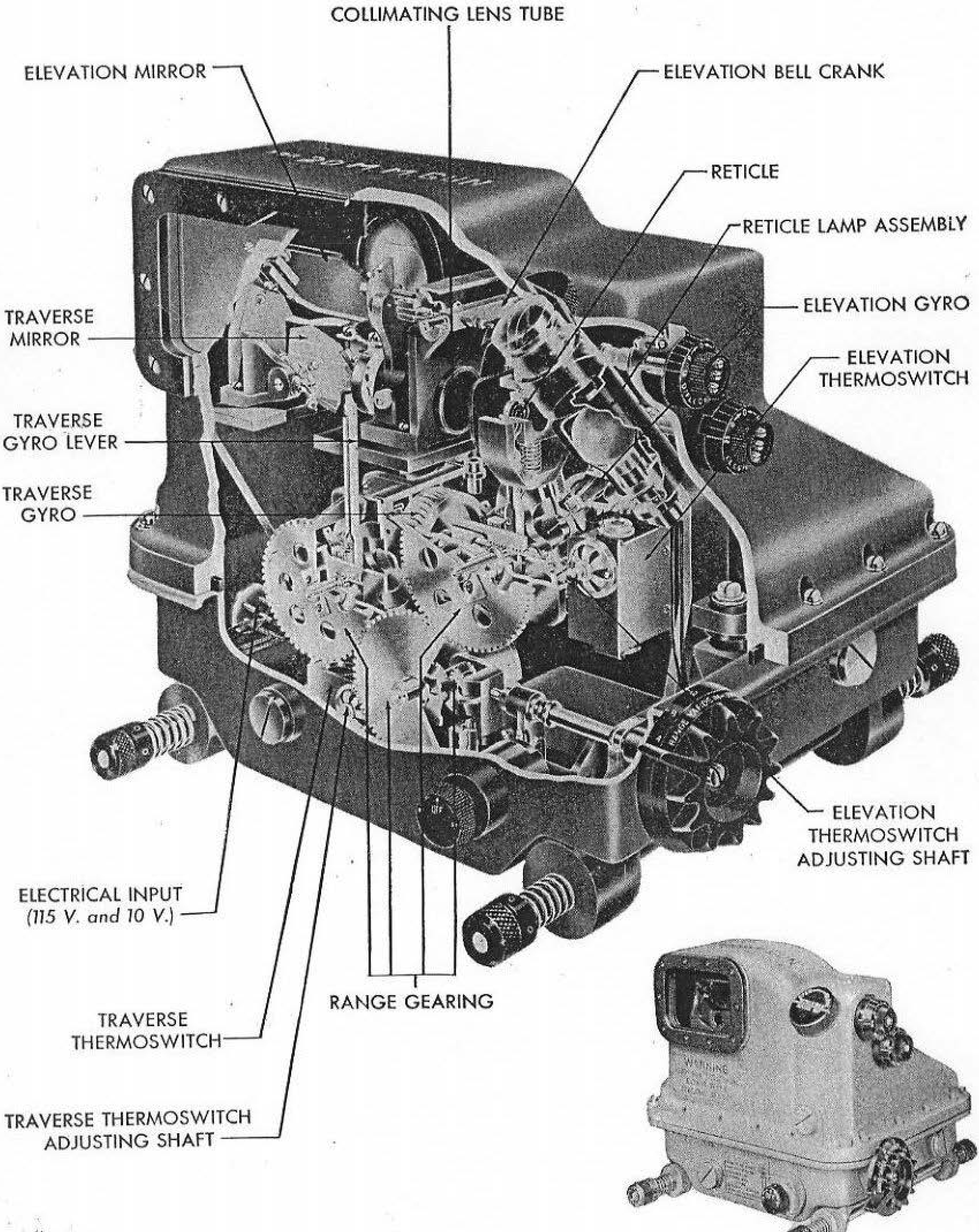

Figure 50.—Gun Sight Mk 14—Cutaway of Rear and Right Side.

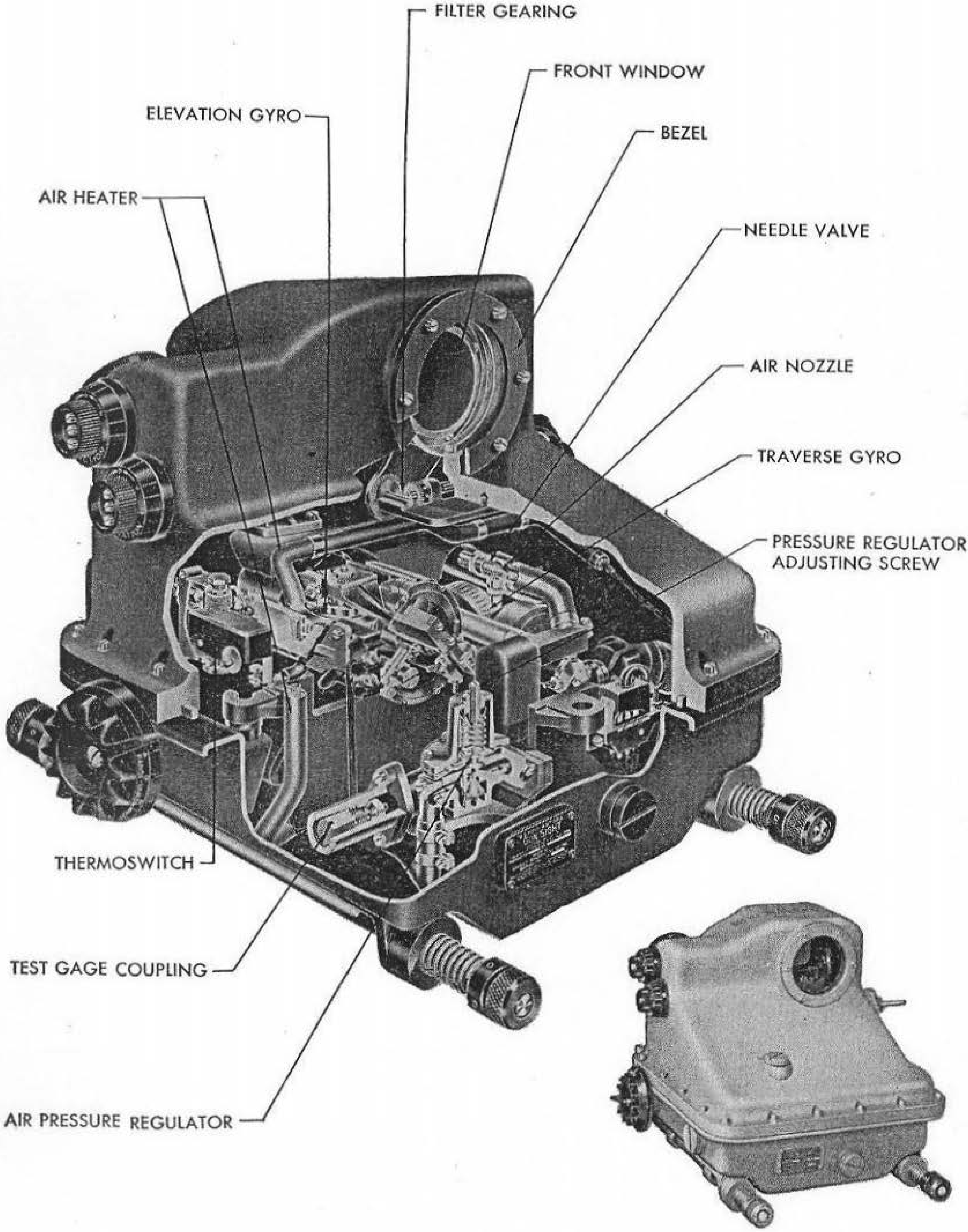

Figure 51.—Gun Sight Mk 14—Cutaway of Front and Right Side.

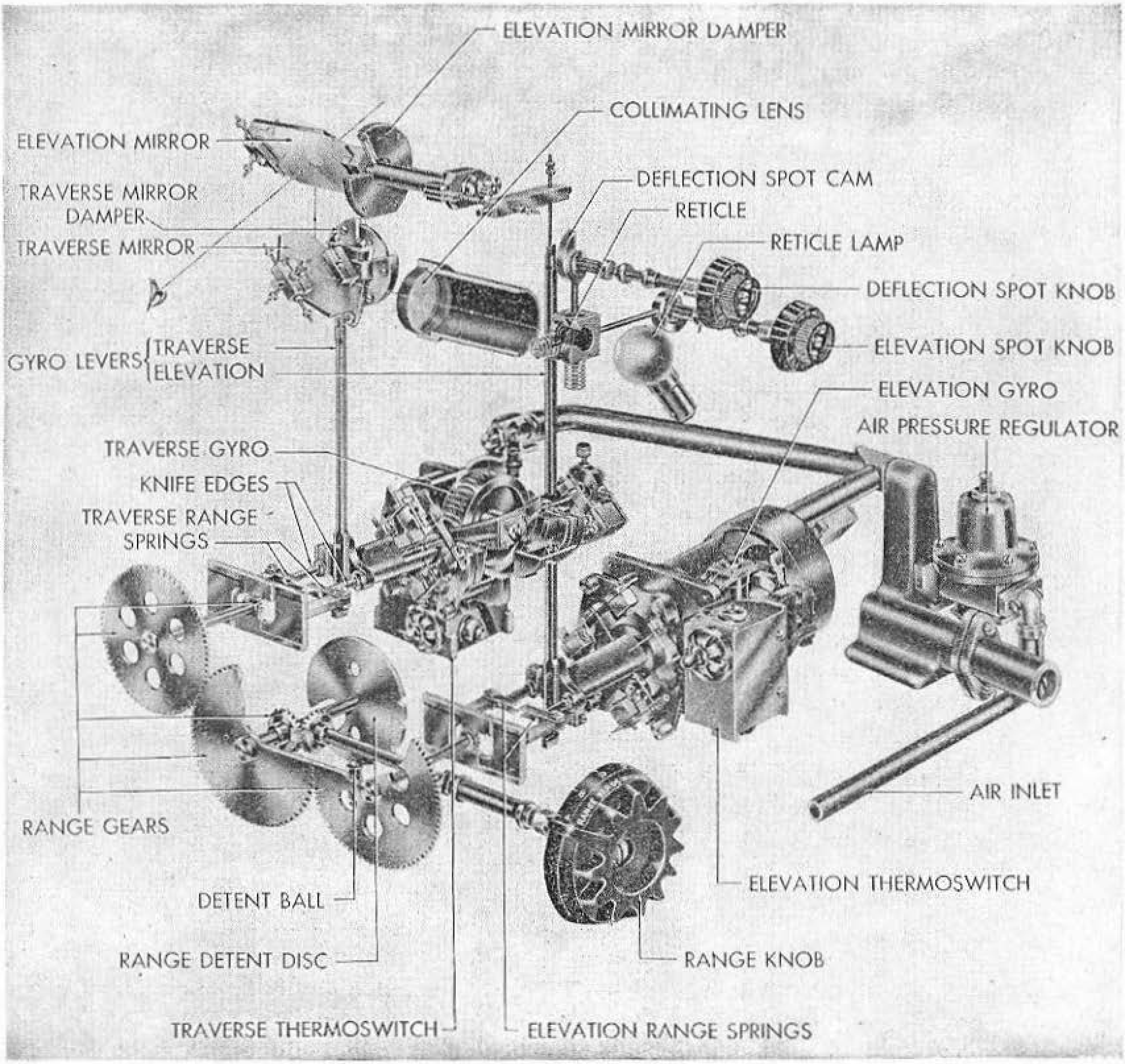

Figure 52.—Gun Sight Mk 14—Schematic.

This resistance, in series with each filament, causes the intensity to be decreased almost to extinction. As the knob is turned, the resistance in series with one filament is reduced while the other is increased. This allows the brilliance of the lamp to be increased as the knob is turned. By this means, either filament can be selected and the reticle brightness can be controlled to suit any background.

Reticle: The reticle mask is mounted in a block which can be moved up and down or back and forth across the optical axis (fig. 53). This opaque mask, or reticle, allows the light beam from the reticle lamp to pass only through two translucent concentric circles with a semi-opaque dot in the center forming the brightline reticle image. The center dot is used for calibration and test purposes, and is visible only with maximum reticle illumination. Movement of the mounting block is controlled by two external spot knobs, one knob controlling vertical motion, and the other controlling lateral movement. Such shifting of the reticle causes a movement of the reticle image position in the field of view.

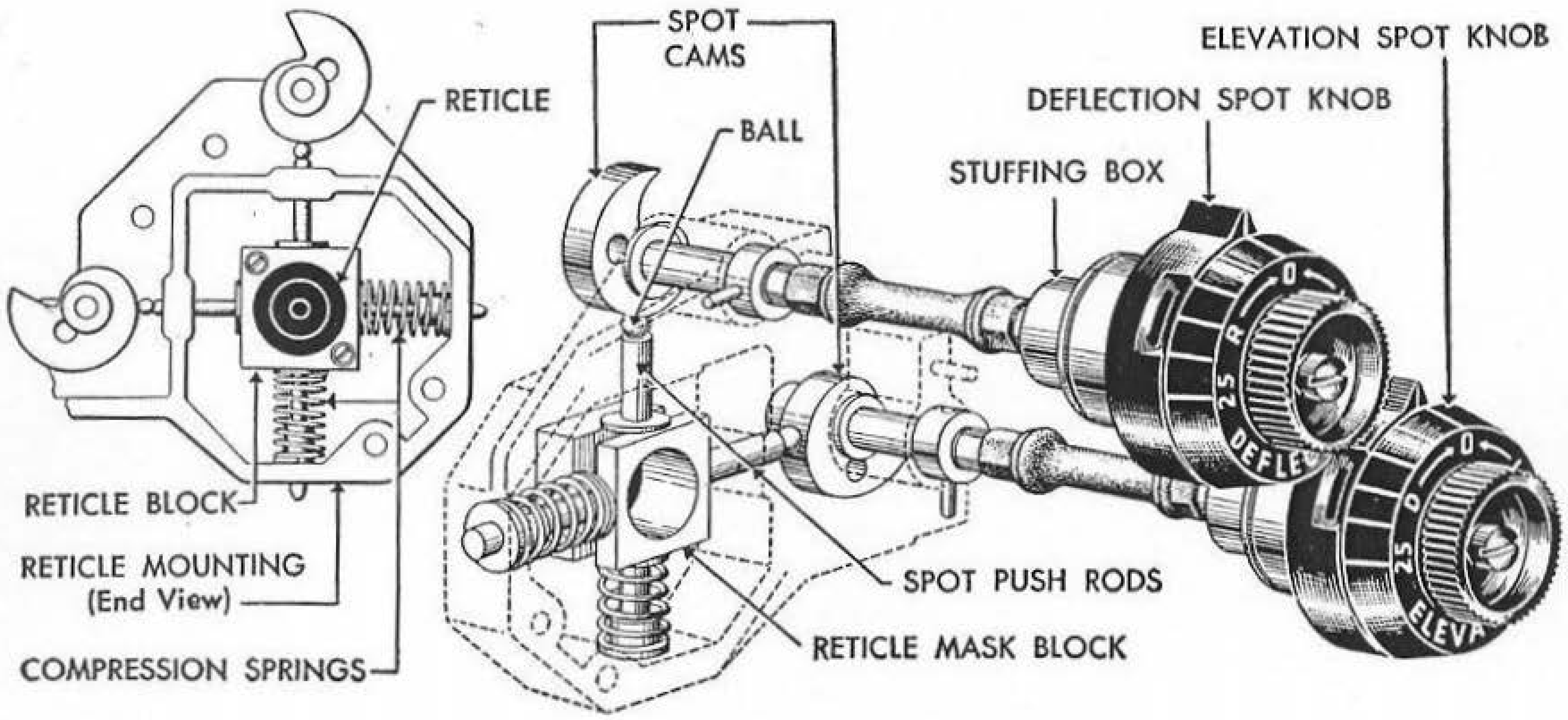

Figure 53.—Reticle Spotting System.

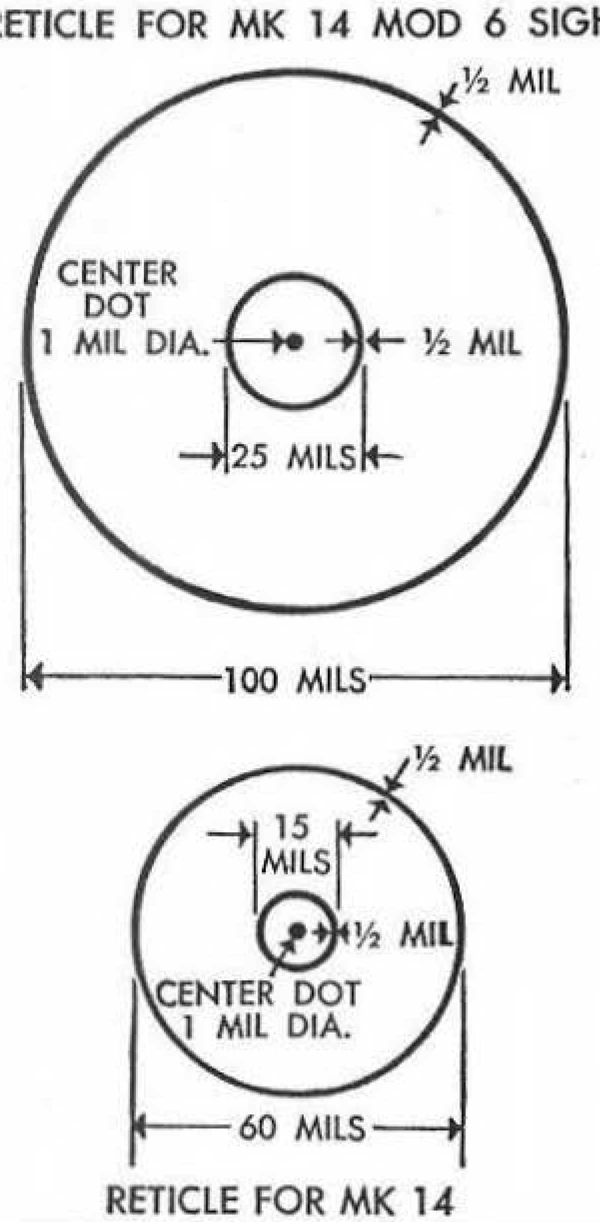

Figure 54.—Reticle Dimensions.

Spotting System: Two externally mounted spot knobs, one for deflection and the other for elevation, control the shift of the reticle mask. The shaft of each knob goes through a stuffing box, provided to maintain tightness against water and air, and terminates in a cam which drives a push rod working against the reticle mask block (fig. 53). Two compression springs hold the block firmly against these push rods. Any movement of a spot knob rotates the cam, moving the block against the pressure of the compression springs. Ball detents are provided so that the spot knobs can be rotated in five-mil increments. This spotting system allows a shift of the reticle image of ± 25 mils in either elevation or deflection.

Collimating Lens: The collimating lens (fig. 55) consists of a convex lens cemented to a concave lens and held in position against a tube by means of a screw cap. The lens and tube assembly is held rigidly in a bracket, with provisions for adjusting the tube at time of manufacture to allow for variations in the focal length. The image of the reticle is projected by the lens out to the traverse mirror as a parallel beam of light. Because of this, the reticle image appears in the same plane as the target, eliminating parallax between target and reticle. This collimated image forms the reference point which

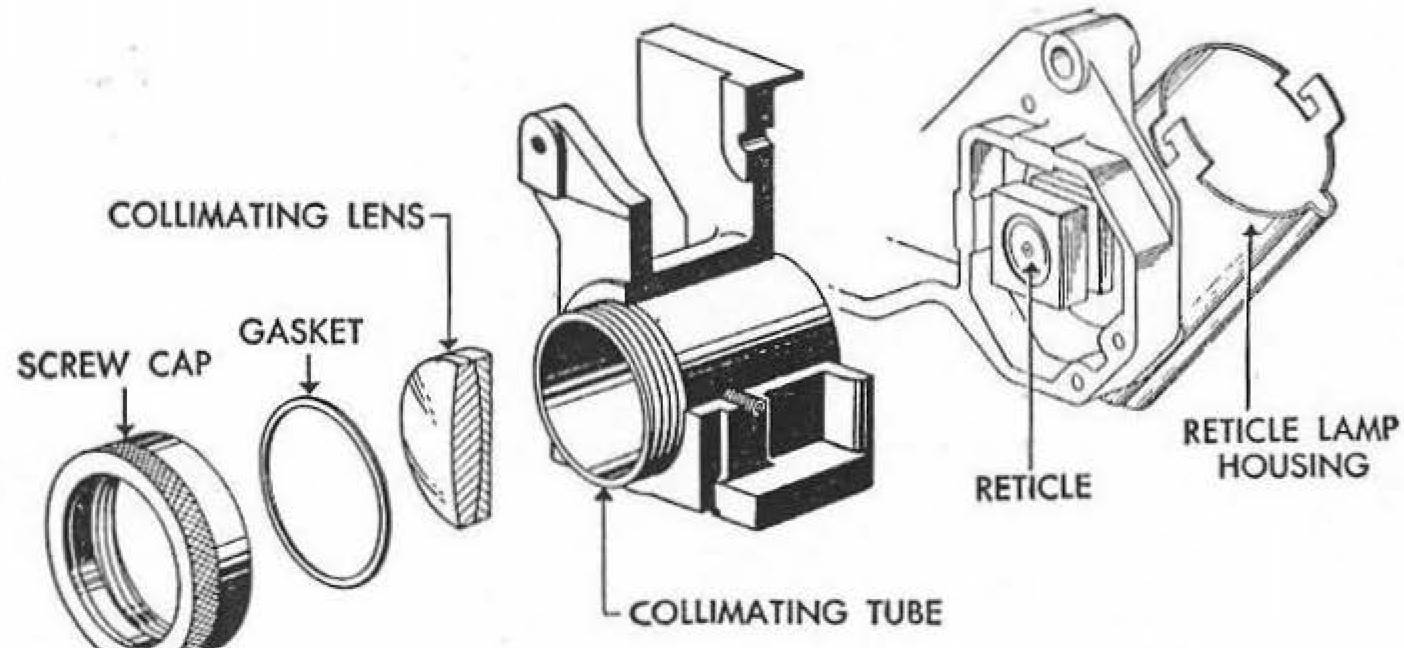

Figure 55.—Collimating Lens Assembly.

establishes the line of sight, the axis of which is disturbed by the action of the gyro-controlled mirrors.

Traverse Mirror: The traverse mirror has a highly reflecting alluminized front surface from which the projected reticle image is reflected onto the elevation mirror. It is mounted on pivots so that it is free to turn about an axis parallel to the gun bore when it is rotated by action of the traverse gyro lever.

Elevation Mirror: The clear glass elevation mirror located in the line of sight, reflects the reticle image back to the pointer's eye and at the same time allows the pointer to look through it and observe the target. Rotation of this mirror about an axis perpendicular to the line of sight is controlled by the elevation gyro lever.

When either mirror is moved to its limit in one direction, the reticle is shifted 25 degrees from its zero position.

Note: These mirrors should never be exposed to damp salt air. They should not be cleaned or touched by other than qualified personnel.

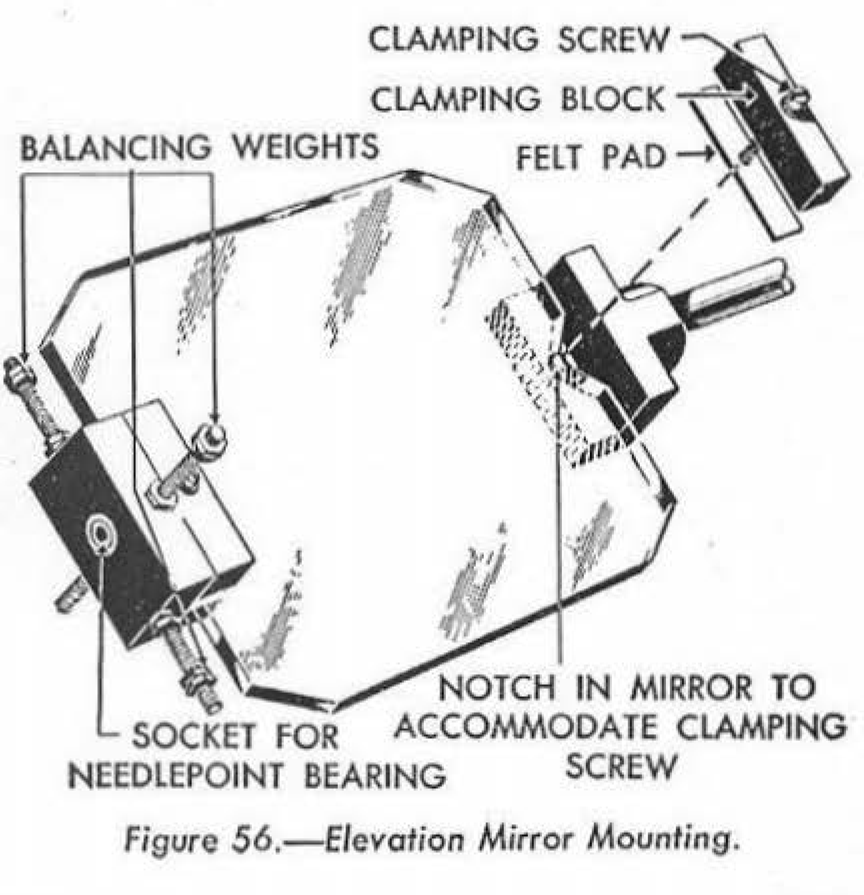

Figure 56.—Elevation Mirror Mounting.

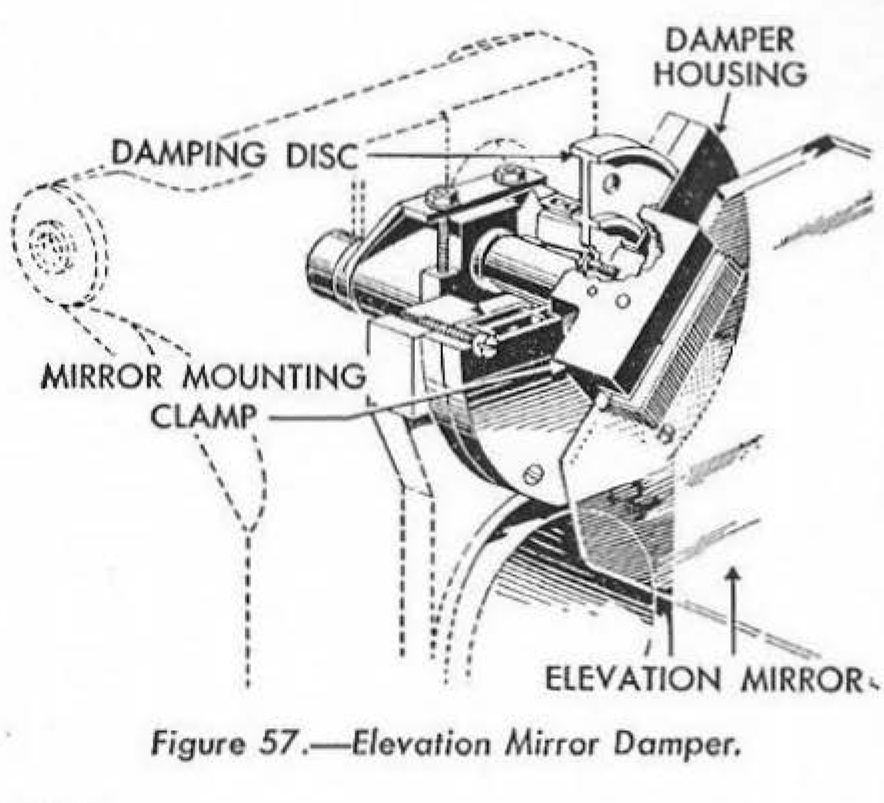

Figure 57.—Elevation Mirror Damper.

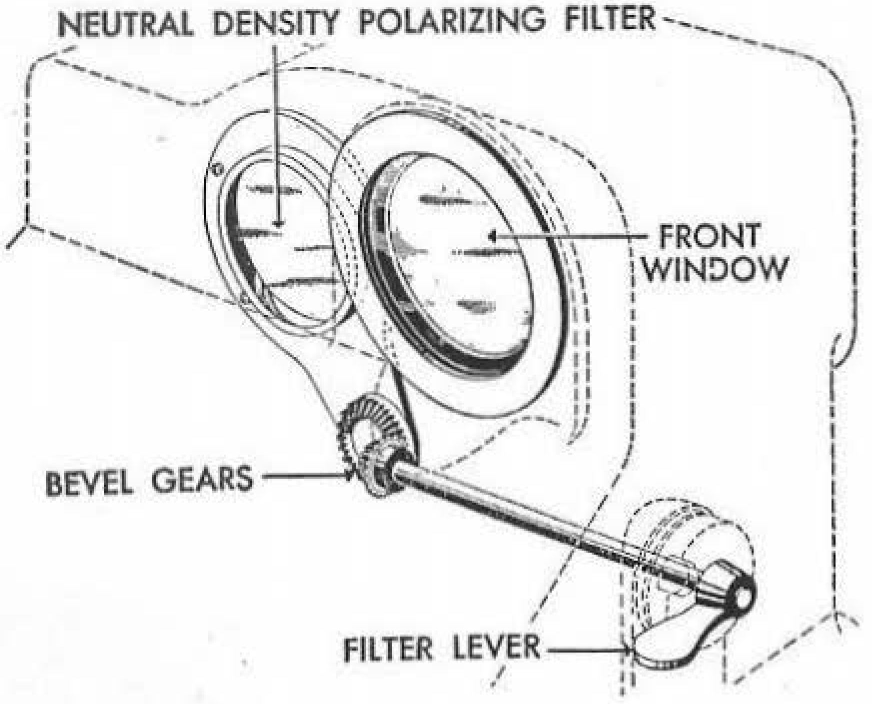

Figure 58.—Neutral Density Polarizing Filter Assembly.

Mirror Mounting: The mirrors are held in place by pairs of mounting blocks, one on either side of the mirror (fig. 56). One of each pair of blocks is attached to a mirror pivot and the other is free. Notches ground in each side of the mirror permit passage of a clamping screw which clamps the mirror solidly between the two blocks.

To prevent any erratic or rapid movements, a damping disc is rigidly attached to one of the pivots of each mirror. As the mirror rotates, the disc turns within a housing containing damping fluid (fig. 57). The resistance of the fluid against rotation of the disc slows the action of the gyro lever arm, thus smoothing or damping the mirror movements.

Optical Filter: A neutral density polarizing filter located inside the gun sight case may be swung into the line of sight to reduce the intensity of the sky background, or to minimize glaring reflections from the water. Rotation of the filter lever shaft, which terminates in a bevel gear, swings the filter, rigidly attached to another bevel gear, into position between the front sight window and the elevation mirror (fig. 58). A spring detent on the filter lever holds it in either of the two positions.

Windows: The two gun sight windows, front and rear, are of clear laminated glass. Both windows are mounted between gaskets in moulded recesses of the gun sight case, and are secured in position by retaining bezels (fig. 59). The rear window retainer is a molded frame with recesses between it and its retainer gasket to permit mounting of the check sight.

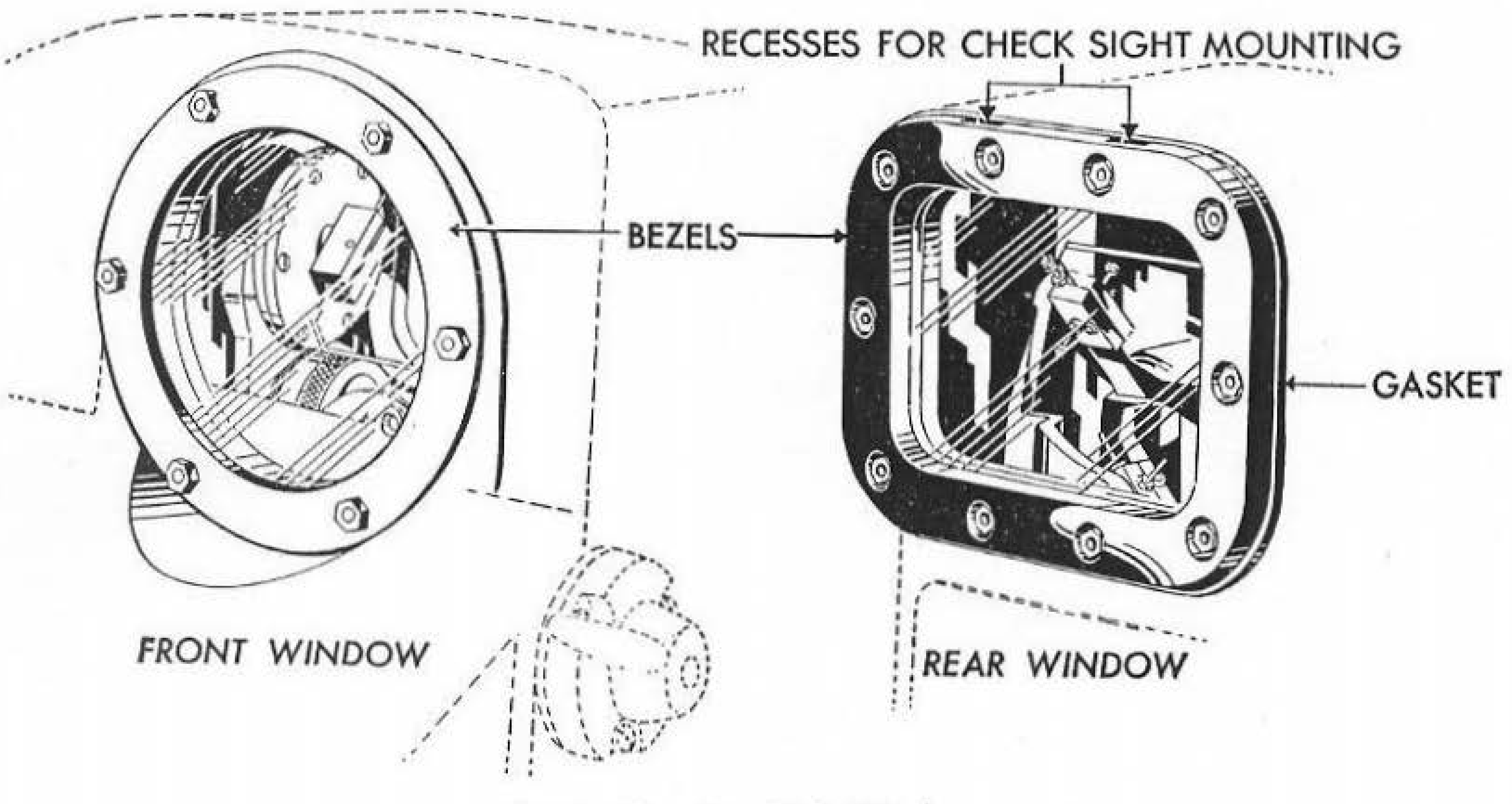

Figure 59.—Gun Sight Windows.

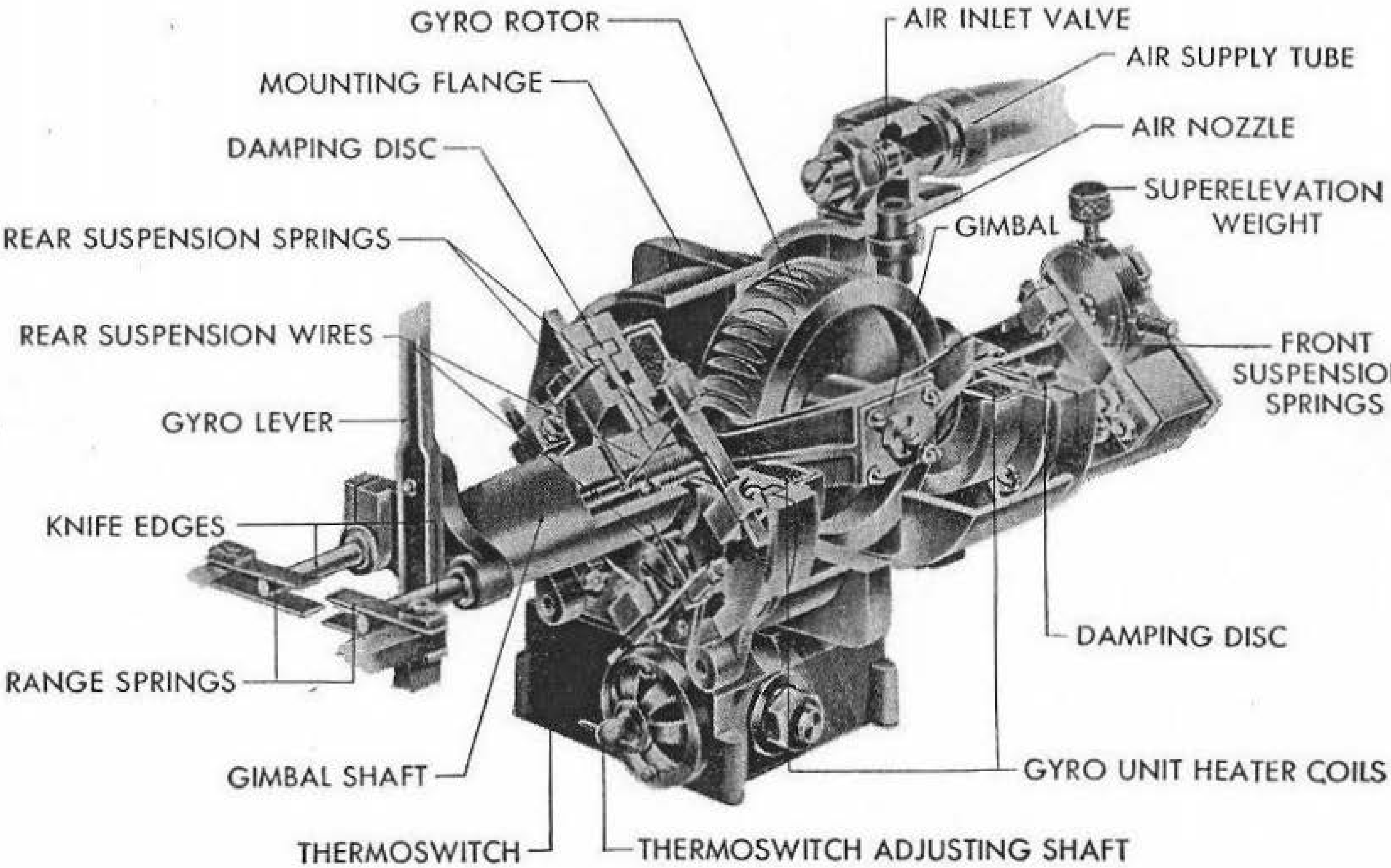

Figure 60.—Traverse Gyro—Cutaway.

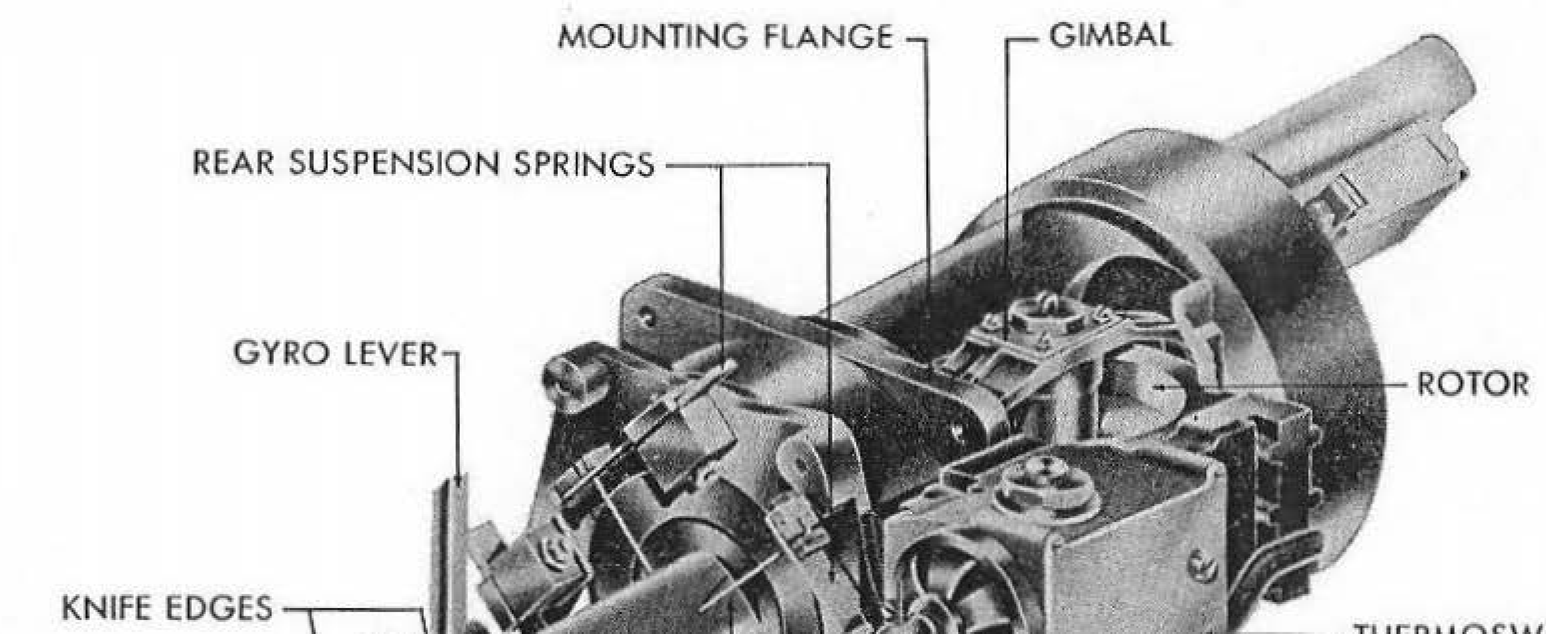

Figure 61.—Elevation Gyro.

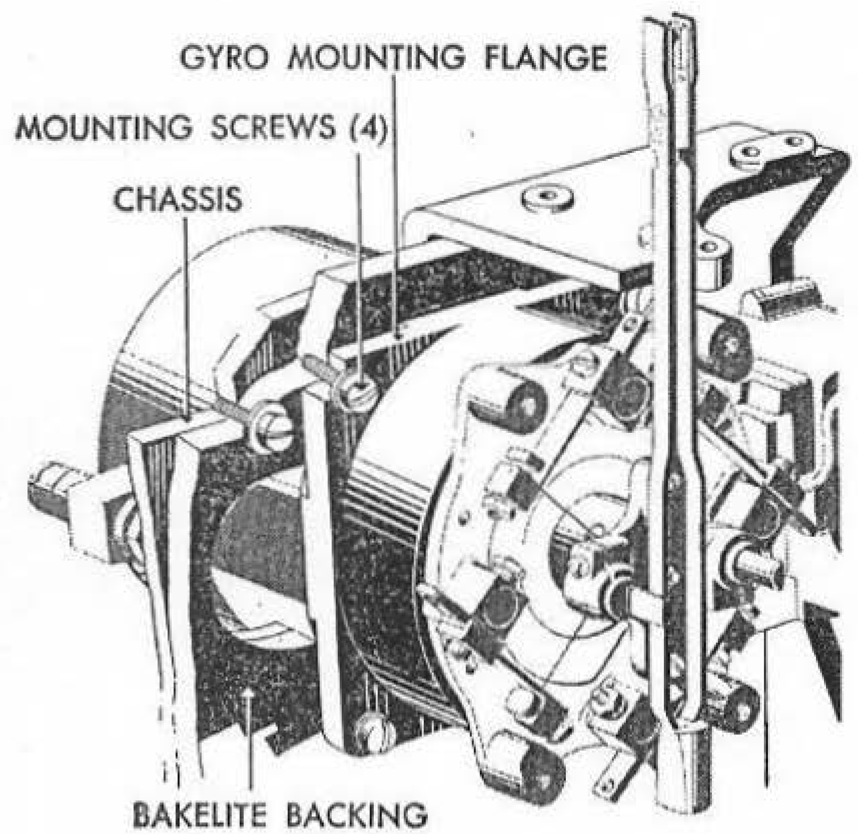

Figure 62.—Gyro Mounting.

Gyro Mechanism

Gyro and Gimbal: The gyro system consists of two rate-of-turn gyro units, one the traverse gyro (fig. 60) and the other the elevation gyro (fig. 61). The gyros are driven by air; their rotor shafts mounted in ball bearings in a gimbal frame. Buckets in the periphery of the rotor build up maximum spin velocity from the driving air stream directed on the rotor by a needle valve located at the end of the air supply tube. The entire rotor assembly is carefully balanced in a special dynamic balancing fixture before assembly.

The aluminum gimbal frame (figs. 60 and 61), free to rotate through a small angle about the gyro output axis, is suspended by the gyro output shaft, which is rigidly fastened to the gimbal frame and protrudes from either end.

Adjustable screw stops prevent the gimbal frame from striking the gyro housing when the gyro precesses, restricting the precession to 2.5 degrees. In effect, these stops determine the limits of rotation of the spin axis about the output axis. A greater allowable angle of precession would permit smaller multiplication to obtain final lead angle, but the accuracy of measurement by the gyro would be reduced. Within the limit of 2.5°, the angle of precession is in extremely accurate proportion to the angular rate.

Gyro Housing: Each die-cast gyro housing is positioned in the gun sight chassis by four mounting screws (fig. 52). The mounting flange, cast integrally with the housing, is located approximately at the center of gravity of the complete gyro unit. Bearing against a sheet of linen-base bakelite, the arrangement of the mounting flange facilitates replacement of the complete gyro unit for maintenance purposes.

Gyro Spring Supports: The rear end of the gyro output shaft is suspended in the gyro housing by two short lengths of piano wire (0.005 in. approx.) stretched between cantilever supports fastened to the case of the gyro (fig. 63). When mounted, the two wires form 90° angles with each other in a plane parallel to the damping discs. The front end of the gyro output shaft is supported by a single strand of 0.015 inch piano wire stretched along the axis of the output shaft. Each end of this wire is attached to a cantilever spring supported from the gyro housing (fig. 64). The wire passes through a plate at the end of a cup-shaped stud attached by four screws to the output axis. Two allen set screws entering the plate 180 degrees apart clamp the wire in position. This arrangement permits the cantilever springs to absorb the fore-and-aft shock of gun fire.

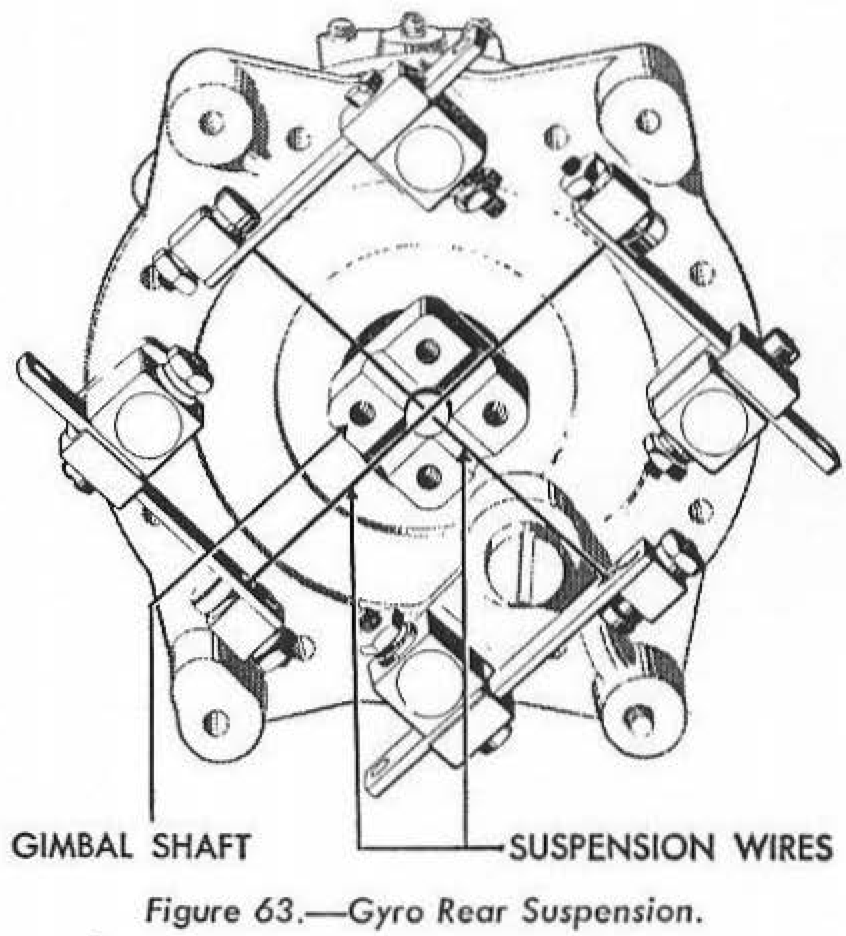

Figure 63.—Gyro Rear Suspension.

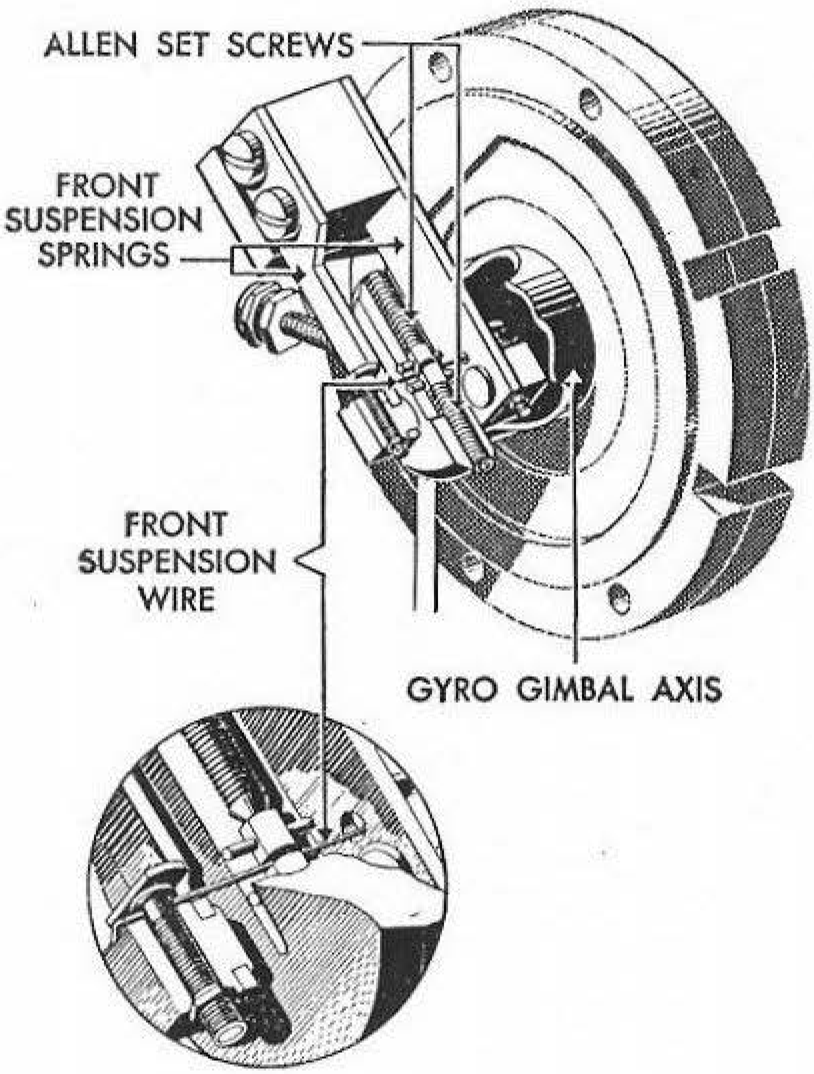

Figure 64.—Gyro Front Suspension.

For the small degree of rotation permitted the output axis, this suspension provides practically frictionless support.

Damping Discs: Smoothing action is applied to the gyro unit by means of a viscous damper in each end of the gyro case. Damping discs, which rotate in a housing partially filled with damping fluid, are fastened to the gyro output shafts (fig. 65). Any angular rotation of the gun sight causes the rotor to tilt, resulting in a small rotation of the gimbal frame and gyro output shafts. This rotation causes the damping discs to move in the damper housings, and, because of the viscosity or stickiness of the damping fluid, the rate of movement is retarded.

Resistance offered to the discs by the damping fluid is increased as the velocity of motion is increased, and as the temperature of the damping fluid is decreased. Thermostatically controlled heating units are attached to each damping unit to eliminate any variables due to temperature change. These heating units, which maintain the damping fluid at a temperature of approximately 140° Fahrenheit, consist of electrical resistance wire imbedded in ceramic material.

Only the lower section of the damping disc housing contains damping fluid when the sight is horizontal. Angular recesses are cut into the mating faces of the housing, and provide a reservoir into which the fluid runs when the gun sight is elevated above horizontal. This prevents the fluid from running out around the output shaft, and eliminates the need for a packing gland.

Note: Although the fluid will remain in the damper housing when the gun sight is elevated, it is essential that the sight be secured in an approximately horizontal position to prevent settling of the damping fluid in the recesses, thereby eliminating the need for an abnormally long warm-up period.

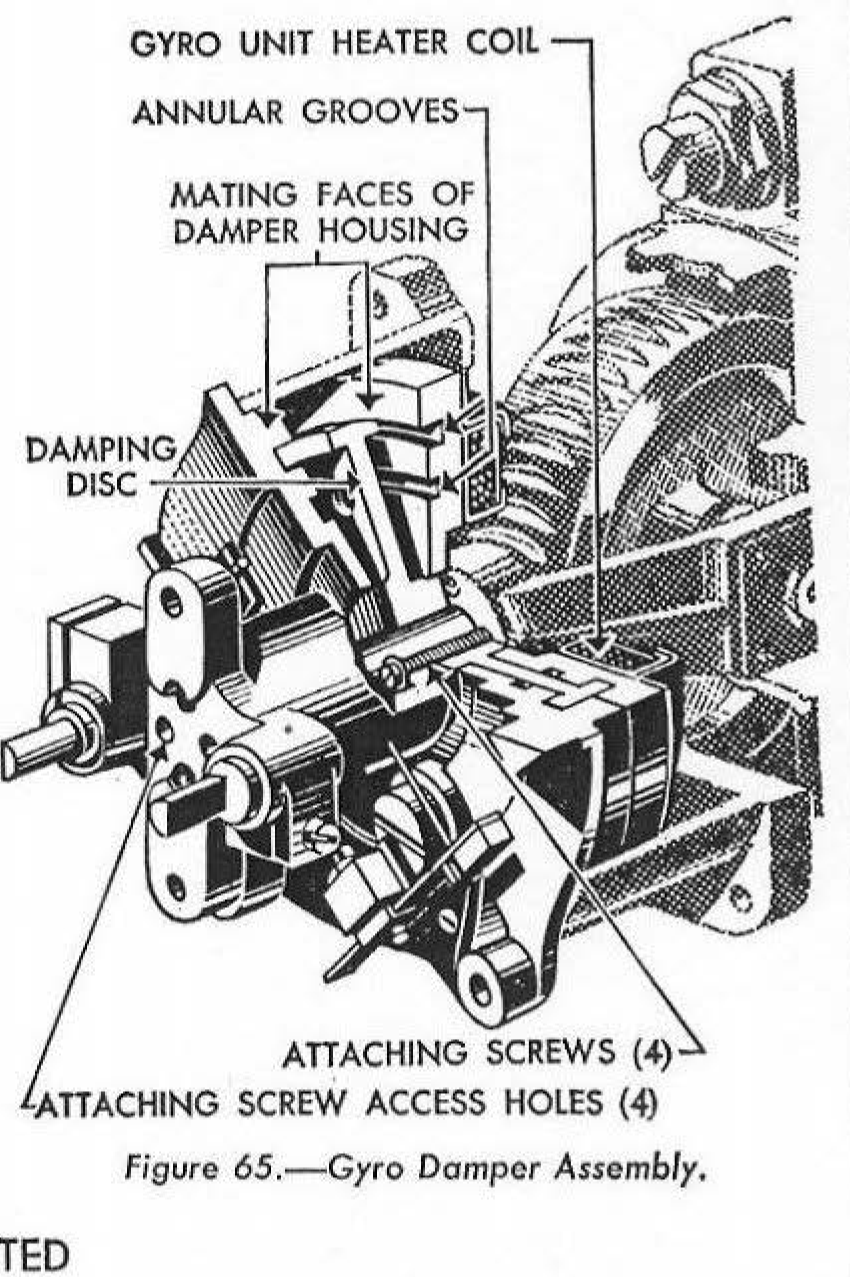

Figure 65.—Gyro Damper Assembly.

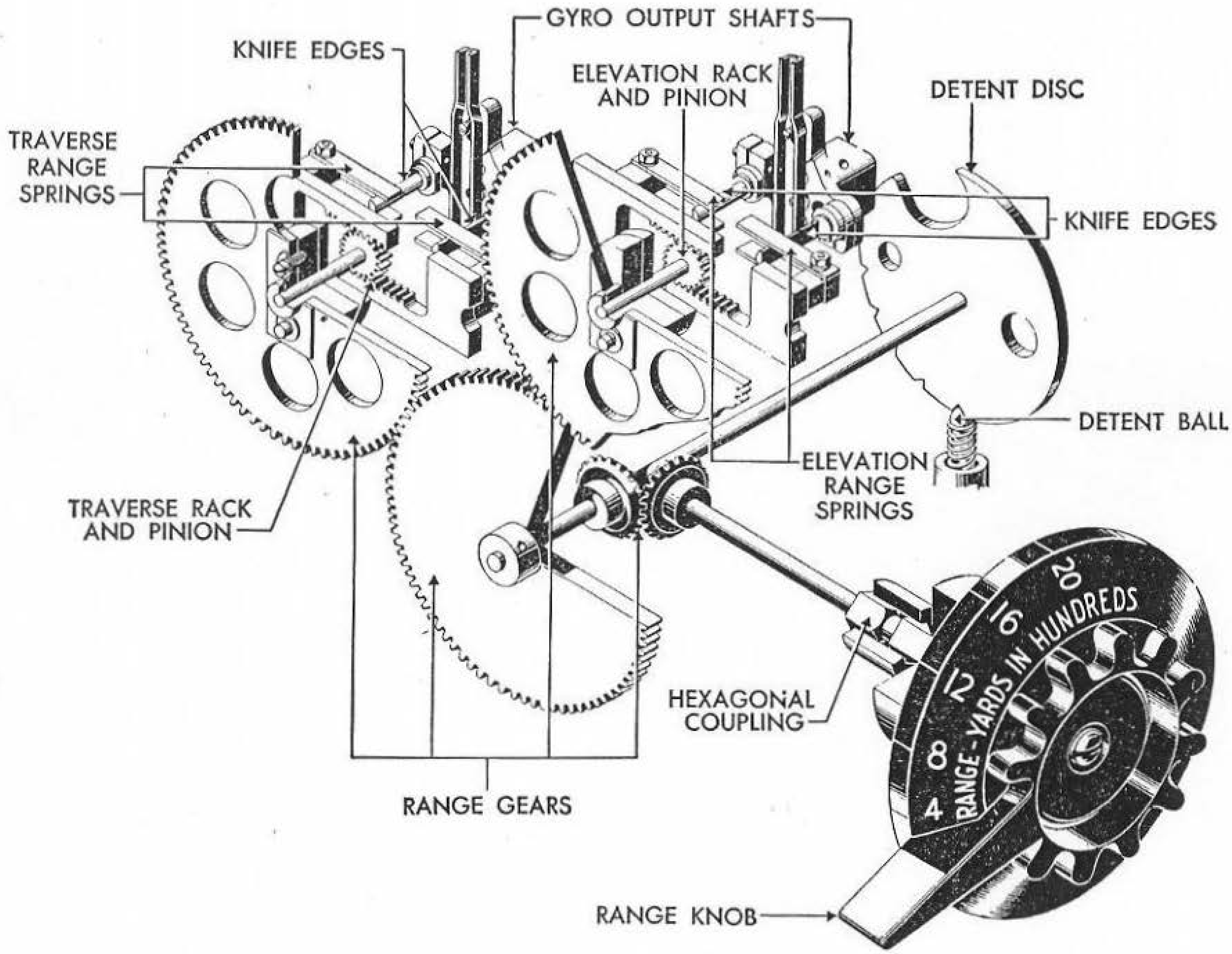

Figure 66.—Range Gearing.

Range System: The range adjustment system provides a means of varying the spring restraint on the gyros, which, as described in chapter 2, must be varied in proportion to the range so that the allowable gyro tilt will result in the correct lead angle.

By means of a gear train, rotation of the externally located range knob turns equally, two identical spur gears (fig. 66). One of these spur gears controls the elevation gyro range unit, and the other controls the traverse gyro range unit.

A yoke, supporting knife edges, is attached to the output axis of the gyro. These knife edges rest between cantilever springs supported at one end by the gyro housing. Rotation of the range spur gear moves the parallel cantilever spring supports together or apart by means of a rack and pinion arrangement.

When the range knob is turned to a low setting, the two spring assemblies are moved closer together, increasing the spring restraint on the gyro. Thus, precession of the gyros is decreased, and a smaller lead angle is generated. When the range knob is turned to a high setting, the spring supports are shifted apart, allowing greater spring deflection of the knife edges under a given angular rotation of the gun sight. This permits the gyro to precess to the larger angle required for the longer range.

The range knob is graduated in 400-yard increments. A spring-loaded detent engages the detent disc at each graduation (fig. 66). Operation of the range knob rotates the disc. Because each Mod is designed for specific ballistics, the range knobs are calibrated to different maximum figures.

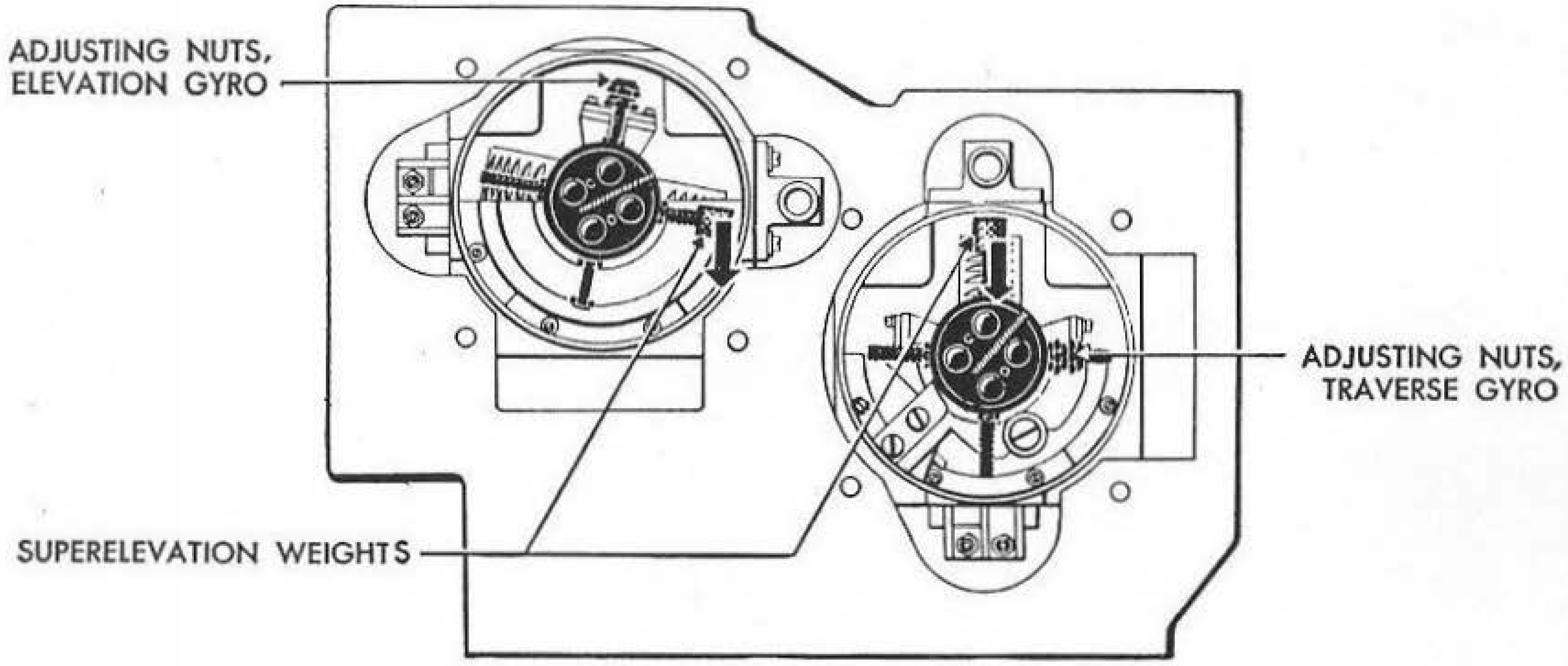

Figure 67.—Superelevation Weights.

Superelevation Weights: To introduce the superelevation correction (described in chapter 2) superelevation weights are installed on both the traverse and the elevation gyros (fig. 67). The weights are installed on the output axes of both gyros, so that, when the effect of one is reduced by a roll or pitch of the ship, the effect of the other is increased in proportion to give the proper total correction.

The elevation gyro superelevation weight is screwed on a threaded shaft extending to one side of the gimbal axis. When the gun sight is horizontal, the deflection of the gyro caused by the weight is at maximum. As the angle of elevation increases, the effect of the weight decreases with the cosine of the angle of elevation, becoming zero when the sight is pointed to the zenith. Variation of the spring restraint on the gyro also varies the effect of the superelevation weight in proportion to range.

The weight for the traverse gyro is directly above the gimbal axis when the gun sight axis is horizontal. Whenever the weight is tilted to one side or the other by roll or pitch gyro precession is caused proportional to the degrees of deviation from the normal to nullify the reduction in the effect of the elevation gyro weight. The superelevation component is introduced independently of the lead angle. Thus, the reticle image in a stationary gun sight is positioned according to the amount of superelevation. When a target is tracked, the resultant reticle position represents a combination of superelevation and lead angle.

Note: The nuts shown attached to the other studs on the gyro axes are adjusted at the time of manufacture to balance the gyro and to obtain the correct angle of precession for each value of spring restraint. These should not be moved unless the entire gun sight is to be recalibrated.

Mirror Linkage: Because the motion of the gyro output shaft is restricted, as described previously, a provision for angular multiplication between the gyro gimbal shaft and the corresponding mirror is necessary to obtain the required lead angle in the field of view. The correct multiplication factor is inserted by the ratio between the lengths of the gyro lever arms and the mirror cranks. The gyro lever arm lengths are designed to give a lead angle of approximately 25° under a gyro deflection of approximately 2.5°.

A spring fork on the outer end of the traverse gyro lever engages a ball, providing point contact, attached to the mirror crank. The mechanical linkage for the elevation mirror is similar to that of the traverse mirror, except that a bell crank (fig. 68) is placed in the system to change the direction of motion of the lever so that it rotates the mirror about an axis perpendicular to the elevation gyro axis.

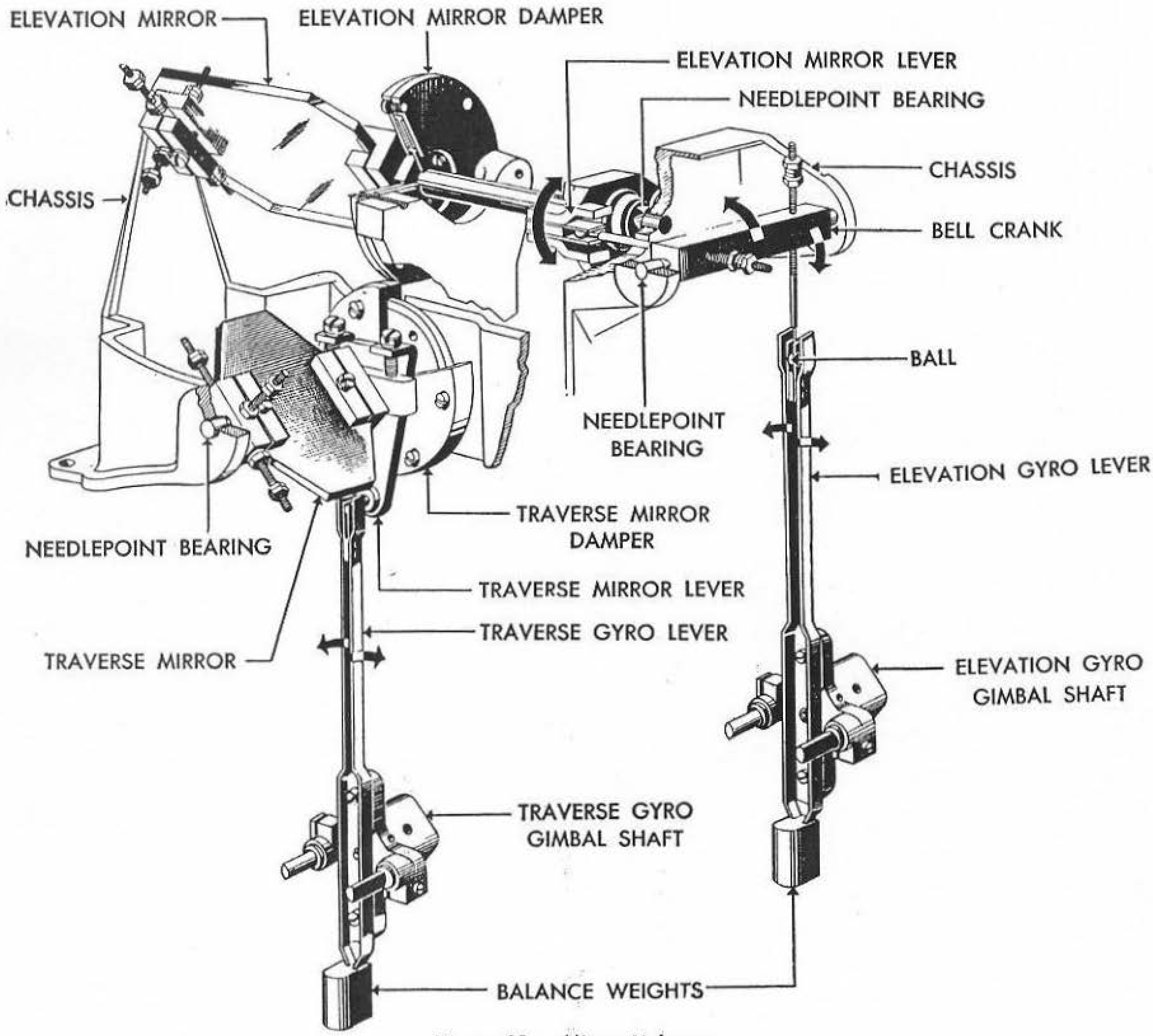

Figure 68.—Mirror Linkages.

Caging: The gyro caging system may be field installed on any of the modifications of Gun Sight Mk 14 in accordance with NAVORD OD 2298, the only difference in the various installations being the method of attachment of the caging valve or button. The caging system is air operated, the air being taken from the gyro air drive line by a T located within the sight case. A tube from the T leads through a spacer under the air return fitting to one side of a duplex tube which connects to a normally closed button-operated valve. Pressure on the button opens the valve, allowing air to return through the second side of the duplex tube to a cylinder mounted just behind the gyro levers of each gyro. Air pressure entering the cylinders spreads the two pistons in each, causing a finger to close on each side of the gyro lever, positioning it and prohibiting movement. Set screws on each side of the cylinders permit centering adjustments of the gyro lever by restricting the distance to which each piston may extend under pressure. On Mod 8, the operating button is mounted on the left handle bar of Gun Director Mk 51 Mod 2. Locations of the valve vary with other installations, but general construction remains the same.

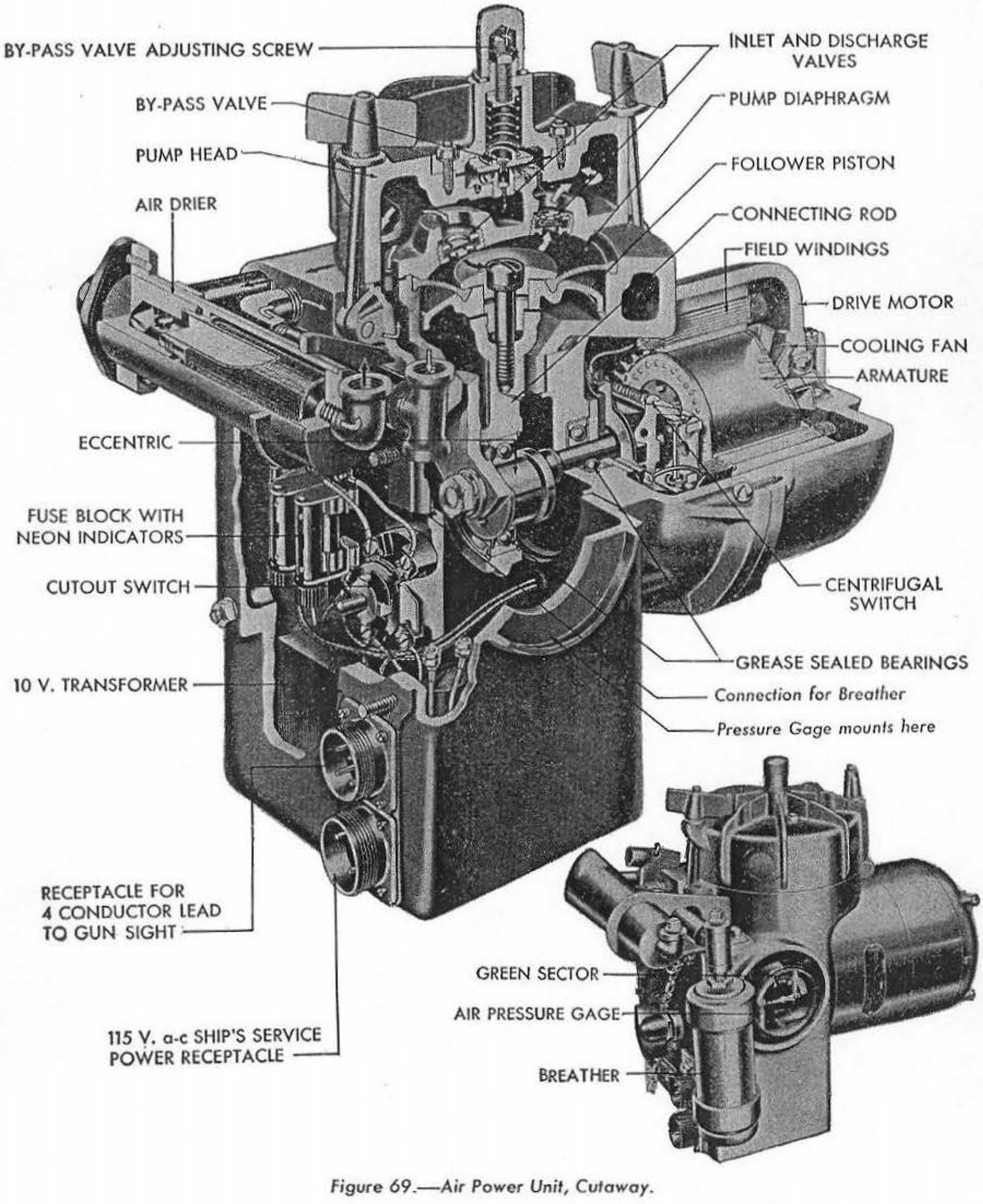

Figure 69.—Air Power Unit, Cutaway.

Air System

The major function of the air power unit (fig. 69) is to supply clean, dry, compressed air for driving the gyros of the gun sight at a nearly constant pressure. In addition, this unit serves as a central point for all of the sight's electrical power and fuse requirements. The same power unit is supplied for use with Gun Sight Mk 14 Mods 6, 7, 8, 12, 13, 14, and 15, except that different lengths of hose and cable are required for Mods 6 and 15.

Air Pump Motor: The pump is driven by a 115-volt, 60-cycle, 1/10-hp, split-phase induction motor, of waterproof construction, operating at 1750 r. p. m.

There are two windings on the motor stator: a running winding for continuous duty, and a starting winding. Centrifugally operated spring contacts (fig. 69) energize the starting winding whenever the motor is running at less than normal speed. This additional winding provides greater torque through an out-of-phase component to bring the motor up to speed.

Eccentric: To convert the rotary motion of the motor shaft into the reciprocating motion of the pump piston, an eccentric is mounted on the end of the motor shaft (fig. 70). The motor shaft extends through a grease-sealed ball bearing into the crankcase of the air pump. A counterbalance attached to the eccentric neutralizes the pounding movement of the off-center mounting of the eccentric. A connecting rod, leading from the piston, is attached to the eccentric by a grease-sealed radial ball bearing.

Diaphragm and Piston: Movement of a rubber diaphragm (fig. 70) at the end of the piston admits air into the pump chamber on the down stroke, and compresses the air on the up stroke.

The piston actually pumps no air, but serves as a means of raising and lowering the diaphragm, as well as acting as a mechanical support. The circumference of the rubber diaphragm is firmly mounted in a recess in the head of the air power unit.

Whenever the center of the diaphragm is raised, by means of an upward motion of the piston, air is displaced and discharged under seven and one-half p. s. i. from the pump through the discharge valve

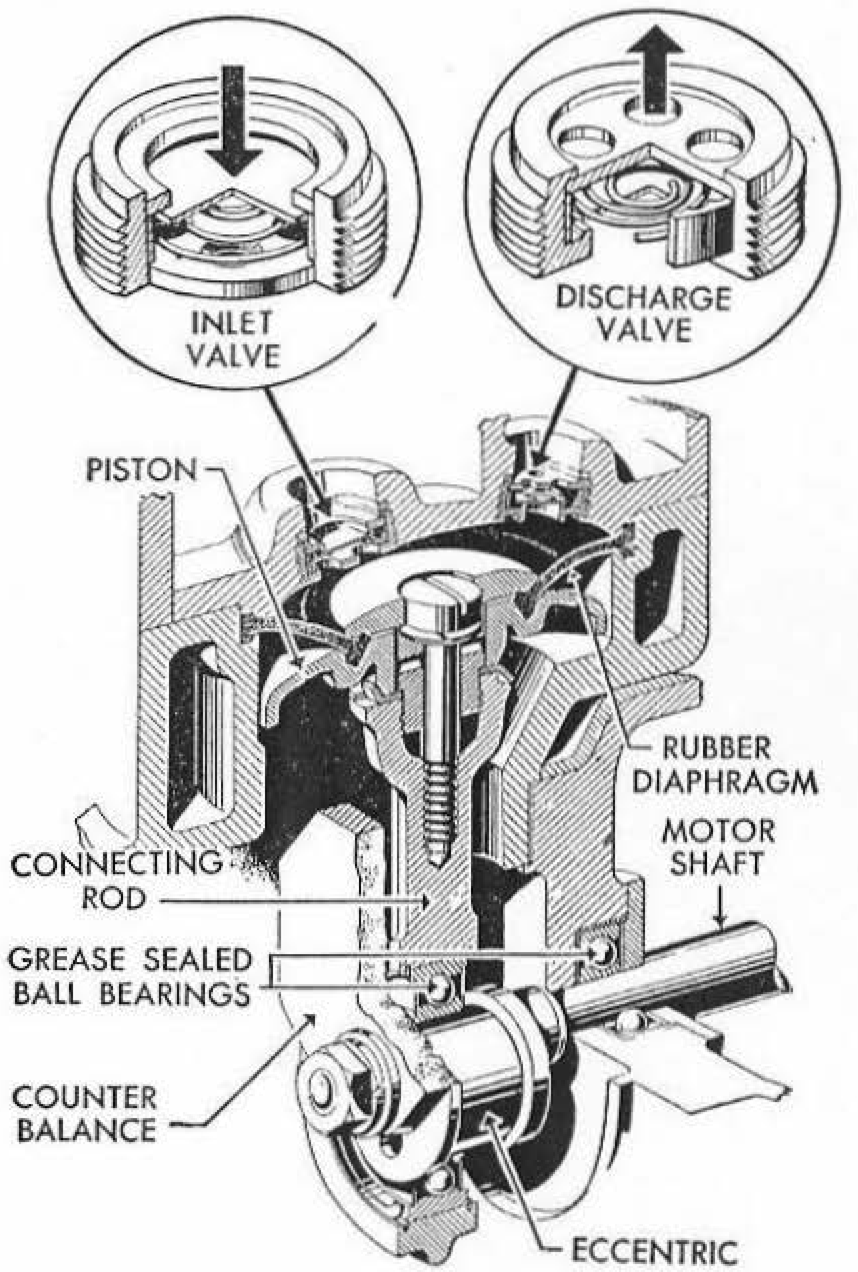

Figure 70.—Air Pump Details.

(fig. 70). As the piston and diaphragm are lowered, the discharge valve closes, and air is admitted through the intake valve to complete the cycle (fig. 71). The intake and discharge valves are not mechanically actuated, but are controlled by the air pressures created by the movement of the diaphragm.

Bypass Valve: The bypass valve (fig. 72) for maintaining a regulated air supply, is located in the head of the pump. This valve normally will remain closed under the pressure of a compression spring. If the pump discharge pressure exceeds that for which the bypass valve is set, the valve will open, and air will be discharged to the intake side of the pump. When the pressure drops below the set pressure, the bypass valve again will close. Automatic regulation of discharge pressure is effected by this means. The compression spring may be easily adjusted so that the pressure at which the bypass valve opens can be regulated to 7 ± 1 p. s. i.

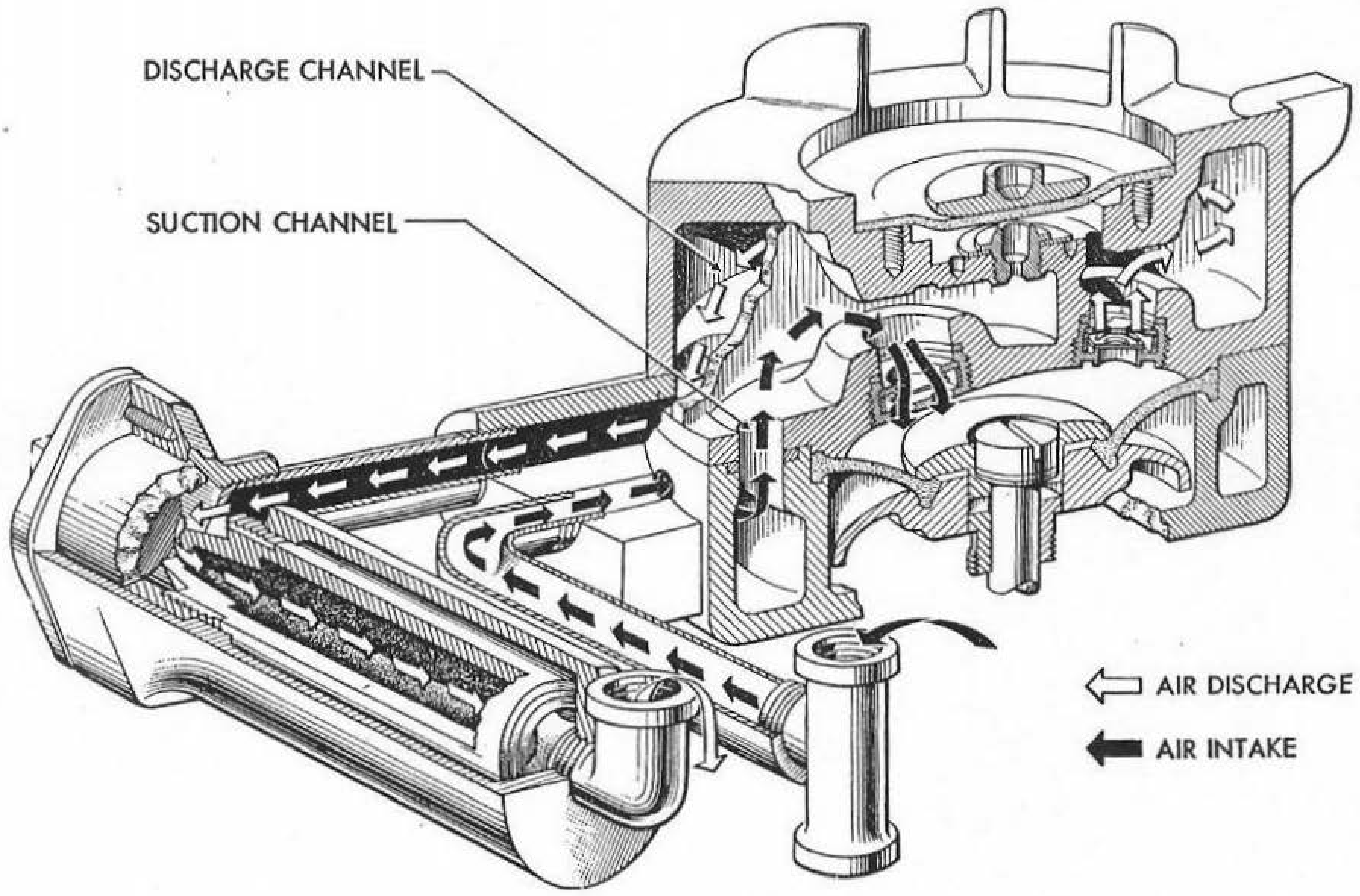

Figure 71.—Air Channels.

A pressure gage, mounted in the crankcase of the unit, indicates the pressure delivered by the pump. When the needle points to the green sector (which represents 6 to 10 p. s. i. above atmosphere), the output is correct.

Air Drier: From the discharge port in the pump head, air delivered by the action of the diaphragm is piped to the air drier. The air drier (fig. 73) consists of a cylindrical housing which contains a wire screen or porous bronze tube filled with an indicating type silica gel.

Silica gel has the property of absorbing moisture from the air. A chemical indicator has been added to the silica gel in the drier unit, so that it has a bright blue color when it is not saturated with moisture. When it becomes saturated and loses its absorbing properties, the silica gel becomes pink in color, and must be replaced, or removed and dried.

When the silica gel becomes saturated, the mois-

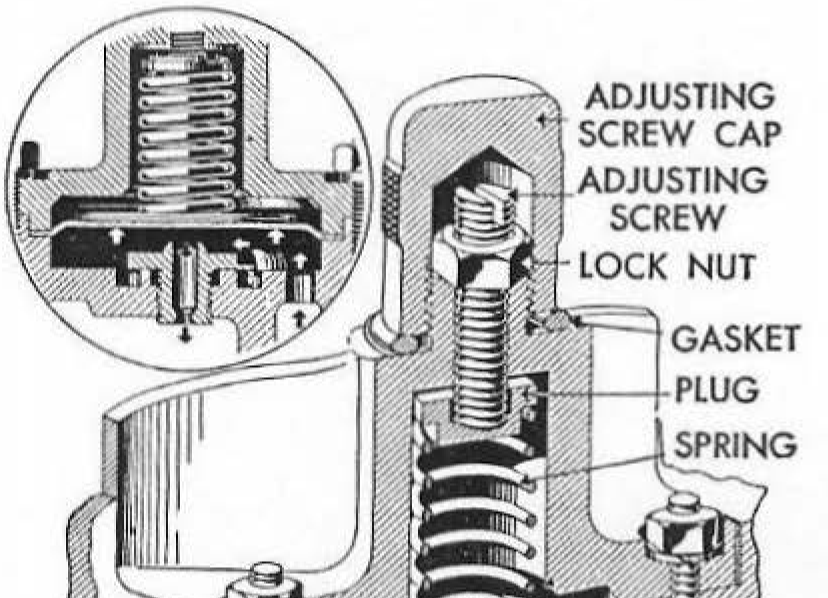

Figure 72.—By-Pass Valve.

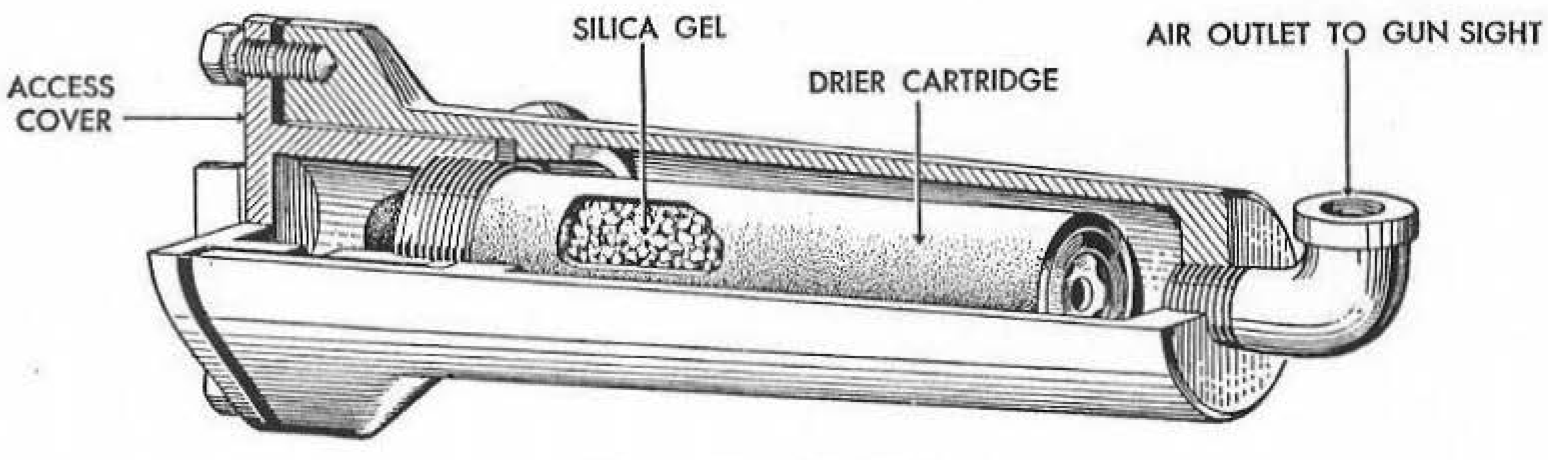

Figure 73.—Air Drier.

ture it contains can be removed by heating it in an oven at a temperature of 300° Fahrenheit for approximately 4 hours. When the silica gel is activated (completely dried), it regains its original blue color, and may again be used in the drier assembly.

At the end of the drier housing, an access cover is held in position against its gasket by two cap screws. Removal of these cap screws allows the cartridge containing the silica gel to be withdrawn from the housing for inspection or replacement.

After passing through the air drier, the air travels to the gun sight through an air hose.

Air Pressure Regulator: An air pressure regulator (fig. 74) is located in the gun sight to eliminate the effects of the air supply pressure variations. Proper operation of the sight requires that air at a constant pressure be supplied to the gyros to maintain constant gyro rotor speeds.

This pressure regulator has the effect of smoothing out the air supply and operates on a principle similar to the bypass valve previously described. The regulator is adjusted by means of an adjustment screw which varies the tension of the compression spring holding the regulator diaphragm in position. It should be adjusted to deliver 2¼ p. s. i. (31 in. water) to the gyros. A test gage is furnished for this adjustment.

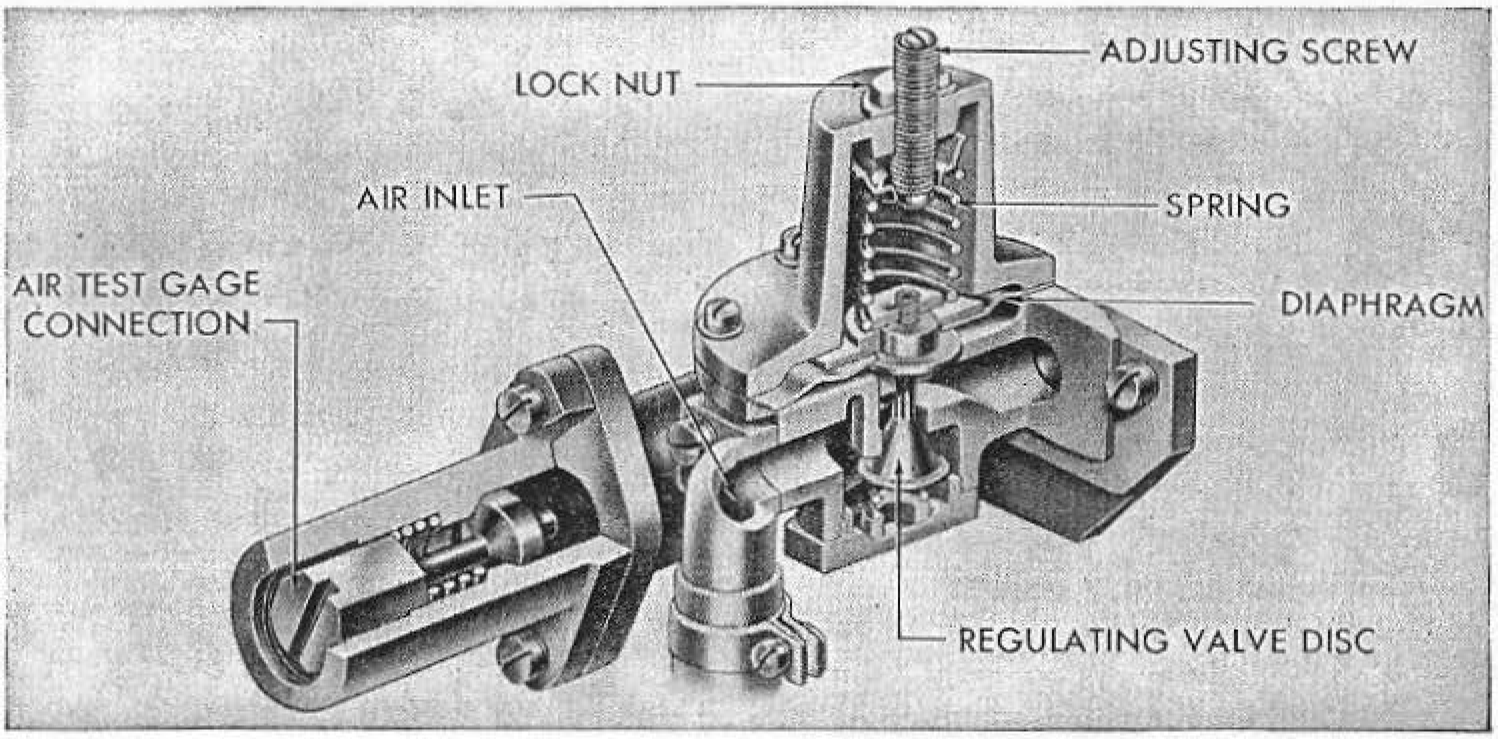

Figure 74.—Air Pressure Regulator

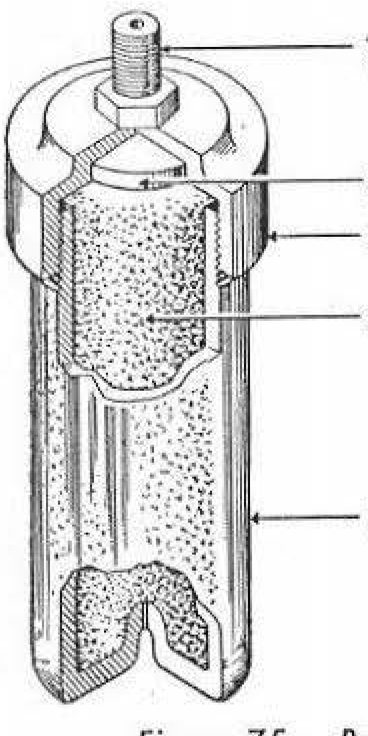

Figure 75.—Breather.

Intake Breather: An intake breather (fig. 75) is installed at the inlet connection to the power unit permitting air to enter or be exhausted from the system, so that approximate atmospheric pressure is maintained in the gun sight housing. If the breather is not installed, defective operation of the air system might result in the creation of either a partial vacuum or excess pressure in the gun sight. Either would change the operating characteristics of the gyros and, in the case of a partial vacuum, would force harmful salt air into the housing. The intake breather is filled with an indicating type silica gel to dry air which may enter the system.

Caution: The installation of the air power unit, together with the gun sight, must include one intake breather located either in the gun sight or in the air power unit. Gun sights which require a power unit with breather are marked with a decalcomania, as shown in figure 43.

The intake breather, attached near the air inlet to a pipe tee on the intake coupling, consists of a transparent plastic cylindrical container which is held in position against a neoprene gasket by a screw cap. The intake breather may be refilled with activated silica gel when necessary.

Electrical Circuits

Located on the outside of the air power unit crankcase are two electrical receptacles and the power unit switch (fig. 45). The two-pole receptacle connects the ship's supply (115 volts A.C.) into the power unit, while the four-pole receptacle is connected to the gun sight by a four-conductor cable. The electrical wiring diagram of Gun Sight Mk 14 is shown in figure 76.

Power Unit Switch: The power unit cut-out switch is a single-pole rotary type, held in either of two positions by tension springs. Continuous rotation of the switch in either direction causes it to close and open successively. Closing the switch connects line voltage to the motor and gun sight. If standby wiring is provided, power will continue to be delivered to the gyro unit heaters although the cut-out switch is OFF.

Fuses: Two 5-ampere, midget cartridge-type, time-delay fuses are located in the crankcase to protect the 10-volt reticle lamp circuit. Access to these fuses may be had by removing the crankcase cover on which the power unit switch is mounted. Neon indicators, mounted on the fuse block (fig. 117), light when a fuse is blown.

Air Heater and Thermostat Switch: The gyro units and the air supply must be maintained at a constant temperature (approximately 120° Fahrenheit) to insure proper operation of the sight. This constant predetermined temperature is realized through a thermostatically controlled air-heater. A tubular, electrical air heater is formed so that it may be clamped directly around and underneath the gun sight chassis.

The heater consists of a single strand of high-resistance wire imbedded in an insulating ceramic material. An electrical terminal, also insulated from the tube wall, is provided at each end of the tube.

The inlet air supply tube is formed to present a maximum area to the base of the chassis and is mounted adjacent to the heater. The temperature of the incoming air passing through this tube, is raised to the proper value by heat conducted from the heater element through the chassis.

A thermostat, connected in series between the 150-watt air heater and line voltage from the air power unit, acts as a bimetallic temperature-sensitive switch, closing a circuit to energize the heater when

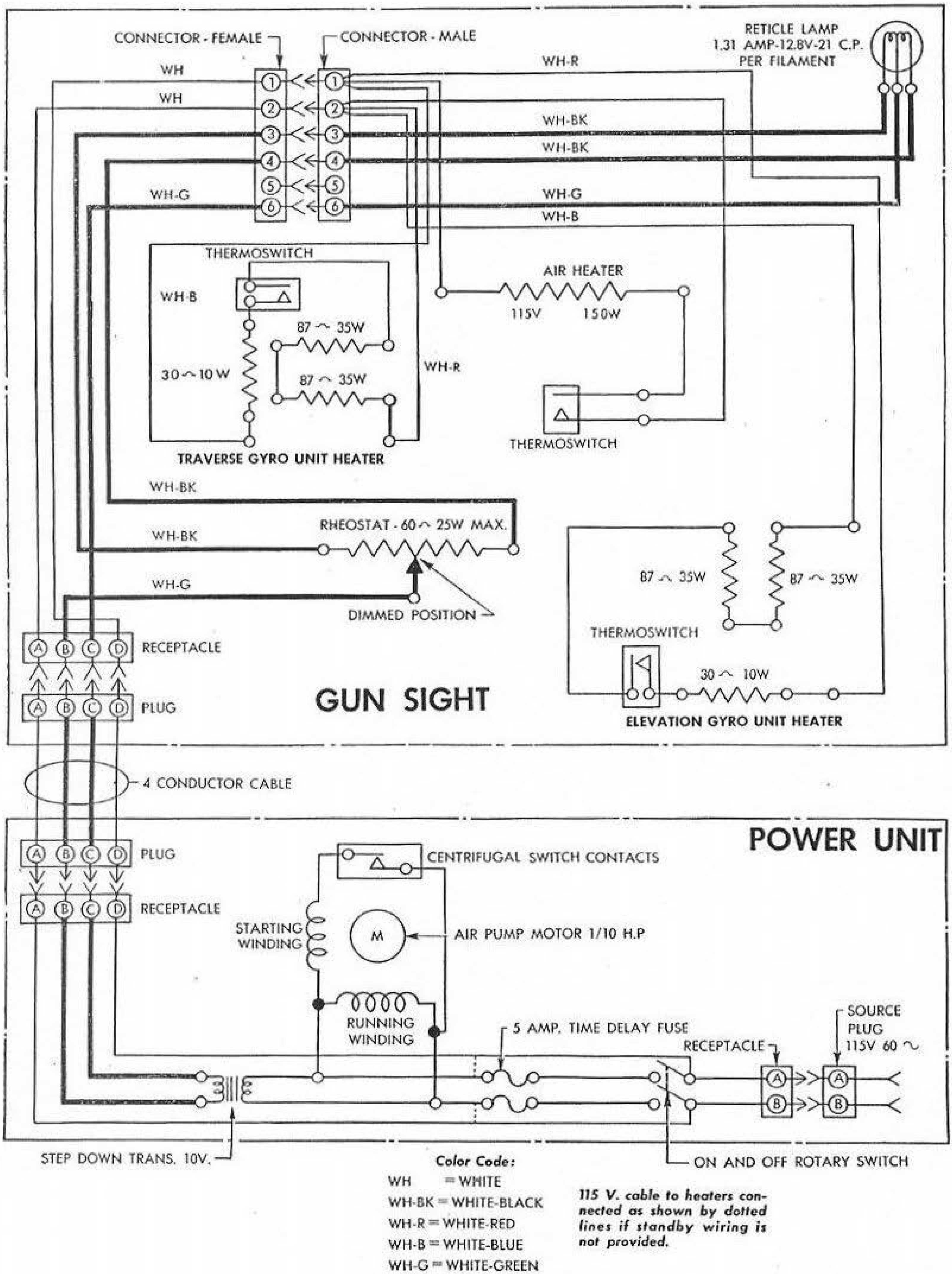

Figure 76.—Gun Sight Mk 14, Wiring Diagram.

the temperature in the gun sight falls below 115° Fahrenheit. Opening of the heater circuit is automatically accomplished by the thermoswitch when the temperature rises above 120° Fahrenheit. Adjustment of the operating temperature range of the thermoswitch is possible by means of an adjustment screw, which may be reached through an access cap in the gun sight case.

Gyro Unit Heaters and Thermoswitch: The correct viscosity of the damping fluid in the gyro units for proper damping characteristics is maintained by thermostatically controlled heaters. Viscosity may be defined as a measure of the "stickiness" of the damping fluid, and is directly dependent upon temperature. Each gyro has two 35-watt electrical heaters fastened to the two damping disc housings.

The gyro unit heaters consist of a coil of high-resistance wire imbedded in ceramic with a wire lead extending from each side of the coil. The two gyro heaters are in series with each other, a 30-ohm control heater, and the thermoswitch (fig. 77). Closing the thermoswitch causes heat to be emitted from the three heaters. A chamber adjacent to the control heater contains a liquid which expands when heated. This liquid is piped to a bellows which expands with the increase in liquid pressure. Expansion of the bellows operates a microswitch to open the circuit, thus de-energizing the control and gyro heaters. Loss of heat then causes the liquid to reduce pressure, allowing the bellows to contract, closing the microswitch. Close temperature regulation is obtained in this manner. The thermoswitch operating temperature may be adjusted through an access cap, by regulating the distance between the microswitch and the actuating bellows. The control heater, since it changes temperature sooner than the others and is closer to the liquid, causes the microswitch to operate before the temperature overshoots the required value, thus maintaining a more nearly constant temperature.

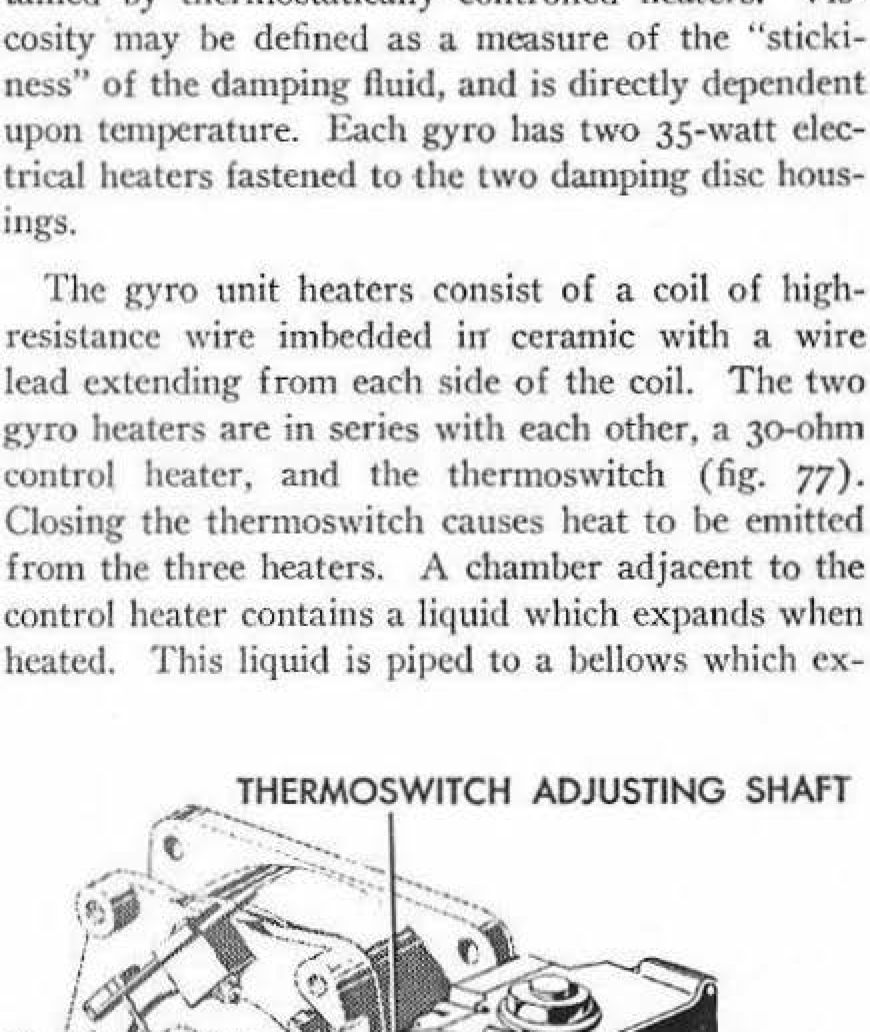

Figure 77.—Thermoswitch.

Standby Wiring: In some gun sights, to eliminate the necessity of a warm-up period, electrical power to the gun sight heaters and thermostats is supplied directly, bypassing the power units cut-out switch. In some cases, a snap switch may be provided at the ship's service receptacle from which the power cable is led. In this case, it is necessary to turn this switch on to place the equipment in standby condition. With standby wiring, the gun sight operating temperature is constantly maintained, allowing the unit to be placed in operation almost immediately.

Ten-Volt Circuit: Closing the rotary switch energizes, in addition to the stator windings of the motor as previously described, the primary side of the 10-volt step-down transformer which supplies power for the reticle lamp in the gun sight. The output of the secondary or 10-volt winding of the transformer passes through 2 poles of the 4-pole receptacle and its cable, to the gun sight. One lead is connected directly to the common filament terminal of the reticle lamp. The other terminal of each lamp filament is connected to each side of a 60-ohm rheostat. With the rheostat slider in its neutral or OFF position, the other side of the 10-volt line is connected to each filament through 30 ohms resistance. As previously described, operation of the rheostat from its neutral position will light one of the two filaments.

INSTALLATION

The different modifications of Gun Sight Mk 14 are installed on 20-mm antiaircraft gun mounts, Gun Directors Mk 51 Mod 2, and 40-mm antiaircraft single (power driven) mounts. The following discussion of installation refers mostly to the installation of Gun Sight Mk 14 Mod 6 on the 20-mm antiaircraft gun mount. Full instructions for mounting Mods 7, 8, 12, 13, and 14 on Gun Director Mk 51 Mod 2 appear in NAVORD OD 4424. Mod 15 is mounted on the 40-mm antiaircraft gun as described in Chapter 7.

To facilitate the installation of Gun Sight Mk 14 Mod 6 on the 20-mm antiaircraft gun mount, two brackets are provided with the sight. One of the brackets supports the gun sight itself on the gun cradle, and the other supports the power unit on the splinter shield. All required air hose and electrical cable, together with a third bracket to support them, are provided with the gun sight. Bolts, nuts, washers, and spacers needed for installation of the sight are included.

Mounting Pads

All 20-mm gun mounts are now furnished with properly machined surfaces for receiving the gun sight bracket and with the additional holes in the splinter shield needed for the installation of the power unit. Some of the older mounts do not have these provisions, necessitating the attachment of machined pads to the cradle to provide a mounting surface, and the use of C-clamps to install the power unit. For information on the installation of these mounting pads, refer to NAVORD OD 1186 and Ordnance Sketch 111237.

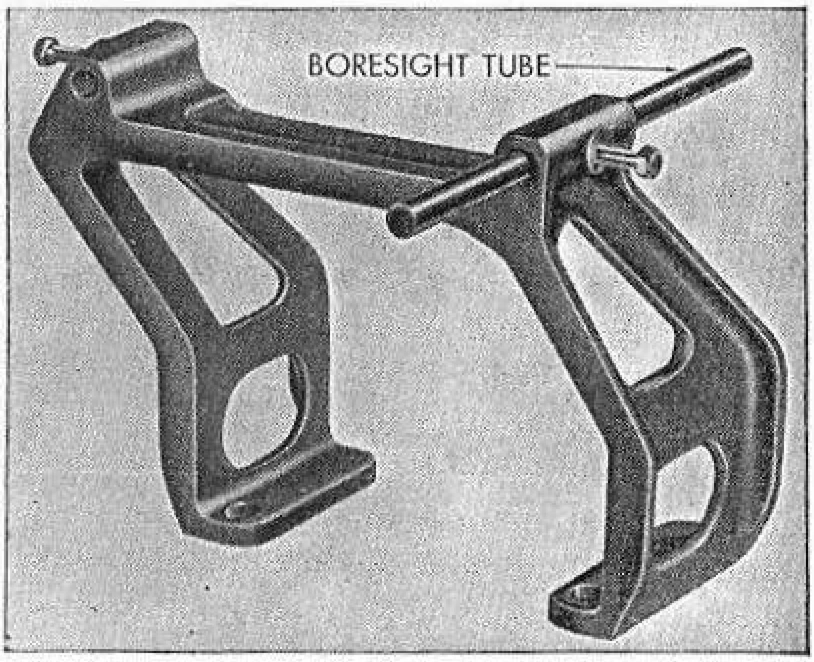

Figure 78.—Gun Sight Bracket with Boresight Tube Installed.

Gun Sight Bracket

The gun sight bracket (fig.78) is mounted on a machined surface on the gun cradle or, if surfaces are not provided, on the mounting pads referred to above. Before the mounting bracket is finally located, it must be boresighted with the gun barrel. Boresighting is accomplished by using the boresight tube (fig. 78) and the muzzle boresight (fig. 79).

Boresight Tube

The boresight tube consists of a hollow cylinder with a peep hole at the rear end and at the front end. When inserted in the right-hand support rod hole of the sight bracket, this tube establishes the line of sight through the bracket.

20-mm Muzzle Boresight Tool

The muzzle boresight tool (fig. 79) provides for the establishment of a line of sight parallel to the gun bore.

The muzzle boresight tool consists of a rod and plate supporting a small Weaver telescope parallel to the rod. The rod, when inserted into the forward end of the gun barrel, positions the telescope parallel to the centerline of the barrel. A conical bushing located between the support plate and the expansion nut takes up in the gun muzzle when the rod is inserted into the barrel and centers the rod there. An expansion nut is provided on the rod's inner end

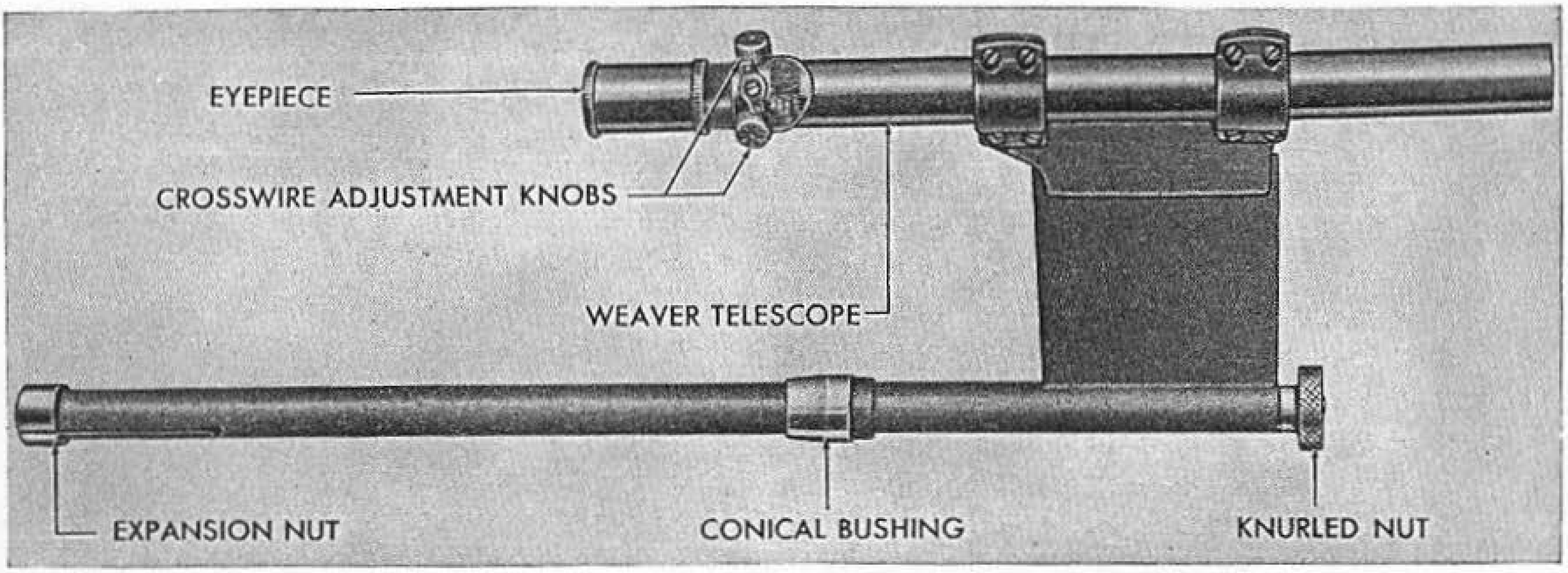

Figure 79.—20-mm Muzzle Boresight Tool.

to hold the rod centered in the barrel. Rotation of the knurled knob on the outer end of the rod will expand the nut until it fits tightly in the barrel.

The telescope installed on the muzzle boresight tool is a Weaver telescope, Type 29–S, with a magnification of 2½. The telescope reticle has a cross-line pattern scribed on a lens blank, and is provided with adjustment knobs to allow centering in the telescope. The telescope has an eye relief of 2½ inches. This means that if the eye is placed this distance behind the rear of the telescope, the full optical field can be used for sighting on the target.

Before installing the tool, turn the knurled knob counterclockwise, and press the bolt in to release the plunger from the expansion nut. This will allow the rod to be inserted into the gun muzzle until the conical bushing takes up the muzzle. Hold the rod so that the bushing fits snugly against the bore, and turn the knurled knob clockwise to spread the expansion nut and hold the rod in position.

Each time the muzzle boresight tool is used, it should be checked for parallelism. The crosswire lens may have shifted from its correct position since the tool was last used. To make this check, insert the tool so that the telescope is directly above the gun barrel, and sight through the telescope at some target at least 500 yards away. Holding the gun barrel in fixed position, rotate the tool 360° around the barrel and again sight. If the crosswires do not stay on the target, move the crosswire lens by means of the two adjustment knobs. Make the adjustment to correct for half the error. Move the gun barrel to bring the lines back on the target, and repeat the procedure. Continue adjusting until the crosswires stay on the target for any position of the tool.

With the boresight tube and the muzzle boresight tool properly installed, the gun sight bracket is ready to be aligned with the gun barrel.

Boresighting Gun Sight Bracket

The process of aligning the gun sight bracket with the gun barrel is called boresighting the bracket. The bracket is first adjusted in train so that the line of sight through the boresight tube in the bracket intersects the line of sight through the muzzle boresight tool at some point 1,000 yards or more from the gun (fig. 80). Aim the gun in train so that the vertical crosswires in the telescope of the muzzle boresight tool fall on the target. Adjust the position of the gun sight bracket so that the vertical wire of the boresight tube is also on the target.

With the gun sight bracket in this position, secure it with a C-clamp to the left-hand side of the cradle. Insert two ½-inch bolts into the two after holes, and tighten down with a nut and washer.

Ream the forward right-hand hole in the bracket upward through the previously drilled half-inch hole in the cradle. Use half-inch ream, making sure it passes through perpendicular to the surface of the bracket foot. Using a half-inch bolt, washer, and nut, pull the bracket up tight on the right-hand side.

Remove the C-clamp and similarly ream the hole on the forward left side. Secure with a bolt, nut, and washer.

Recheck the crosswires to see that they have remained in alignment. If they are out of alignment, loosen the bolts slightly, and tap the bracket in the proper direction to realign the crosswires; then, retighten the bolts.

Boresight the bracket in elevation by bringing the horizontal crosswires of the muzzle boresight tool and the boresight tube together. To do this, loosen the bolts and place shims under the bracket feet as necessary. When boresighting is complete in train and elevation, and the bolts are tightened, secure them with a cotter pin passed through each nut and bolt.

Power Unit Bracket

The power unit bracket is attached to the splinter shield of the gun, and supports the power unit. Use the two bolt holes provided in the splinter shield to make the attachment. Remove the two short lower bolts holding the splinter shield to its bracket, and secure the power unit bracket, inserting the longer (1½-inch) bolts provided through the same holes. If the splinter shield permits two possible locations for the bracket, use the higher location if the maximum depression of the gun is not thereby restricted.

If there are no bolt holes in the splinter shield, secure the power unit bracket with two C-clamps (BuOrd Number 325416-3). If C-clamps are used, they must be secured after tightening by passing a wire through the heads of all screws.

Caution: In placing the power unit bracket for installation, be sure to leave room for the use of the power unit tool.

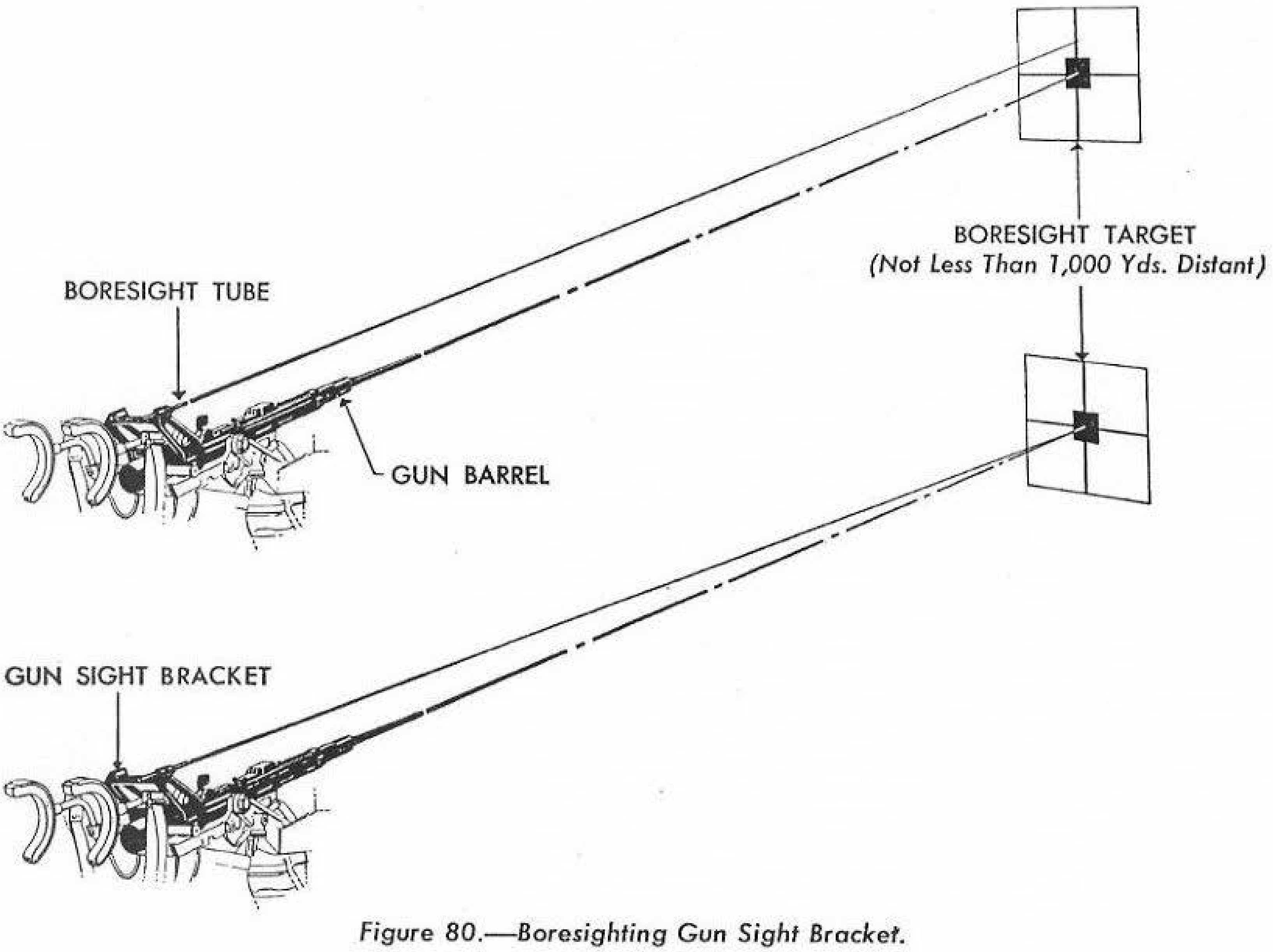

Figure 80.—Boresighting Gun Sight Bracket.

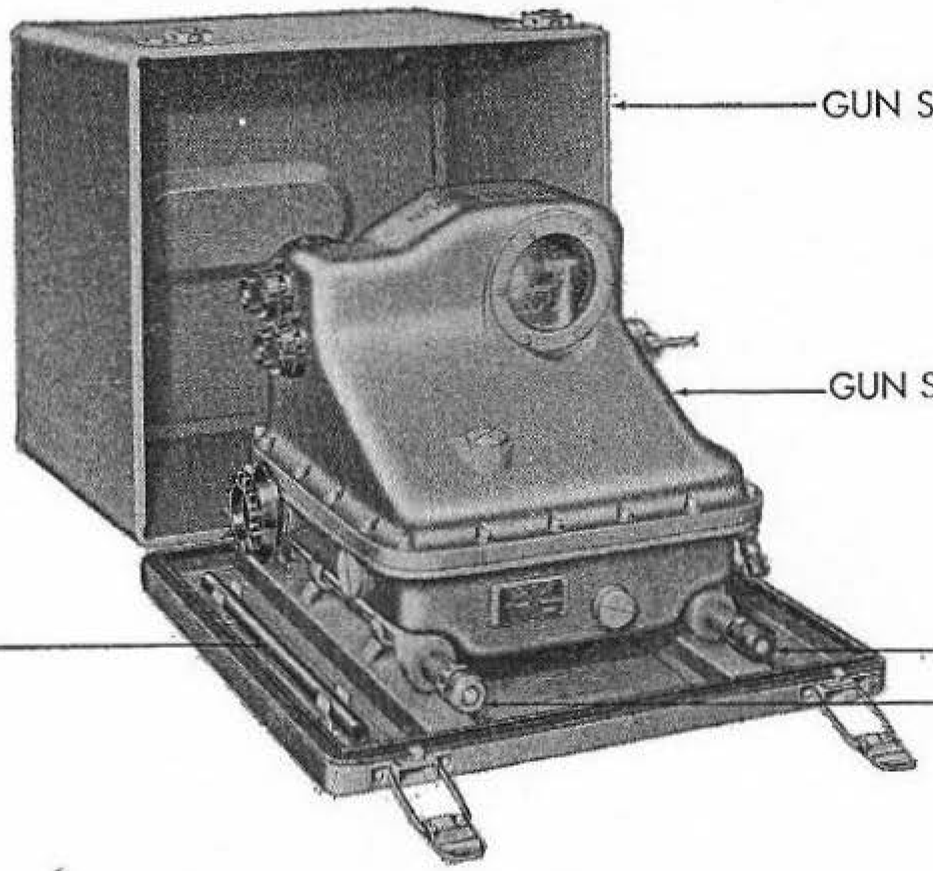

Figure 81.—Gun Sight Mk 14 in Carrying Case.

Mounting Gun Sight

The gun sight with support rods installed is furnished in a carrying case (fig. 81). Remove the sight from the case, and disassemble the support rods from the base of the sight.

Place the sight in its bracket (fig. 82) so that the holes in its base line up with the hole in each arm of the bracket. Insert the support rods, and install the shock absorber springs and cap nuts on each end of the rods, as shown.

Note: Spacers replace the shock absorber springs on Mods 7, 8, 12, 13, and 14 installed on Gun Director Mk 51 Mod 2.

In the side of each support rod are five shallow holes. Set screws, passing through each arm of the bracket, will lock the support rods in place when screwed in to engage any of these holes. Five holes are provided to allow for adjusting the fore-and-aft position of the gun sight to suit the individual gunner. When Mod 7, 8, 12, 13, and 14 sights are installed on Gun Director Mk 51 Mod 2, the sight position is not adjustable. The sight must be so located that the range knob extension handle of the gun director will mate directly with the range knob of the gun sight, and the sight locked in that position.

When installed on the gun mount, the sight should slide freely back and forth on the support rods, except for the spring restraint. If it does not slide freely, the rods should be checked for straightness, and crocus cloth or fine sandpaper used to clean the inside of the holes in the gun sight and to remove burrs or paint.

Note: In shifting the sight on the support rods, an accuracy of alignment within 15 minutes should be maintained.

Mounting Power Unit

After the power unit bracket is attached to the splinter shield, the power unit is installed with the pressure gage facing the gunner. Six studs located on the rear of the power unit match six holes in the bracket. Install lock washers and nuts as provided on the studs to secure the power unit. In case the unit does not lie flush against the bracket at all six points, four spacer washers are provided for use between the unit and the bracket as needed to take up space.

Air Hose and Electrical Connections

From the power unit, remove the pipe plugs from the air inlet and outlet connections; and, from the gun sight, remove the caps from the air connections. The air outlet connection at the power unit and the air inlet at the sight are painted red for identification. The air hose for connection between these two points is also red, the male fitting connecting to the power unit, and the female fitting connecting to the gun sight.

Caution: Take up these connections just enough to prevent leaks. Overtightening will damage the fittings. Moisture or dust entering the units will reduce their efficiency. Therefore, at no time leave open the fittings on the gun sight or power unit.

Two electrical cables are provided, one having a four-conductor plug at each end, and the other having a two-prong connection at one end and a standard ship's connector at the other. The four-conductor cable connects the power unit to the gun sight with the angle connector attaching to the gun sight and the straight connector to the power units. The two-conductor cable is plugged into the two-prong receptacle at the power unit and into the ship's electrical supply on the base of the gun mount. This provides the 115-volt, 60-cycle, single-phase a-c primary power supply to the unit.

To insure watertightness, make sure that the rubber washers provided are in place before making the connections.

Caution: In making electrical connections, be sure the tongue on the plug engages the groove in the receptacle. If this is not done, wrong contacts may be made, thus passing improper voltages through the circuits, resulting in serious damage to the components.

Hose and Cable Supports

A special bracket, three clamps, and grommets are provided with the gun sight for the support of the air hoses and electrical cables (fig. 83).

The cable and hose supporting bracket is installed to support the hose and cable between the power unit and the gun sight. It is attached to the left side of the mount by removing the two after bolts holding the left side of the splinter shield bracket to the gun mount. Insert the longer bolts provided through the two holes in the hose supporting bracket and the splinter shield bracket, and take them up.

Three clamps and grommets are provided for

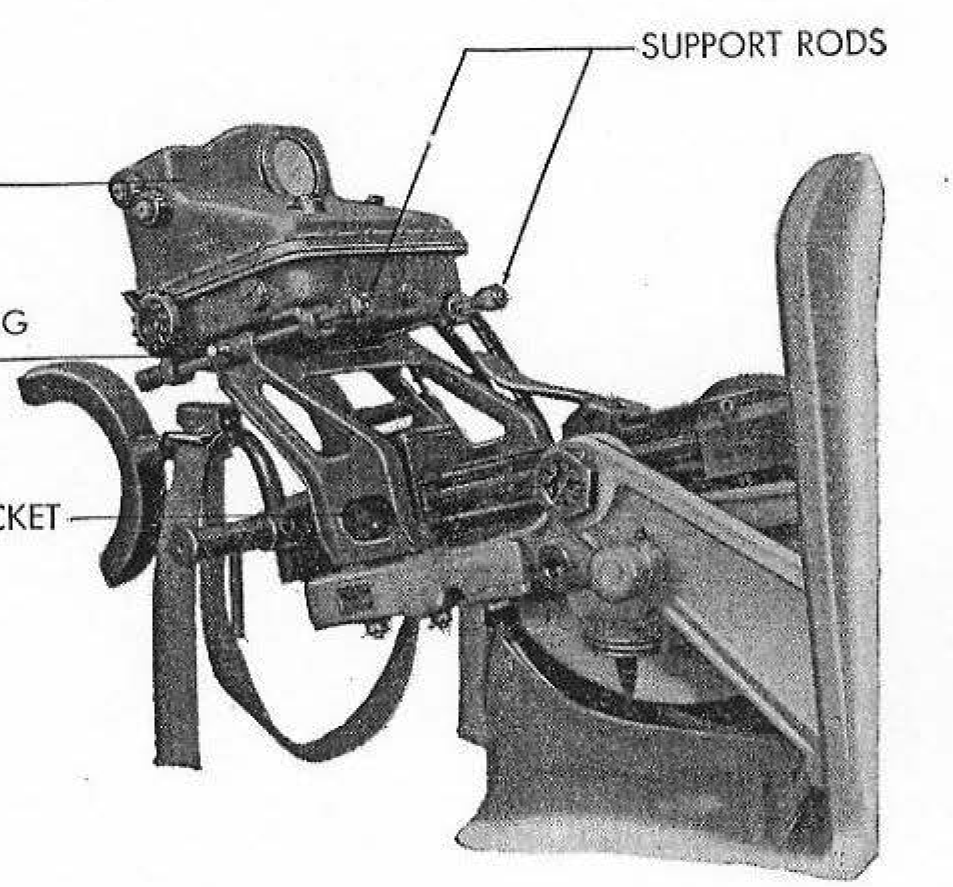

Figure 82.—Gun Sight Mk 14 Mounted on 20-mm Mount.

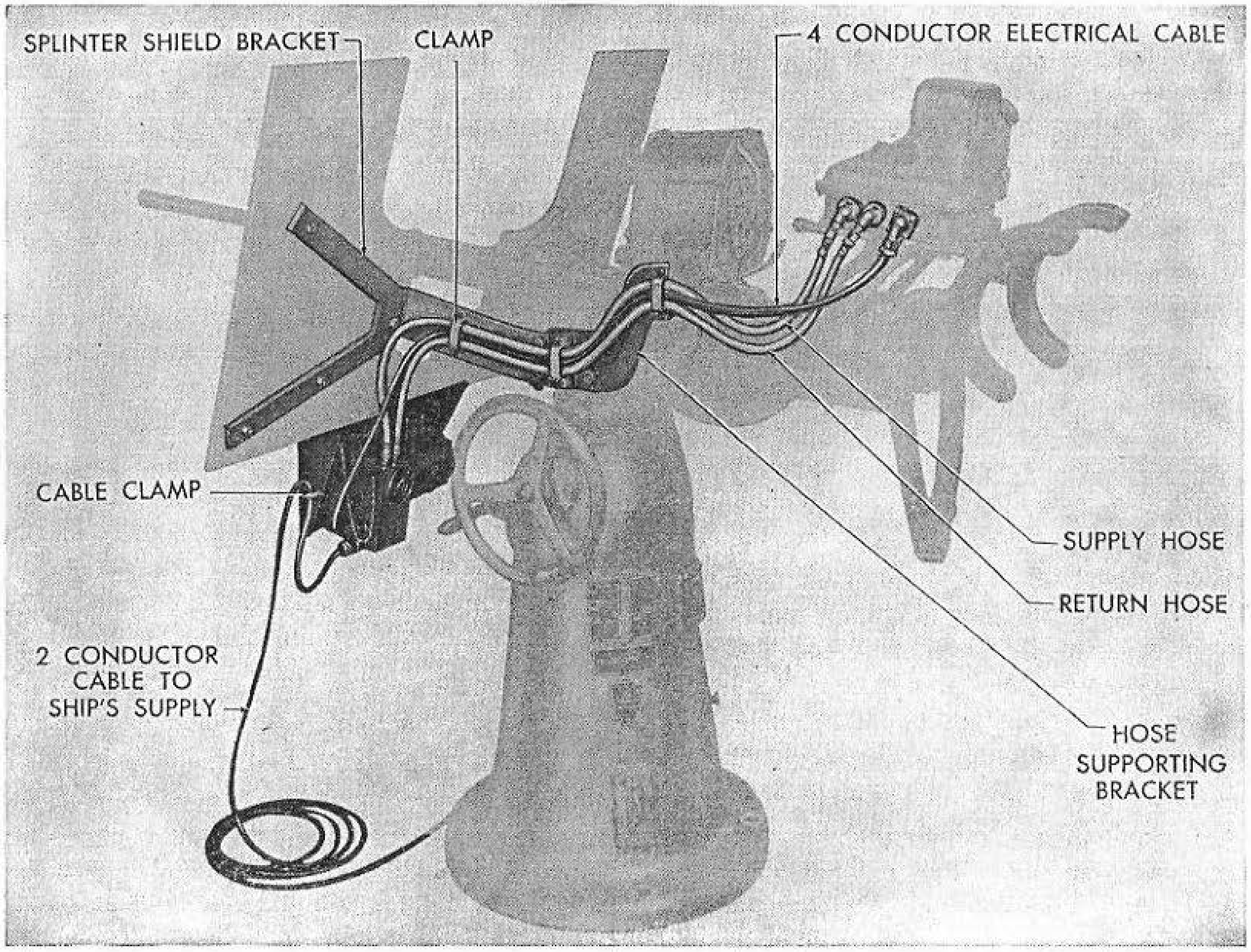

Figure 83.—Hose and Cable Run, 20-mm Mount.

hanging the air hose and cable to the splinter shield bracket and the support bracket (fig. 83). The clamp nearest the power unit is installed by drilling two holes in the splinter shield bracket to receive its holding bolts. The middle clamp is held down by the same bolts which secure the cable and hose supporting bracket to the splinter shield bracket. The after clamp is attached through holes provided in the supporting bracket.

A fourth clamp, part of the power unit bracket, tightens around the two-connector cable to prevent strain on the connection at the power unit.

Initial Tests and Adjustments

A newly installed gun sight requires a warming-up period of from two to three hours before it can be checked out. Gun sights provided with standby wiring as described in chapter 5 will start to warm up immediately upon connection to the ship's service supply. Where standby wiring is not provided, the power unit cut-out switch must be turned ON. The long warming-up period is necessar to permit the return of the damping fluid to the bottom of the damping chambers.

Caution: During this warming-up period, lock the 20-mm antiaircraft gun in 5° elevation and Gun Director MK 51 Mod 2 at 0°.

After the sight has been sufficiently warmed up, check the pressure gage to see that the pointer is in the green sector.

Check the operation of the sight pressure regulator. Attach the test pressure gage (BuOrd No. 325723–2) to the gun sight. The pressure indicated should be 2¼ pounds (31 in. water), this

Master Installation Check-Off Sheet for Gun Sight MK 14

Mod ______________________ **Serial No.** ______________________

Power Unit Serial No. ______________________ **Installation Date** ______________________

Location ______________________

1. Power Cable and hose connections are tight. . . . . ______________________
2. Power unit pressure gage reads between 6 and 8 p. s. i., or pointer is within green sector on dial. . . . . ______________________
3. Sight pressure is correct on Mods 2, 3, 4, 9, 10, and 11 when pointer of gage is indicating on red mark. On Mods 6, 7, 8, 12, 13, 14, or 15, check has been made with portable standard gage. . . . . ______________________
4. Reticle lamp is illuminated as dimmer is turned in each direction. . . . . ______________________
5. Following tests are made and sight is within tolerances only when ship is in calm water. (Use Calibration and Training Fixture Mk 1 Mod 0). . . . . ______________________
   a. Cycling . . . . ______________________
   b. Dead Zero in elevation. . . . . ______________________
   c. Dead Zero in train. . . . . ______________________
   d. Range Shift in train. . . . . ______________________
   e. Superelevation test. . . . . ______________________
   f. Characteristic time. . . . . ______________________
   g. Deflection (Sensitivity) test. . . . . ______________________
6. After all tests are made and sight is within tolerance, sight reticle is boresighted properly and range is set correctly. . . . . ______________________
7. The following parts are covered with vaseline or light grease:
   a. Mounting rods, springs, and nuts. . . . . ______________________
   b. Spot knob detent plates (if exposed type). . . . . ______________________
   c. Range scale. . . . . ______________________
   d. Locking screws and nuts on mounting bracket. ______________________
   e. Sun ray filter pivot. . . . . ______________________

Figure 84.—Master Installation Check-off Sheet.

range lying within the green sector of the gage.

Caution: Gages should be checked frequently for accuracy against a standard gage, especially if a number of sights seem to go out of adjustment at the same time.

Upon completion of installation and the above checks, make the following tests to check the performance of the gun sight:

1. Dead Zero Test
2. Range Shift and Superelevation Test
3. Deflection (Sensitivity) Test
4. Characteristic Time Test

These tests are described in detail in chapter 8.

Upon satisfactory completion of the performance tests, the gun sight should be boresighted to the bracket or to the gun; greater accuracy will be obtained by boresighting to the gun. The boresighting procedure is described in chapter 8.

To insure proper operation, it is recommended that a master installation check-off sheet (similar to that shown in fig. 84) be used to check installation of Gun Sight Mk 14.

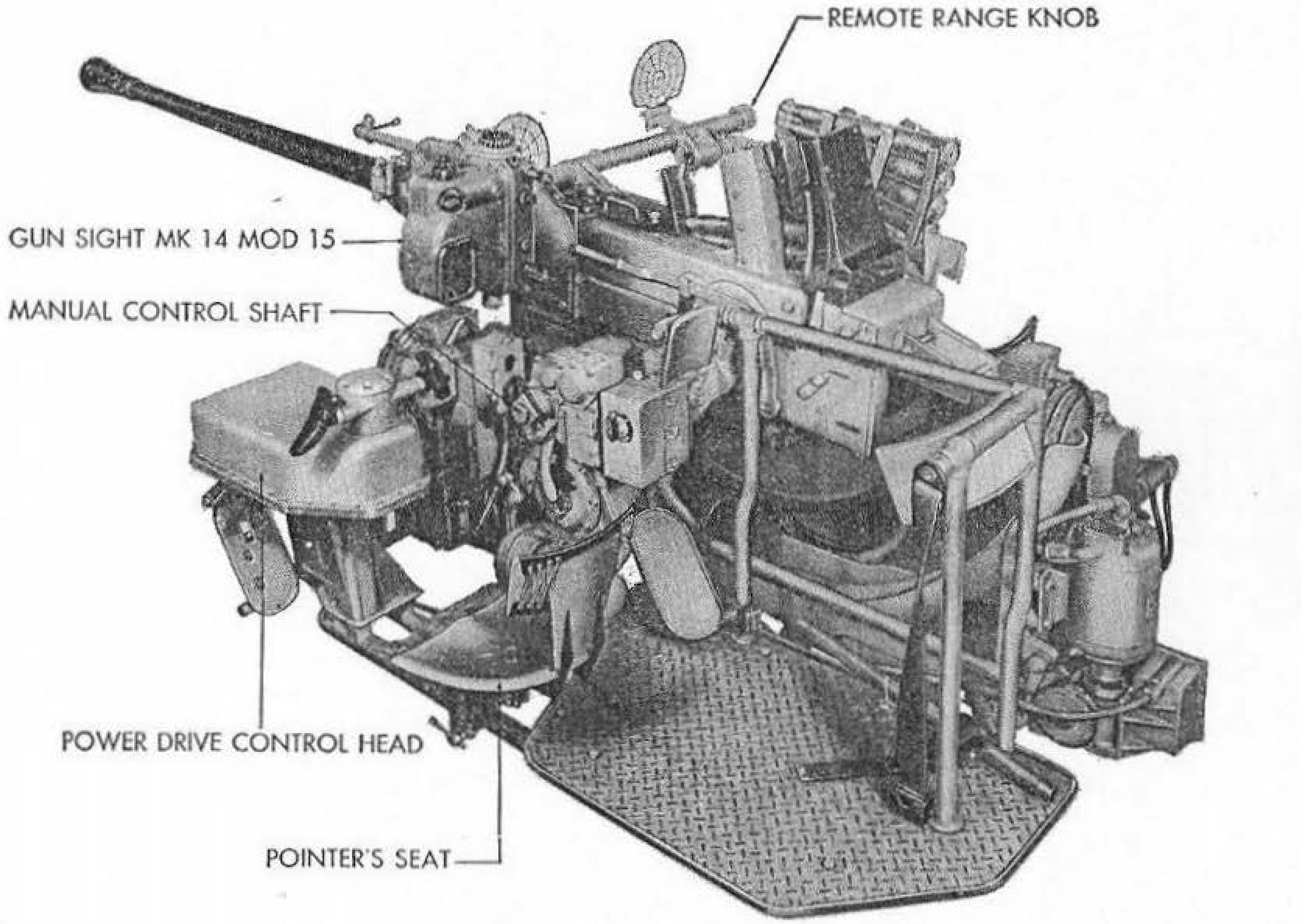

Figure 85.—40-mm Single (Power Driven) Mount Mk 4 Mod 3 with Gun Sight Mk 14 Mod 15 Installed

GUN SIGHT MK 14 MOD 15

Introduction

Gun Sight Mk 14 Mod 15 is mounted directly on 40-mm Single (power-driven) Mount Mk 4 Mod 3. Ballistically, it is the same as Gun Sight Mk 14 Mod 8 installed on Gun Director Mk 51 Mod 2 for control of 40-mm multiple mounts. The most noticeable difference between the two is that, in order to bring it into a usable position, Mod 15 is installed on its side (figs. 85 and 86).

Basic Principles

Since Gun Sight Mk 14 Mod 15 is mounted on its side, i.e., turned 90° about its fore-and-aft axis, the traverse gyro (in other Mods) now becomes the elevation gyro for Mod 15 and the elevation gyro becomes the traverse gyro.

Similarly, the traverse and elevation mirrors, as well as the deflection and elevation spotting systems, exchange functions. This interchange of

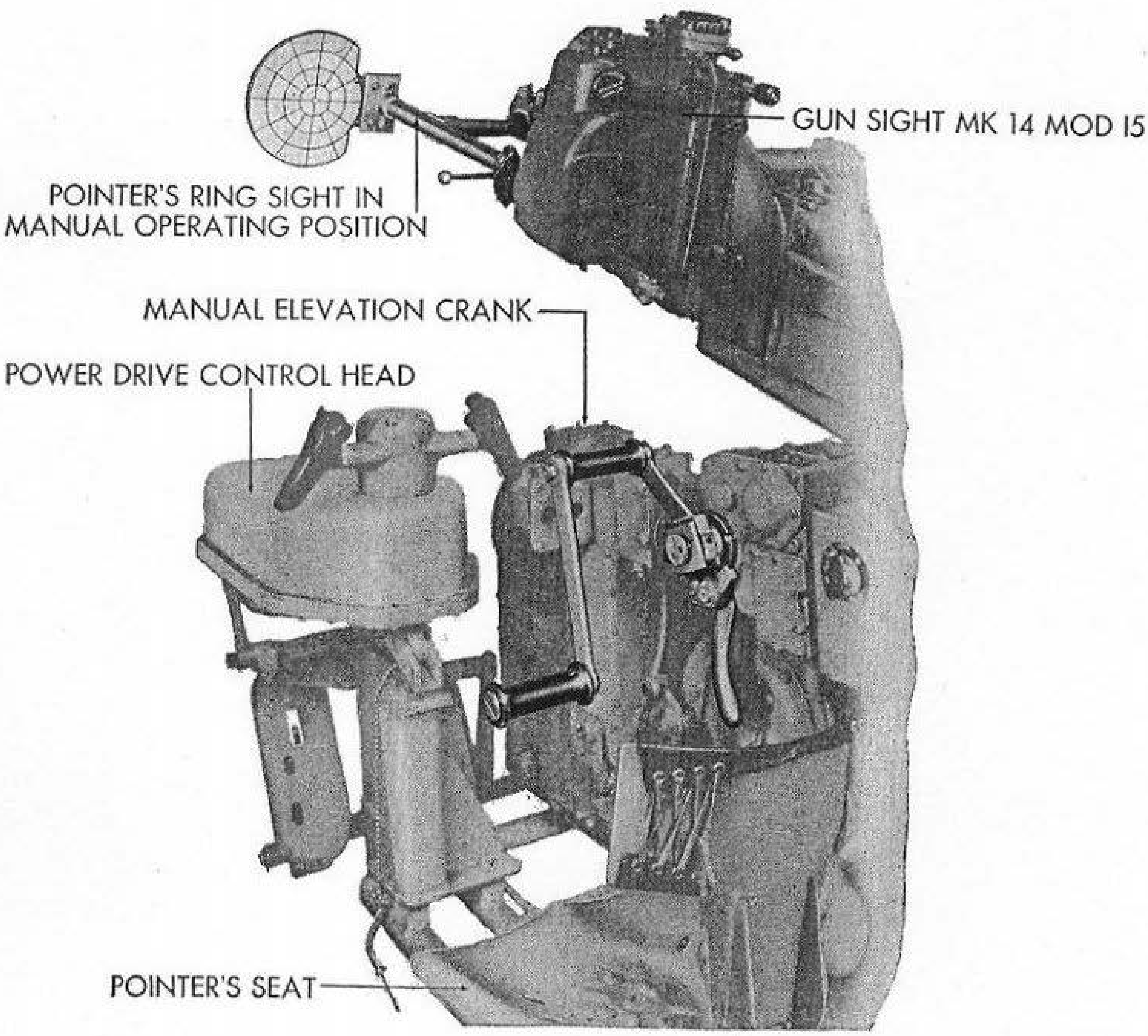

Figure 86.—40-mm Single Mount set up for Manual Operations.

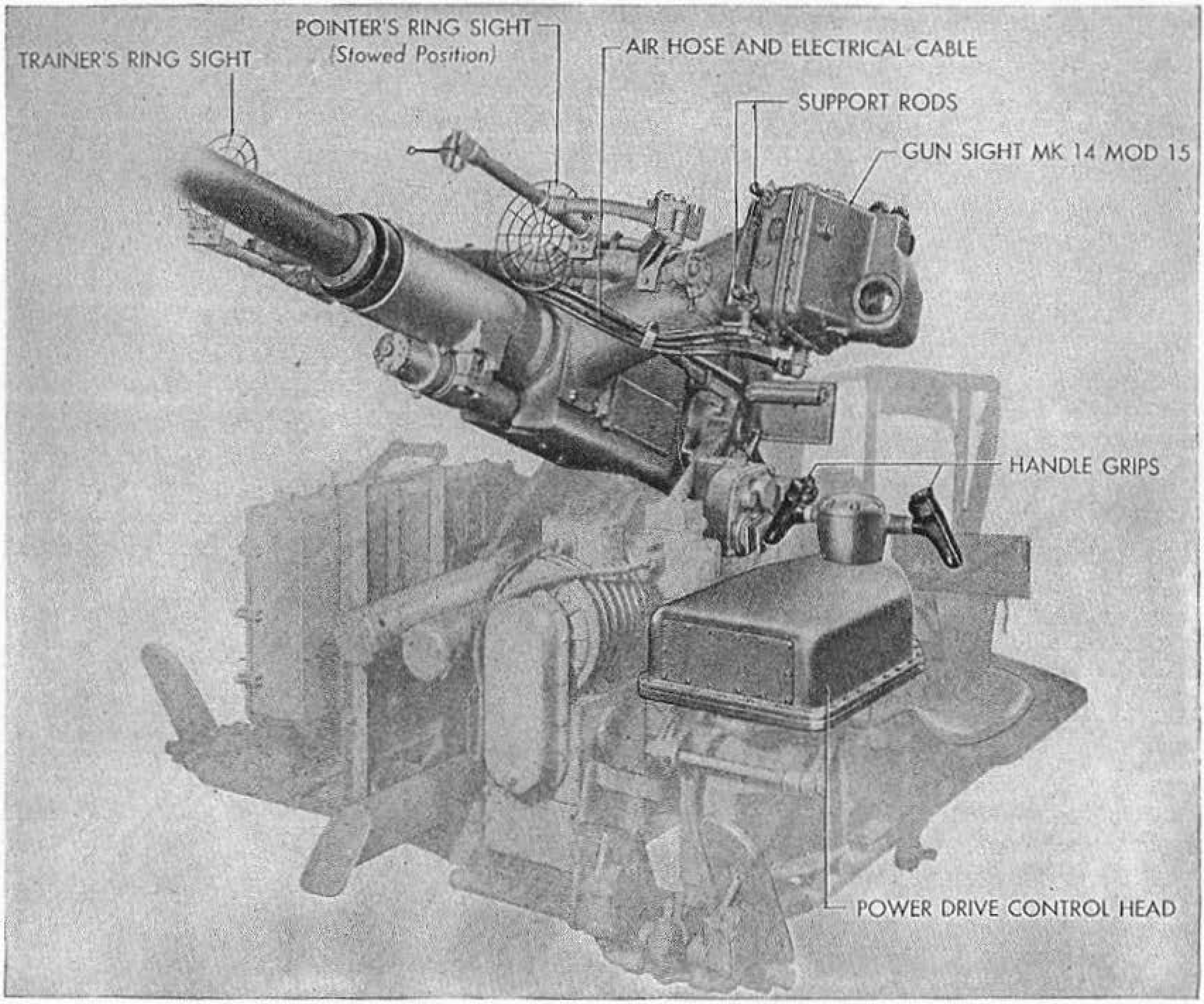

Figure 87.—40-mm Single Mount, set up for Use of Gun Sight Mark 14 Mod 15 Operation.

functions requires that the unit be calibrated in its new position for the new functions of the elements.

Operation

The 40-mm Single (power-driven) Mount Mk 4 Mod 3 can be trained and elevated either with a power drive or manually. When the power drive is in use, the gun pointer has control of both elevation and train through the dual power drive handle grips. When the mount is operated manually, the gun pointer controls elevation only through a manual crank and the gun trainer controls the gun in train through a similar crank.

When the mount is under manual operation, both pointer and trainer use the ring sights provided, since one must estimate lead in elevation, and the other lead in traverse. However, when the power drive is used, the gun pointer, controlling both train and elevation, uses Gun Sight Mk 14 Mod 15. To prevent interference, the ring sight on the pointer's side of the mount is fitted so that it may be swung out of the way when the gun sight is being used, and returned to operating position when the gun sight is not in use.

Figure 86 shows the gun pointer's station rigged for manual operation, and figure 87 shows the same station rigged to use the power drive and gun sight. For manual operation, the power control drive is pushed away from the pointer and locked out of gear, and the manual crank installed. When

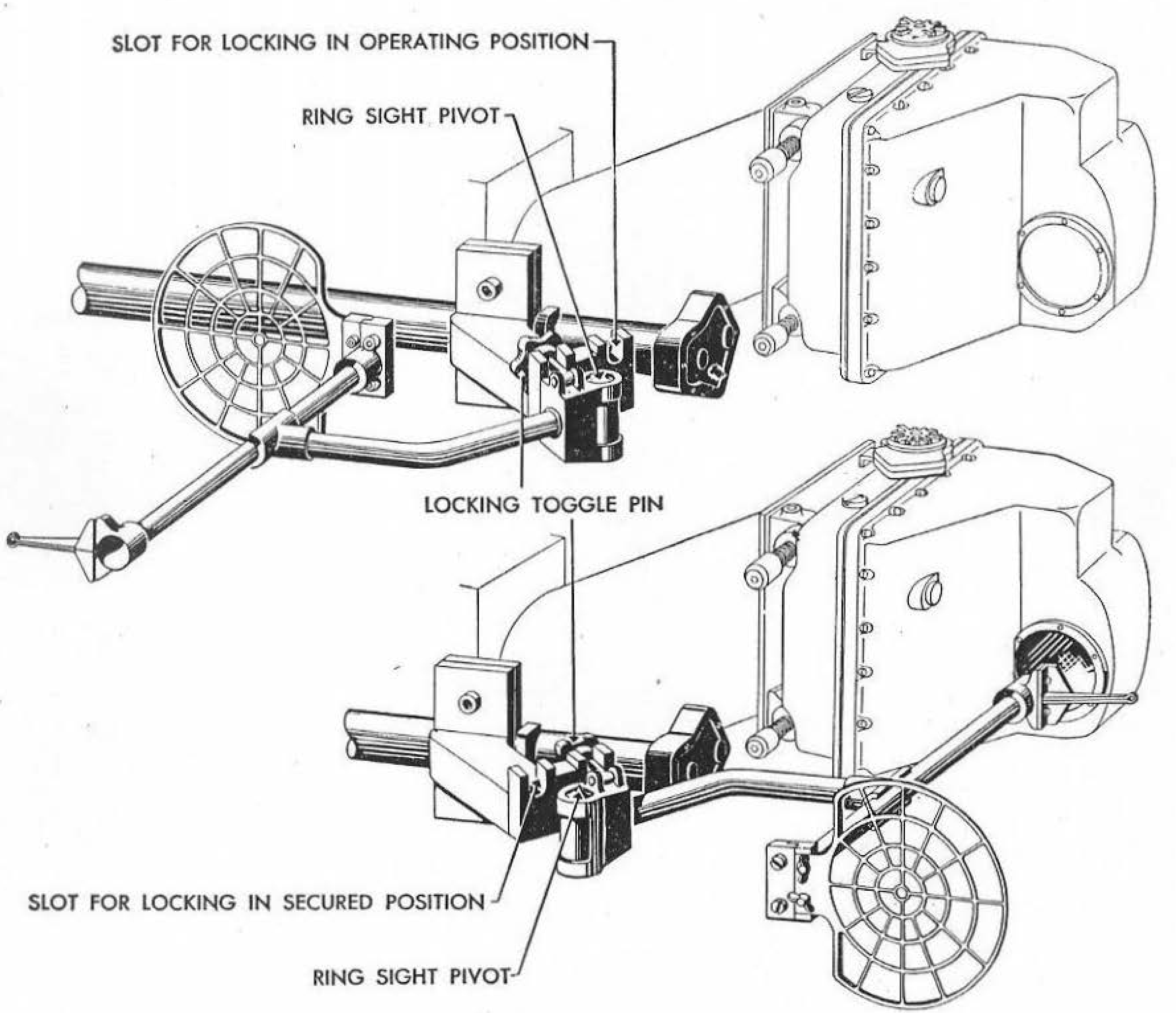

Figure 88.—Stowed and Operating Positions of the Ring Sight.

using the power drive, pull the control head toward the pointer and lock it in gear, and remove the manual crank.

The two positions of the ring sight are shown in figure 88. It can be locked in either position by inserting the toggle pin into the notch on one or the other side of the pivot.

Facilities for range setting must be provided for Mod 15, and, since it would be impracticable to station another man alongside the pointer, a remote range system is provided. This leads to the trainer's side of the gun through a series of gears and levers (fig. 91) to a knob, graduated the same as the range knob on the gun sight (fig. 89). Thus, the gun trainer becomes the range setter when Gun Sight Mk 14 Mod 15 is in use.

As in all other installations of Gun Sight Mk 14, it must be warmed up for at least 30 minutes before it can be used accurately. The suggested operational procedures described in chapter 4 apply equally to Mod 15. When not in use, the gun mount should be secured at zero degree elevation.

During operation, it will be impracticable to use the spot knobs, now interchanged in position since no remote control system is provided. Their major remaining function is in connection with tests and boresighting.

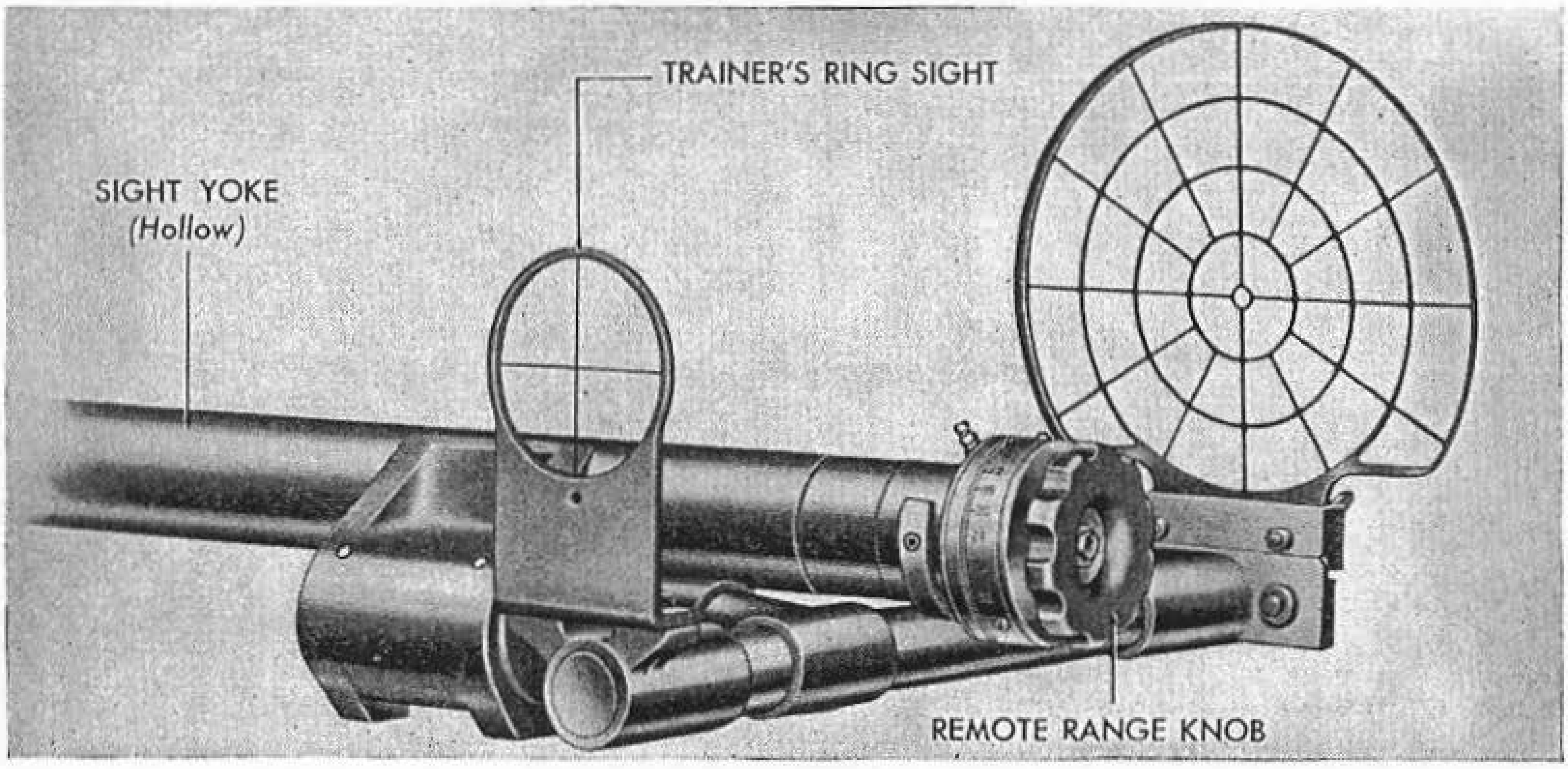

Figure 89.—Remote Range Knob.

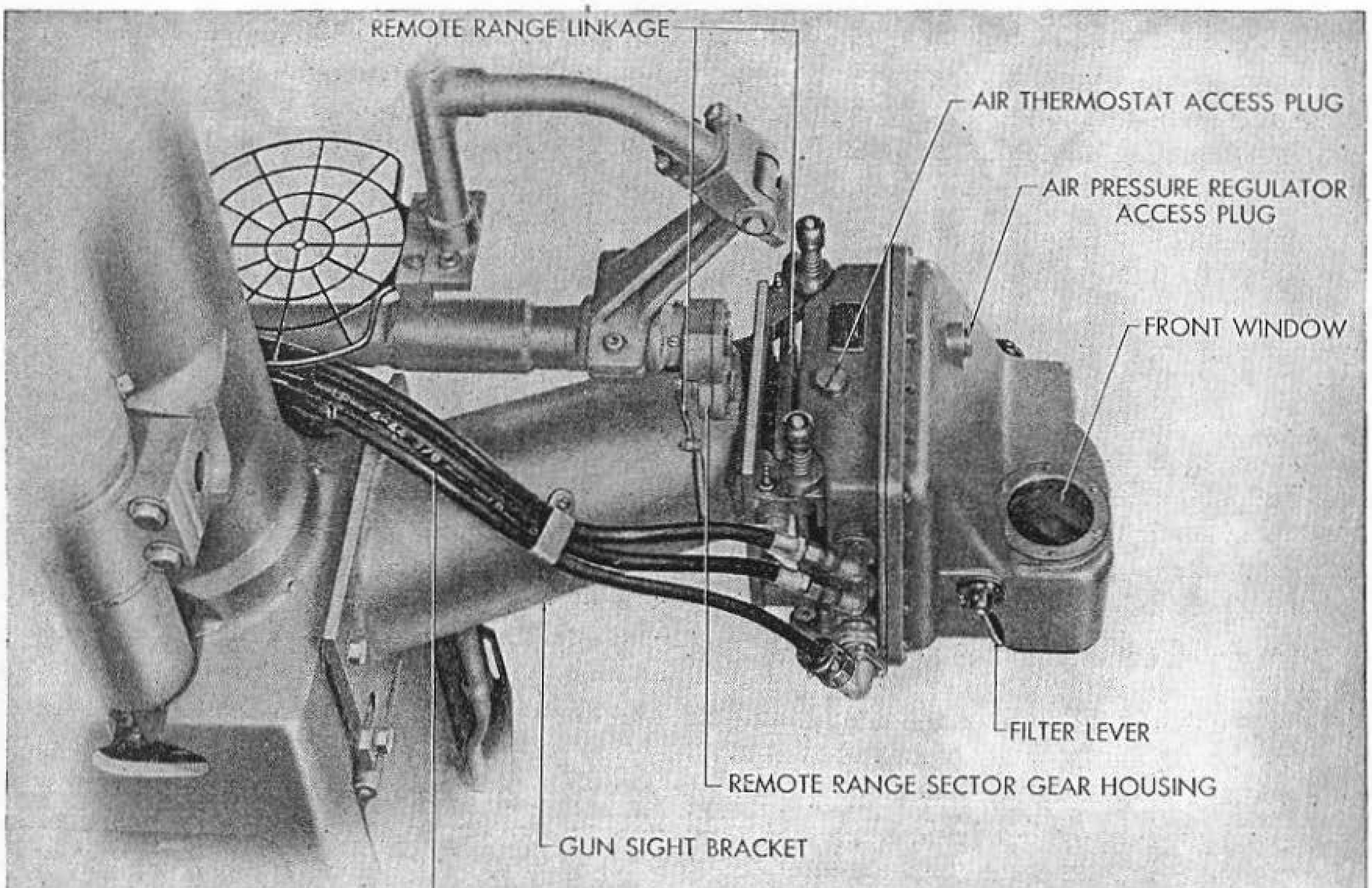

Figure 90.—Gun Sight Mk 14 Mod 15 Front View.

Installation

Gun Sight Mk 14 Mod 15 is attached to the left side of 40-mm Single (power-driven) Mount Mk 4 Mod 3 by means of a piece of hollow steel tubing with square flanges on each end (fig. 90). The photograph shown was taken from the front of the mount with the gun elevated 45 degrees. Four bolts secure the base flange to the gun mount. On the flange at the other end are four lugs through which the gun sight support rods pass.

As on Mod 6 installations, springs are provided at each end of the support rods to act as shock absorbers, and set screws, through each of the four lugs, hold the support rods firmly in place.

To connect the range knob on the gun sight to remote range system, an adapter is fitted between the range knob and the gun sight housing. This consists of two sector gears, one attached to the range knob shaft and meshing with the other, which drives a lever (fig. 91). This lever links with a shaft which passes between the gun sight and its mounting bracket to operate, through another lever, a similar set of sector gears on the end of the hollow sight yoke. Through the sight yoke passes a rod

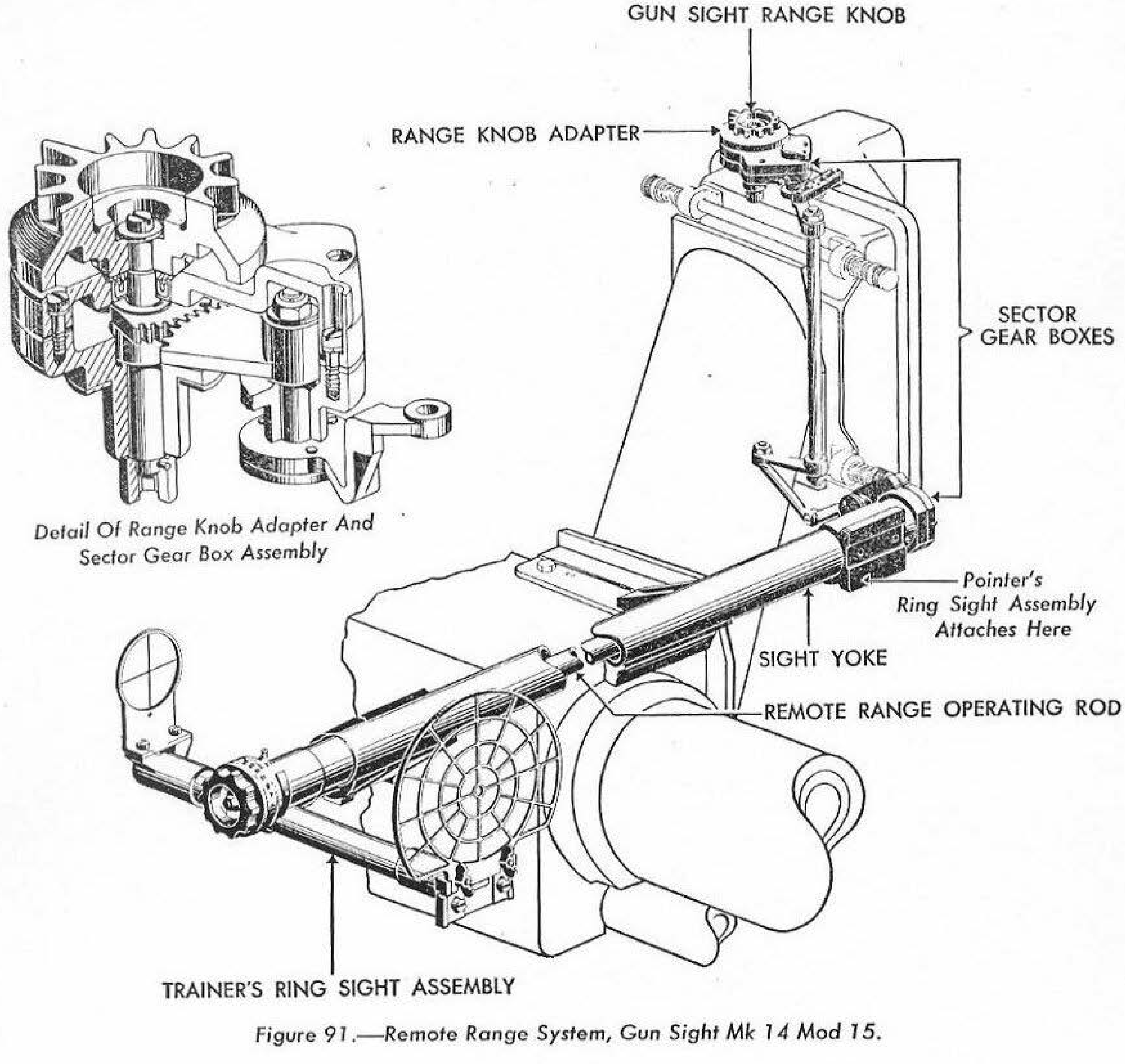

Figure 91.—Remote Range System, Gun Sight Mk 14 Mod 15.

connected to one of the sector gears at the pointer's side of the gun mount, and to the remote range knob on the trainer's side of the gun mount.

The power unit for the gun sight is installed on the right side of the gun mount behind the trainer's seat (fig. 92). It is secured by an angle bracket and the six studs at its rear. Air hoses and electrical cable pass in front of the mount under the gun barrel to reach the sight.

Maintenance checks and adjustments are the same as for Gun Sight Mk 14 Mod 8, detailed in chapters 8 and 9, except that the functions of the traverse and elevation gyros are reversed, with corresponding changes in the position of access plugs. The new functions of access plugs are indicated in figures 90 and 93.

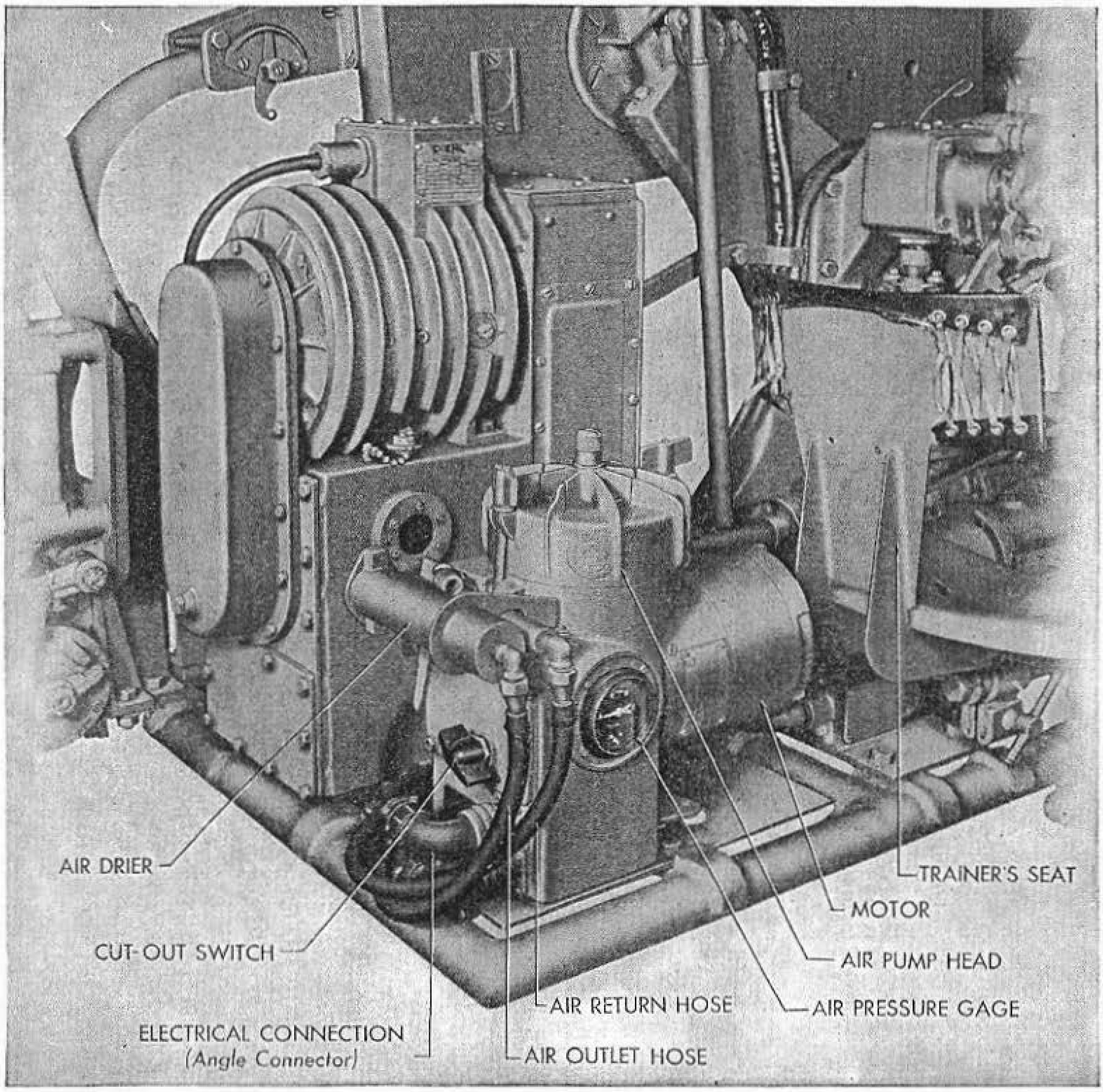

Figure 92.—Gun Sight Mk 14 Mod 15 Air Power Unit.

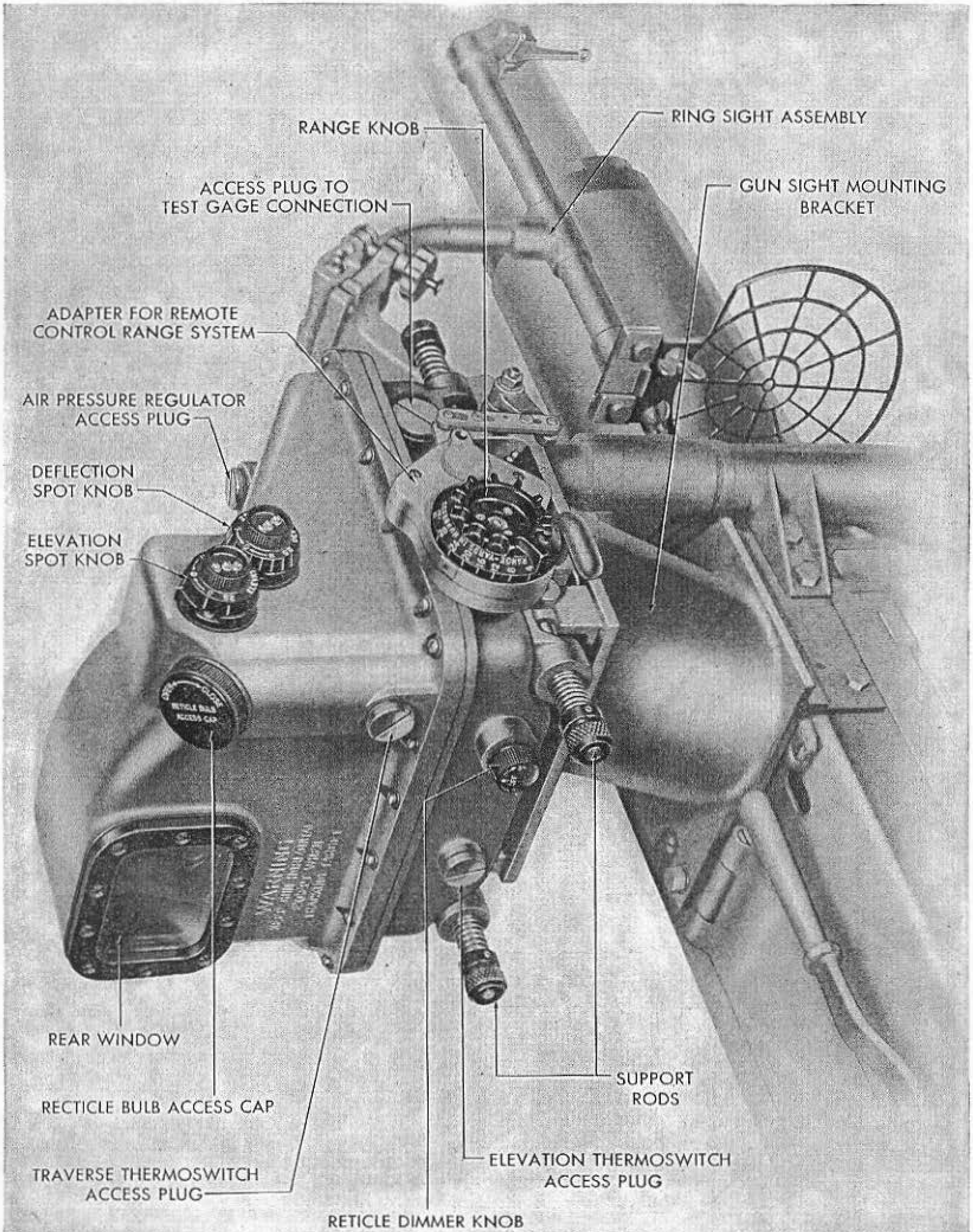

Figure 93.—Gun Sight Mk 14 Mod 15 Mounted—Rear View.

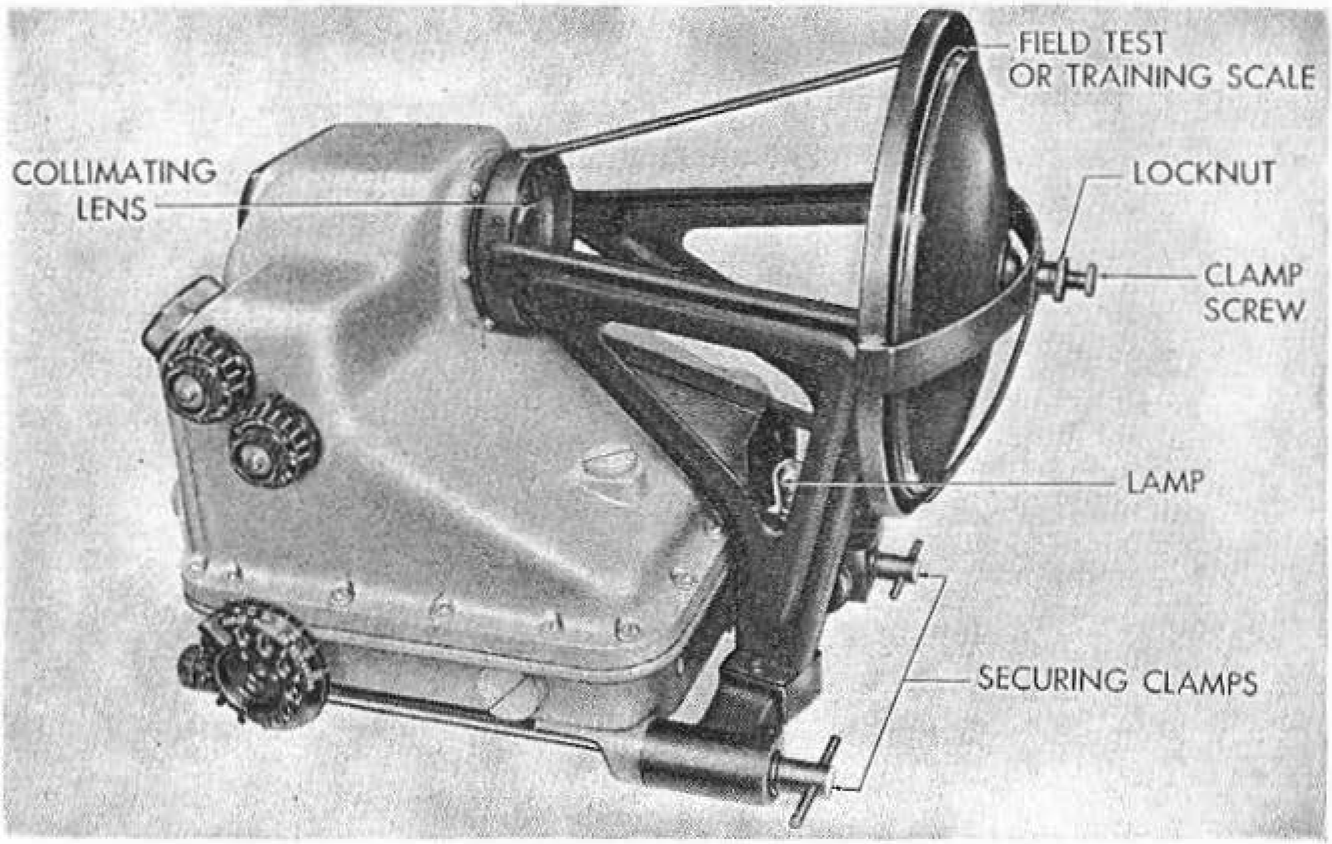

Figure 94.—Calibration and Training Fixture Mk 1 Mod O.

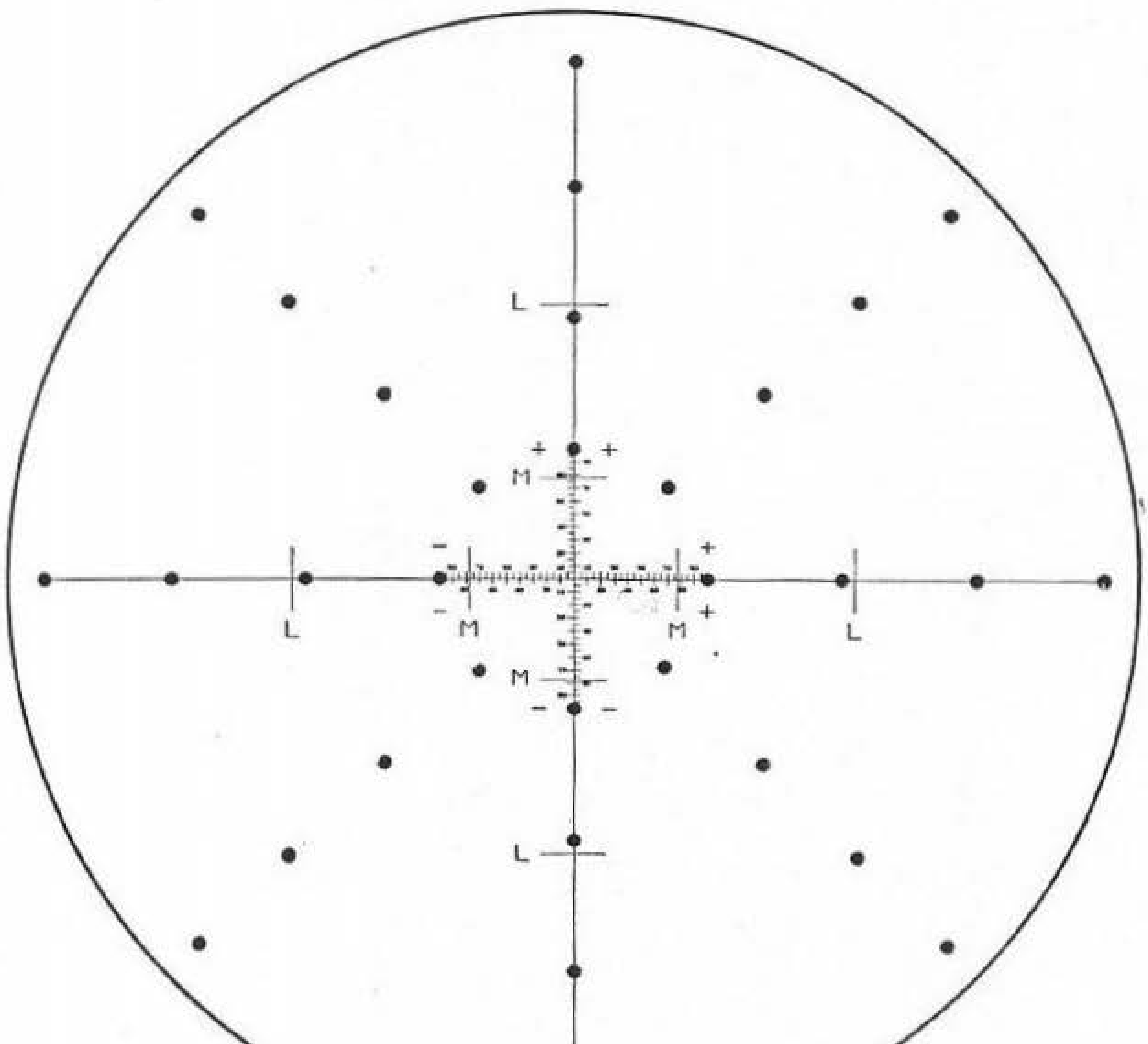

Figure 95.—Field Test Scale.

MAINTENANCE — PERFORMANCE TESTS

Introduction

Normal shipboard maintenance of Gun Sight Mk 14 must include certain tests made periodically to establish satisfactory operation. The following performance tests should be made, in the order named, every two weeks, or after each 200 hours of operation:

1. Dead Zero Test
2. Range Shift and Superelevation Test
3. Deflection (Sensitivity) Test
4. Characteristic Time Test

Immediately following these tests, the gun sight should be boresighted to its mount. To insure continued alignment, boresighting may be required more frequently than indicated above.

All tests should be made as soon as practicable after extensive firing or abnormal weather conditions, whether or not the regular test period has been reached.

Precautions While Testing

To insure valid results, the following precautions should be taken prior to and during the performance tests:

1. A warm-up period of at least a half hour must be allowed prior to beginning any test.

2. Before each performance test, the gun sight must be cycled, following the procedure described in chapter 4, to settle the reticle in its true zero position. If the Field Test Scale is in place while cycling, its adjustment should be checked before proceeding with the next performance test.

3. During the tests, it is essential that all motions originating outside of the gun mount and gun sight be kept at a minimum. For this reason, performance tests should be accomplished while the ship is in extremely calm water, preferably while at anchor or tied to a pier. To minimize any possible motion of the ship, tests should be made with the gun or director trained as nearly fore-and-aft as possible.

Note: Performance tests made while the ship is underway will be only rough checks, and cannot be depended upon for any accurate determination of the effciency of the gun sight.

4. In making performance tests, hold the sight motionless whenever the reticle is to be allowed to settle after a prescribed swing.

Caution: Whenever instructions call for rapid swinging of the gun sight, care should be taken to swing the sight only rapidly enough to bring the reticle to the end of the Field Test Scale. Repeated rapid swinging into the stops may damage a gyro unit.

Testing Equipment

Performance tests are made using the Field Test Scale supported in the Calibration and Training Fixture Mk 1 Mod 0. Figure 94 shows this fixture mounted in position on the gun sight. The same fixture also is used to support the Training Scale used for tracking practice, as described in chapter 10.

Calibration and Training Fixture Mk 1 Mod 0: The calibration fixture is mounted on the forward ends of the gun sight support rods, with the lens of the fixture in front of the forward window of the gun sight.

In mounting the fixture on the Mod 6 or 15, remove the forward cap nut and shock absorber spring from each support rod. Then, install the calibration fixture and tighten the clamp nuts until the rear shock absorber springs are fully compressed. When installing on Mods 7, 8, 12, 13, and 14, remove the forward clamping bushings, install the calibration fixture, and take up the clamp nuts to secure the fixture. Small bushings are supplied with the fixture for those sights having solid bushings on mounting rods.

Field Test Scale: A Field Test Scale used in making all performance tests except boresighting, is inserted in the calibration fixture. The scale consists of a shallow dish, graduated as shown in figure 95. The intersection of the horizontal and vertical centerlines is defined as "scale zero." From scale zero, each of the centerlines is marked off in 5- and 10-mil graduations to a total of 90 mils in each direction. On each of the centerlines, marks are located 210 mils and 78 mils from scale zero; these are used in measuring the characteristic time. The black dots radiating at 45° angles from scale zero are at 100-mil intervals and may be used for deflection tests; they are primarily for use in tracking practice, as described in chapter 10.

Adjusting Field Test Scale: Set the field test scale in the fixture with the scale face numerals upright, and tighten the clamp screw shown in figure 94. Set the range knob to the maximum range (highest graduation of the range dial), and the spot knobs to zero. Throw in the light filter. Adjust the reticle brightness until the center dot of the reticle is clearly visible. With the reticle settled in its zero position, look through the rear sight window. The reticle center dot should be superimposed upon the scale zero of the field test scale. If it is not, loosen the clamp screw and adjust the position of the scale until the center dot and scale zero coincide and the horizontal centerline appears to be level. Spot knobs may also be used to set the spot at scale zero.

To place the horizontal centerline in true level, first lock the gun mount in 5° elevation or the gun director in zero. Swing the mount in train, and observe the travel of the reticle dot as it moves along the centerline. If the dot appears to travel parallel to or directly along the horizontal centerline, the centerline is level. If the motion of the dot is not parallel to the centerline, rotate the scale, and repeat the tests until the reticle center dot is on scale zero and the centerline is level. When these conditions are met, the gun sight is ready for performance testing.

DEAD ZERO TEST

The Dead Zero Test is performed to determine the width and height of the dead zero area, and to adjust the reticle neutral position to the center of that area. The dead zero area is that area within which the reticle may settle when returning to neutral from any lead angle.

A sample work sheet used in recording dead zero test data is shown in figure 96.

Before beginning the dead zero test, set the gun sight in horizontal position, and adjust the range knob to maximum range. Proceed with the test as follows:

1. Swing the gun sight in train to the left so as to generate the maximum lead angle on the right side of the field test scale. Bring the sight to rest, and allow two minutes for the reticle to settle, being careful to keep the sight motionless. Using deflection spot knobs, move the reticle to scale zero.

2. Swing the sight to the right, generating a maximum lead angle on the left side of the scale. Stop the movement and let the reticle settle for two minutes. Record the horizontal-displacement reading on the scale directly under the reticle center spot. This reading is the width of the dead zero area.

3. Using the deflection spot knob, return the reticle to the center of the area just determined. For example, if the reticle settled four mils to the left of scale zero, spot the reticle so that it is two mils to the left of scale zero.

4. Lock the gun or director in train to make the dead zero test in elevation.

5. Elevate the sight. Return it to horizontal with sufficient rapidity to approximate a maximum angular rate and lock it in that position (5° elevation for the 20-mm gun and zero for Gun Director Mk 51).

6. Allow the reticle two minutes to settle following its movement down the scale. Using the elevation spot knob, move the reticle back to scale zero, the horizontal centerline of the scale.

DEAD ZERO TEST

Gun Sight Mk 14 Mod ______________ **Serial No.** ______________

Location ______________________________

TEST IN ELEVATION

	Date of test run	Elevate sight, and record spot	Depress sight, and record spot	Difference between readings (not to exceed 7 mils)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Total mils ______________

Average mils ______________

TEST IN TRAIN

	Date of test run	Swing sight to left, and record spot	Swing sight to right, and record spot	Difference between readings (not to exceed 7 mils)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Total mils ______________

Average mils ______________

Figure 96.—Dead Zero Test Work Sheet.

7. Depress the sight as far as it will go; return it rapidly to horizontal, locking it in that position.

8. Allow two minutes for the reticle to settle after moving up the scale. Record the scale reading (height of the dead zero area).

9. Using the elevation spot knob, adjust the reticle to the center of the area just determined. If the dead zero area as just determined exceeds seven mils in either train or elevation, the gun sight must be adjusted at a gun sight repair station.

RANGE SHIFT AND SUPERELEVATION TEST

The range shift and superelevation test is made to determine the amount of reticle movement in train and elevation when the range knob is shifted from median range to minimum range and from median range to maximum range.

Median and maximum ranges for each Mod of the gun sight are listed in table 3. Figures 97 and 98 illustrate sample work sheets to be used in making this test. The test should follow immediately after the dead zero test and be preceded by cycling the gun sight and checking the adjustment of the field test scale.

Note: The range shift and superelevation test is made with the gun sight in two positions of elevation: horizontal (5° for the 20-mm antiaircraft mount; zero for Gun Director Mk 41 Mod 2), and elevated 60°.

1. If the gun sight is mounted on the 20-mm gun, lock the mount fore-and-aft in train by use of a clamp or locking pin and at five degrees elevation with the lower elevation locking pin. If the gun sight is mounted on Gun Director Mk 51, lock the director at zero train and elevation by use of the director locking pins.

2. Set the range knob to median range, and allow the reticle to settle for two minutes.

3. Using the spot knobs, set the reticle center dot on scale zero.

4. Shift the range knob setting to 400 yards, and allow the reticle to settle. Record the settling point in train and elevation.

5. Shift the range knob to maximum range. Allow the reticle to settle, and again record the settling point.

6. With the range knob still at maximum range, elevate the gun sight to 60°, holding it in this position. Gun Director Mk 51 Mod 2 can be locked at this elevation. Allow the reticle to settle, and record the settling point in train and elevation.

7. With the gun sight still at 60° elevation, shift the range knob setting to median range, and allow the reticle to settle. Record the settling point in train and elevation.

8. Shift the range knob setting to 400 yards, allow the reticle to settle, and again record the settling point.

If for any shift of range (4, 5, 6, 7, and 8 above), the reticle movement is more than seven mils in train or is not within the limits in elevation shown in table 4, superelevation test limits, the gun sight must be adjusted at a repair station.

Table 3—MEDIAN RANGE TABLE

Gun sight Mk 14 Mod	For use with gun	Set range knob at median range listed (yards)
6	20-mm	1,200
7	1.1-inch	1,600
8	40-mm	2,000
12	3"/50	1,800
13	5"/25	1,400
14	5"/38	2,000

Table 4—SUPERELEVATION TABLE

Gun Sight Mk 14 Mod	Range (yards)	Gun Sight horizontal Min.	Gun Sight horizontal Max.	Gun Sight, elevated 60° Min.	Gun Sight, elevated 60° Max.
6	400	+ 4	+19	+ 6	+21
	1,200 (med)	0	0	0	+15
	2,000	—10	—25	+ 6	— 9
7	400	+ 4	+18	+ 5	+20
	1,600 (med)	0	0	0	+14
	2,800	— 8	—23	+ 7	— 8
8	400	+ 5	+19	+ 6	+21
	2,000 (med)	0	0	0	+15
	3,200	— 5	—19	+ 9	— 6
12	400	+ 4	+19	+ 6	+20
	1,800 (med)	0	0	0	+15
	3,600	—11	—26	+ 5	— 9
13	400	+ 4	+19	+ 6	+21
	1,400 (med)	0	0	0	+15
	3,000	—14	—29	+ 4	—10
14	400	+ 5	+20	+ 7	+21
	2,000 (med)	0	0	0	+15
	4,000	—10	025	+ 6	— 9
15	Same values as Mod 8				

In this table — denotes values above, and + denotes values below the horizontal reference line.

Range Shift Test in Train

Gun Sight Mk 14 Mod ________________ **Serial No.** ________________

Location ________________________________

Date of test run	Set range to median, and record spot	Shift range to minimum, and record spot	Difference between readings (not to exceed 7 mils)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Total mils ________

Average mils ________

Date of test run	Set range to median, and record spot	Shift range to maximum, and record spot	Difference between readings (not to exceed 7 mils)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Total mils ________

Average mils ________

Figure 97.—Range Shift Test Work Sheet.

SUPERELEVATION TEST

Gun Sight Mk 14 Mod ______________________________ **Serial No.** ____________________

Location ____

Date of test run	Set range to median, and record spot	Shift range to minimum, and record spot	Reticle movement (allowed ± 7 Mils)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Total mils ____________

Average mils ____________

Date of test run	Set range to median, and record spot	Shift range to maximum, and record spot	Reticle movement (allowed ± 7 Mils)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Total mils ____________

Average mils ____________

Figure 98.—Superelevation Test Work Sheet.

DEFLECTION (SENSITIVITY) TEST

The Deflection, or Sensitivity, Test is designed to check the calibration of the sight by tracking a target on the Field Test Scale through an angle of 60° in train. The test should be made immediately following the completion of the Range Shift and Superelevation Test. A sample work sheet for recording test data is shown in figure 99. Before proceeding with the test, first cycle the sight and correct the adjustment of the Field Test Scale if necessary.

To obtain the necessary 60° timing arc on the 20-mm antiaircraft gun, place two marks on the gun mount 60° apart. On Gun Director Mk 51 Mod 2, the 60° interval can be noted on the train scale.

1. Lock the gun in 5° elevation or gun director in zero elevation.

2. Set the range knob at the median range.

3. Starting to the left of the first mark, swing to the right fast enough to keep the reticle on the 100-mil dot to the left of scale zero. The reticle must be on the dot before the gun or director passes the first mark and remain on it until after the second mark is passed.

4. Start a stop watch at the instant the gun or director passes the first reference mark and stop it just as the second (or 60°) mark is reached. Record the time interval.

5. Repeat steps 3 and 4, swinging the gun to the left while holding the reticle on the 100-mil dot at the right of scale zero.

6. Shift the range knob setting to maximum range. Repeat the test in each direction in train and record the times required.

7. Shift the range knob to 400 yards and again repeat the test in each direction in train, recording the results.

8. Repeat the entire test as described in steps 2 through 8 inclusive, moving the sight at a rate sufficient to hold the reticle on the 200-mil dot if possible.

If the times recorded do not fall within the limits given in table 5, the sight must be adjusted at a gun sight repair station.

Table 5

DEFLECTION (SENSITIVITY) TABLE

Gun Sight Mk 14 Mod	Range (yards)	Time (seconds) for 60° swing: 100-mil dot Min.	100-mil dot Max.	200-mil dot Min.	200-mil dot Max.
6	400	4.4	5.9	2.3	2.7
	1,200 (med.)	19.5	25.8	10.4	11.9
	2,000	40.8	54.3	21.8	25.1
7	400	4.2	5.6	—	—
	1,600 (med.)	22.0	29.2	11.8	13.5
	2,800	45.2	59.8	24.0	27.6
8	400	3.9	5.9	—	—
	2,000 (med.)	24.8	32.9	13.2	15.2
	3,200	45.5	60.3	24.2	27.8
12	400	4.2	5.6	—	—
	1,800 (med.)	20.7	27.3	11.0	12.7
	3,600	44.8	59.4	23.9	27.4
13	400	4.9	6.6	2.6	3.0
	1,400 (med.)	18.8	25.0	10.0	11.5
	3,000	43.7	58.0	23.4	26.8
14	400	4.2	5.6	—	—
	2,000 (med.)	22.1	29.2	11.8	13.6
	4,000	45.6	60.5	24.3	27.9
15	400	3.9	5.2	—	—
	2,000 (med.)	24.8	32.9	13.2	15.2
	3,200	45.5	60.3	24.2	27.8

DEFLECTION (SENSITIVITY) TEST

Gun Sight Mk Mod ______________________ **Serial No.** ____________

Location ____

100-mil dot
Minimum range

Date of test	Swing to right 60°	Swing to left 60°
1		
2		

Average time

Median range

1		
2		

Average time

Maximum range

1		
2		

Average time

200-mil dot
Minimum range

Date of test	Swing to right 60°	Swing to left 60°
1		
2		

Average time

Median range

1		
2		

Average time

Maximum range

1		
2		

Average time

Figure 99.—Deflection (Sensitivity) Test Work Sheet.

CHARACTERISTIC TIME TEST

The Characteristic Time Test is designed to determine the time required for the reticle to return from some previously established initial deflection to 37 percent of that deflection. The characteristic time thus developed is a measure of the smoothing action of the gun sight, and must be controlled within definite limits in order for the sight to perform correctly. The initial deflection for this test is established at 210 mils, with 37 percent of initial deflection at 78 mils.

The Field Test Scale has four marks, each 210 mils from scale zero and four marks each 78 mils from scale zero. These are the marks used in establishing the characteristic time of the sight.

The characteristic time test should be made directly following the deflection test, and be preceded by cycling the gun sight and any necessary adjustment of the field test scale. It is recommended that a work sheet for recording test data, similar to that shown in figure 100, be used.

Note: During characteristic time test it is essential that the sight remain motionless while the observation of time is being made.

Characteristic Time of Traverse System: If the sight is mounted on a 20-mm antiaircraft gun mount, lock the mount in five degrees elevation; if on a Gun Director Mk 51 Mod 2, lock it at zero elevation. Set the range knob at maximum.

1. Swing the sight to the right through an arc of approximately 45°; stop the sight quickly, and hold it motionless. The reticle will be seen moving to the right from the left end of the scale.

Caution: Swing the sight only rapidly enough to bring the reticle to the end of the scale. Too rapid swinging may damage the gyro unit.

2. Start a stop watch when the reticle center dot passes the 210-mil mark. Stop the watch as the 78-mil mark is passed, and record the time interval.

3. Following the same procedure, swing the sight in the opposite direction, and record the characteristic time for the reticle moving from right to left.

4. Continue taking readings in alternate directions until a total of ten readings (five in each direction) have been taken. Average the time of movement in each direction, to minimize any personal error.

Caution: If it is found that the ten observations of time, taken in any run, differ by 0.4 second or more, the figures should be discarded. After checking the set-up, a new run should be made.

Characteristic Time of Elevation System: Lock the gun mount or gun director in zero train (fore-and-aft) and set the range knob for the maximum range for the gun sight Mod being tested.

1. Depress the sight as far as possible, and allow the reticle to settle.

2. Return the sight rapidly to horizontal, and hold it motionless in that position. With a stop watch, time the return of the reticle along the vertical centerline between the characteristic time marks. Record the time.

3. Elevate the sight about 60°; allow the reticle to settle, and repeat the foregoing procedure.

4. Repeat each of the above steps five times alternately, and determine the average time in each direction. Again, if the figures in the run differ by 0.4 second or more, they should be discarded and retaken after the test set-up has been inspected.

Allowable Limits of Characteristic Time: Table 6 lists the allowable limits of characteristic time for the various Mods of Gun Sight Mk 14. The limits given are for two different temperature ranges, room temperature and extreme temperature. The limits allowed for room temperature (65° to 85° F.) apply when the sight is being checked at a service station, provided the temperature is within those limits. When the sight is being checked aboard ship, or when the temperature surrounding the sight at the station is below 65° F. or above 85° F., wider tolerances must be allowed. The values for extreme temperature (0° to 100° F.) are then used.

CHARACTERISTIC TIME TESTS

Gun Sight Mk 14 Mod ______________ **Serial No.** ______________

Location ______________ **Date of Test** ______________

TEST IN ELEVATION

Elevate sight to horizontal, and time reticle movement	Depress sight to horizontal, and time reticle movement	Time (not to vary 0.4 second or more from one to another)

1. ______________
2. ______________
3. ______________
4. ______________
5. ______________
6. ______________
7. ______________
8. ______________
9. ______________
10. ______________

Note: ______________ Total time ______________

Take readings in alternate directions. Average time ______________

TEST IN TRAIN

Swing sight to left, anl time reticle movement	Swing sight to right, and time reticle movement	Time (not to vary 0.4 second or more from one another)

1. ______________
2. ______________
3. ______________
4. ______________
5. ______________
6. ______________
7. ______________
8. ______________
9. ______________
10. ______________

Note: ______________ Total time ______________

Take readings in alternate directions. Average time ______________

Figure 100.—Characteristic Time Test Work Sheet.

Table 6 — CHARACTERISTIC TIME TABLE

Gun Sight Mk 14 Mod	Range setting (yards)	Characteristic time, seconds: Room temp. (65° to 85° F.) Min.	Room temp. Max.	Extreme temp. (0° or 100° F.) Min.	Extreme temp. Max.
6	2,000	5.3	6.3	5.3	6.7
7	2,800	5.9	6.9	5.9	7.4
8	3,200	5.9	6.9	5.9	7.4
12	3,600	5.9	6.9	5.9	7.4
13	3,000	5.7	6.7	5.7	8.2
14	4,000	6.0	7.0	6.0	7.5
15	3,200	5.9	6.9	5.9	7.4

Correction for Characteristic Time

Characteristic time is the only performance test for which correction can be made aboard ship. If the characteristic time is not within the limits allowed on table 6, the thermoswitch of the gyro unit concerned can be adjusted to change its temperature. After making the thermoswitch adjustment, wait ten minutes for the temperature to stabilize, and repeat the test. If the characteristic time is too slow, the temperature of the unit should be increased; if too fast, the temperature of the unit should be decreased. Detailed instructions for this adjustment are contained in chapter 9.

Performance Test Records

A permanent record of the results of the performance tests is extremely valuable. A master form similar to that shown in figure 101 for entry of test results from the work sheets is recommended. When a gun sight must be returned to a repair station for overhaul, the results of the last performance tests should be returned with it. These test data will facilitate diagnosis of the trouble, and expediate the return of the gun sight into service.

Boresighting

The procedure of boresighting is designed to make a line projected from the gun barrel intersect with the line of sight through the reticle of the sight at some predetermined point. As shown in figure 102, the lateral and vertical distance between the gun barrel and the gun sight would cause the two lines to be directed at different points if the sight were not offset to make them intersect. The distance between the two lines at the sighting point is called parallax. Boresighting is the adjustment to compensate for the existing parallax.

In boresighting Gun Sight Mk 14 Mod 6 or 15 to a gun, the predetermined point of intersection of the two lines of sight should be some convenient target at a distance not less than 1,000 yards. The boresight range should be approximately equal to the median range of the particular Mod installed. If parallax is corrected at the median range, the error will be negligible for all other ranges at which the sight can be used.

Basically, all boresighting is accomplished in the same manner, the different methods hereafter described differing only in the equipment used.

The most effective method of boresighting is by aligning the barrel of the gun on the target, and shifting the reference point in the sight (the reticle) until both gun and sight are directed on the target. Two tools are available which lend themselves to boresighting the 20-mm gun by this method. One is the muzzle boresight tool described in chapter 6. With this tool the small amount of parallax between the telescope and the gun barrel is negligible. The second tool, the boreclear mirror, permits viewing through the gun barrel. Crosswires placed over the muzzle of the gun barrel then allow the gun barrel to be used as a telescope.

Another method of boresighting involves aligning the gun sight to the gun sight bracket, which was previously boresighted to the gun as described in chapter 6. If the gun sight bracket has been boresighted with the gun barrel upon installation, bringing the sight into line with the bracket should also bring it into line with the gun barrel. This procedure involves the use of the boresight tube furnished with the gun sight.

Before boresighting, always cycle the gun sight as described in chapter 4.

MASTER TEST DATA SHEET

Gun Sight Mk Mod____________________ **Serial No.** ____________________

Location____________________ **Date**____________________

Dead Zero Tests

	Average difference (mils)
Elevation	
Train	

Range Shift Tests / Superelevation Tests

	Range Shift Tests: Average difference (mils)	Superelevation Tests: Average difference (mils)
Median to minimum		
Median to maximum		

Characteristic Time Tests

	Average reading (sec.)	Maximum variation of readings (sec.)
Elevation		
Train		

Deflection (Sensitivity) Tests

	Average time, 100-mil dot	Average time, 200-mil dot
Minimum range		
Median range		
Maximum range		

Figure 101.—Master Test Data Sheet.

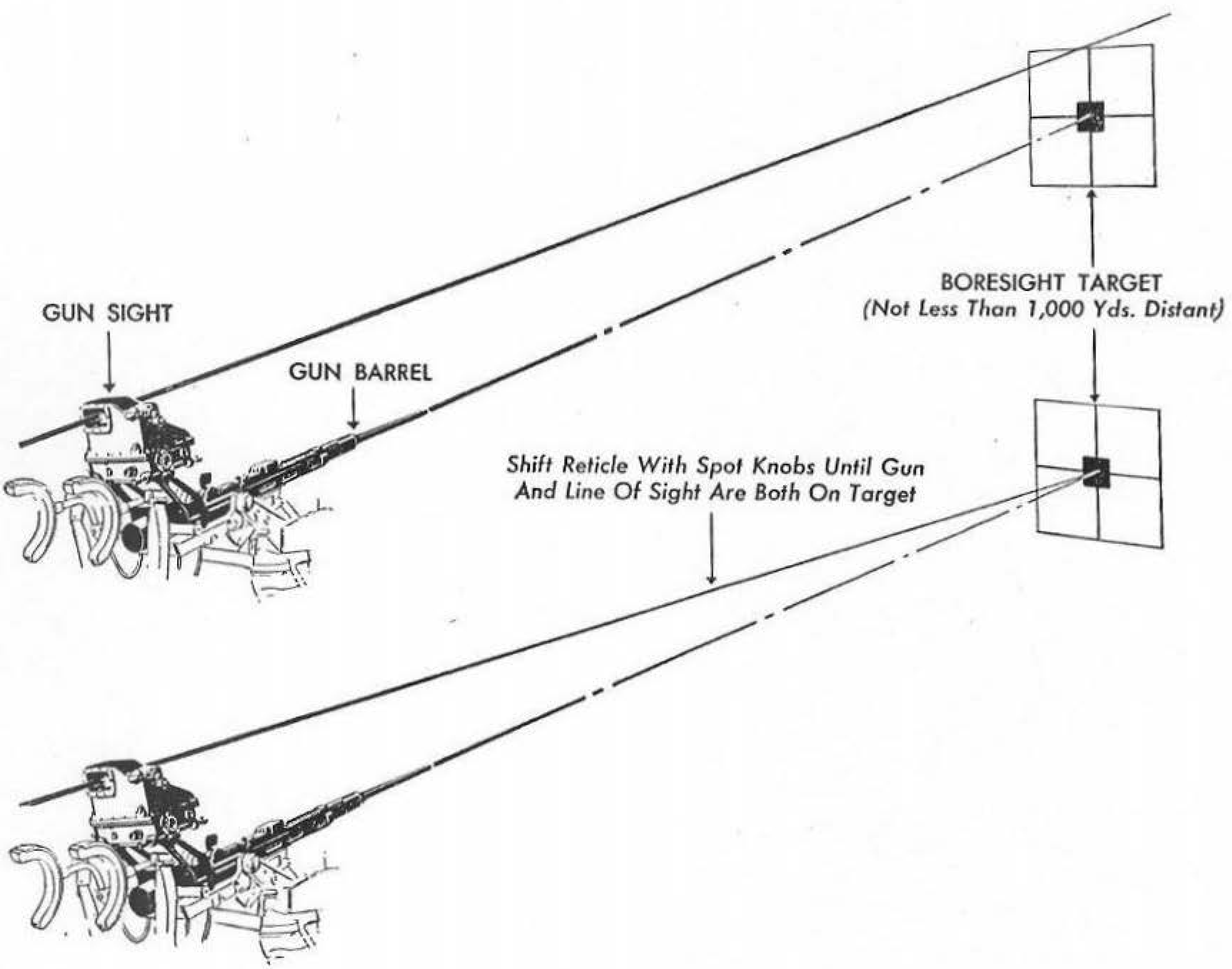

Figure 102.—Boresighting Reticle to the Barrel.

Boresighting With Muzzle Boresight Tool

Insert the muzzle boresight tool into the gun barrel as described in chapter 6, and move the gun to align the telescope with the target. Check the telescope crosslines by rotating the tool 360° in the gun barrel, and noting at each 90° position whether the lines stay on target. If they do not, adjust the position of the crosslines until they do stay on during a complete revolution.

Since the superelevation weights on the gyros apply superelevation whether the gun is being operated or not, a spot in elevation must be applied to the reticle to return it to its neutral position. The correct adjustment of the elevation spot knob is 15 mils down. When tht indicator is opposite the red D on the knob, the proper correction for median range has been applied.

The deflection spot knob is set on zero, and the range knob is set to median range. To see the reticle center dot during the operation, use the neutral filter to cut down the background intensity and increase the reticle brightness to maximum.

Boresighting is accomplished when both the muzzle boresight tool and the gun sight reticle center dot are on the identical portion of the target. The gun barrel having been aligned on the target, the reticle is moved to coincide with it by adjusting the spot knobs. When the boresight tool and the reticle center dot are both on target, as shown in figure 102, the spot knobs are shifted on their shafts to bring them back to their proper position on the scale as described later.

Boresighting With Boreclear Mirror

The boreclear mirror is a mirror which is inserted into the breech of the 20-mm gun at an angle of 45°. This enables an observer above the breech to have a direct view through the bore of the gun. Two wires or fine strings may be stretched across the gun muzzle, one horizontally and the other vertically. These may be centered in the muzzle by eye, as the error will be negligible. When viewed in the boreclear mirror, the wires will appear as the crosslines of a telescope, and can be centered on the target in the same manner as the crosswires of the muzzle boresight tool.

From here on, the procedure of boresighting is the same as outlined for the muzzle boresight tool. One man is stationed at the boreclear mirror, and the other at the gun sight.

Boresighting With the Boresight Tube

The boresight tube, used in boresighting the gun sight bracket to the gun barrel, can also be used to boresight the gun sight.

Remove the right-hand gun sight support rod, and, in its place, insert the boresight tube. If the gun sight bracket has remained in the same position in which it was installed, the boresight tube should now be lined up to intersect a line through the gun barrel at the target.

Before proceeding, the boresight tube should be checked by rotating it through 360°, stopping at every 90° to see that the crosswires are still on the target. If they are not, rotate the caps holding the crosswires and peephole and try to adjust them. If they cannot be adjusted in this way, the tube is probably bent, and another one must be used.

The reticle now is adjusted by moving the spot knobs until its center dot and the crosswires of the boresight tube are centered on the target at the same time.

If one of the first two methods described is used, there is no need to be concerned about any shift in the alignment of the gun sight bracket, since the sight is boresighted directly to the gun barrel. If the latter method is used, any shift of position of the bracket will cause the gun sight to be misaligned by the same amount.

Adjusting Spot Knobs

If the gun sight has not been correctly boresighted, and the spot knobs have had to be moved, they must be shifted until they read correctly again.

Two types of spot knobs will be encountered: the early design, which is identified by three small fillister head screws in the recess on the face of the knob (fig. 103), and the late design, which has only one large fillister head screw in the center of the recess (fig. 104). The graduations and markings on both designs are exactly the same. The method of adjusting the early design is somewhat different from that of adjusting the late design. Each method will be described.

To facilitate spot knob adjustment, stuffing boxes for both types of spot knobs are provided with elongated holes for the three attaching screws (fig. 106).

On knobs of the early design, the outer screws in the face of the knob are fitted into elongated holes for the same reason.

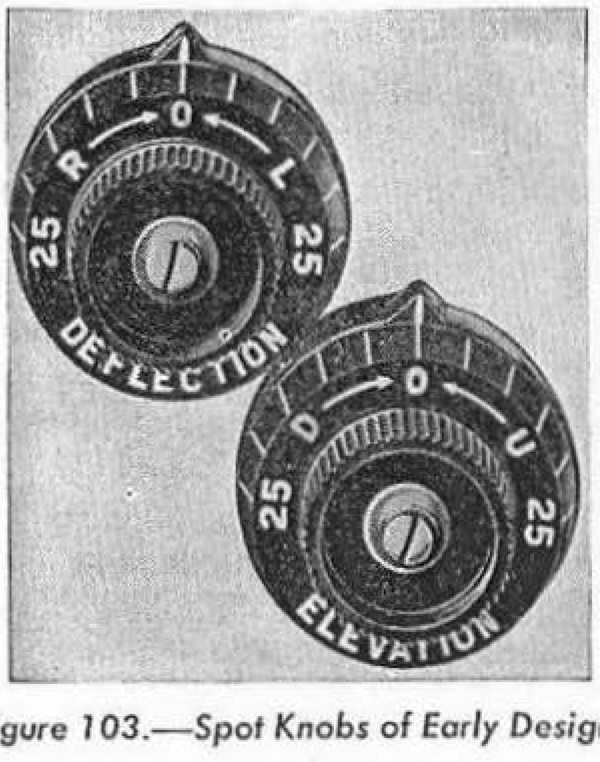

Figure 103.—Spot Knobs of Early Design.

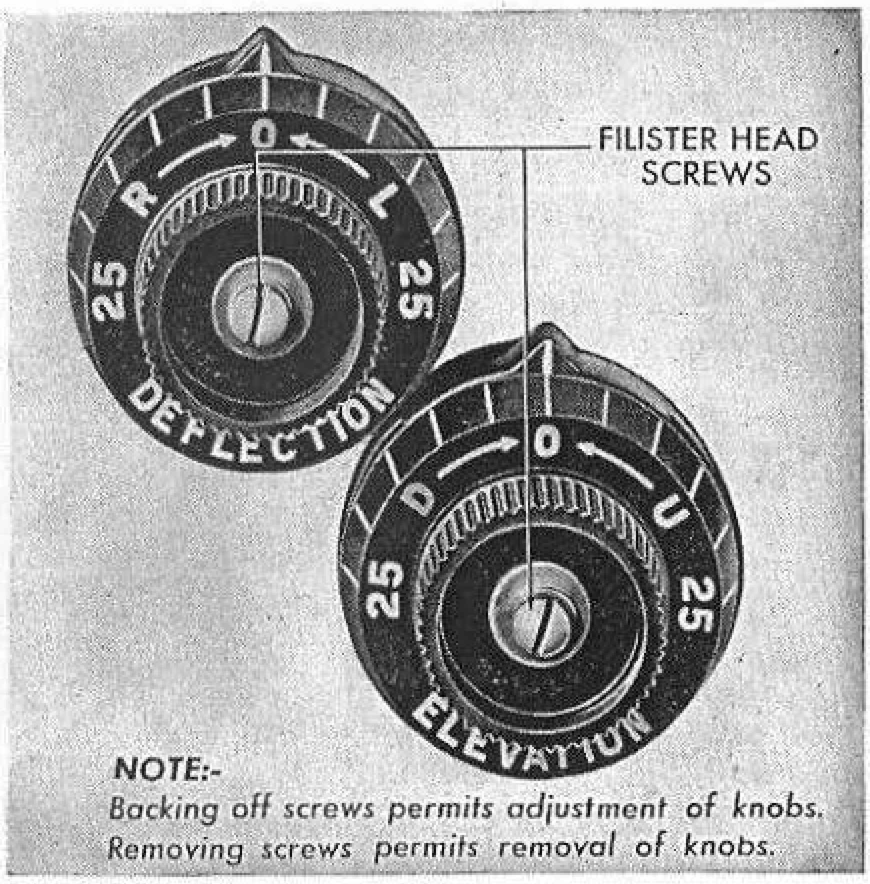

Figure 104.—Spot Knobs of Late Design.

Adjusting Knobs of Early Design: After boresighting, if each knob is exactly in a detent, proceed as follows:

1. Remove the center screw which holds the elevation knob and bushing to the spotting shaft, and remove the knob and bushing until they are clear of the shaft.

2. Turn the knob until the 15-mil mark on the DOWN scale (opposite red D) coincides as nearly as possible with the index mark.

3. Push the knob and bushing back on the shaft.

4. If final adjustment is necessary, loosen the two outside screws and turn the knob only, until the index is exactly on the 15-mil mark.

5. Tighten the two outside screws, and then replace and tighten the center screw.

6. Adjusting the deflection spot knob is accomplished in the same manner, except that the index must finally coincide with the red O mark on the scale.

If either knob is not set exactly in a detent, it becomes necessary to shift the stuffing box. To accomplish this, the spot knob is removed, exposing the stuffing box with its three attaching screws (figs. 105 and 106). Loosen the three screws. Turn the spotting shaft until it falls into the next detent. This will throw the reticle off target.

It will be necessary to boresight again, but this time move the reticle back onto the target by loosening the screws and turning the stuffing box, being careful that the shaft stays in the detent. After boresighting, tighten the three screws in the stuffing box and replace the spot knob, adjusting it to the proper position as outlined above.

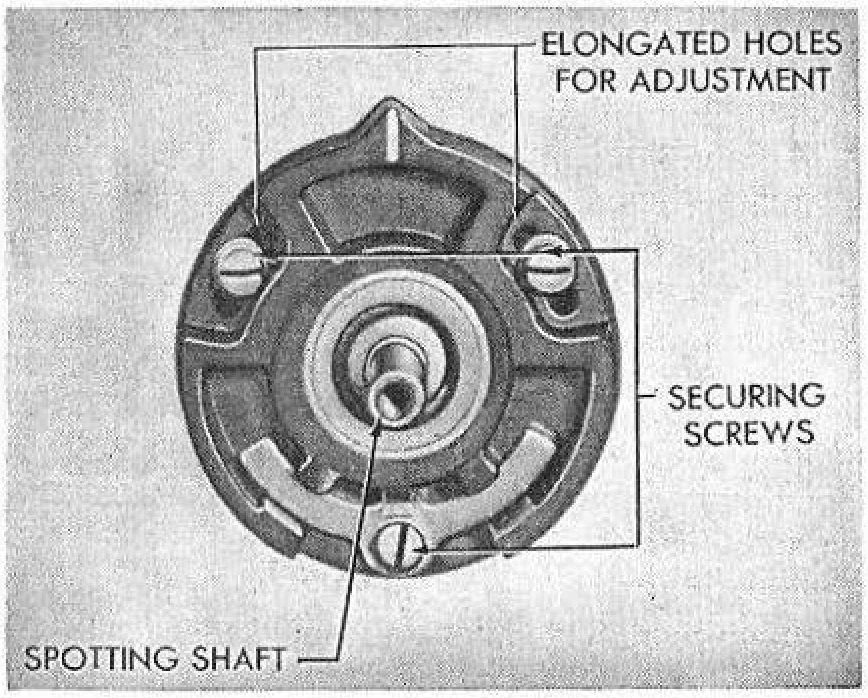

Figure 105.—Spot Knob Stuffing Box.

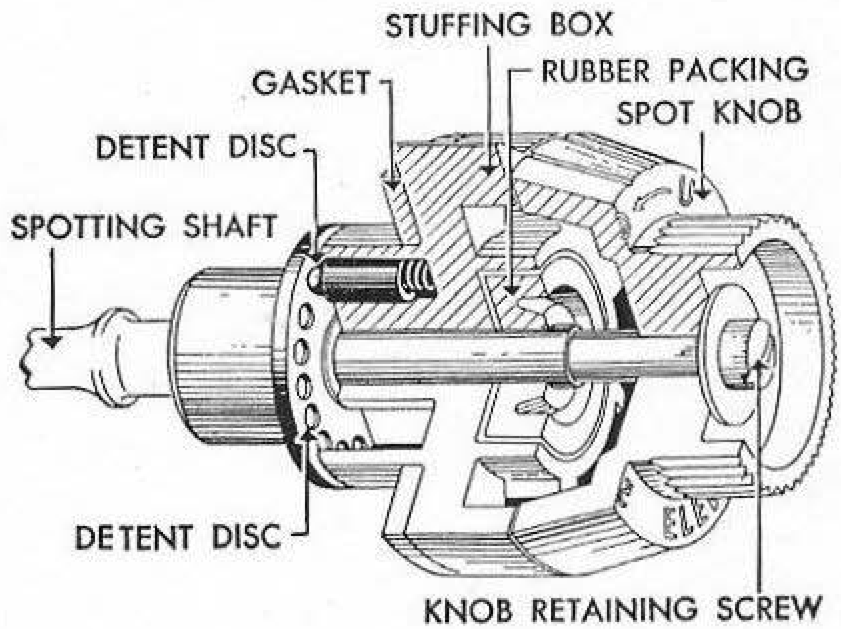

Figure 106.—Spot Knob Stuffing Box Details.

Adjusting Knobs of Late Design: After boresighting, if a spot knob has come to rest in a detent, it is only necessary to loosen the single screw in the knob face, turn the knob until the index lines up with the proper graduation (red D on elevation, red O on deflection), and tighten the screw.

If a knob has come to rest between two detents, first turn the knob to the nearest detent and then completely remove the knob, exposing the stuffing box.

From here on, follow the same procedure as outlined for the early design. After adjusting the stuffing box, replace the knob, setting the index opposite the proper graduation on the knob.

Caution: After spot knobs have been adjusted, always recheck the boresight to make sure there has been no shift.

Set the elevation spot knob back to zero, and remove whatever tool has been used in boresighting.

Chapter 9

MAINTENANCE — CHECKS AND ADJUSTMENTS

Introduction

Maintenance instructions given here for Gun Sight Mk 14 apply to Mods 7, 8, 12, 13, 14, and 15 (used on Gun Director 51), as well as to Mod 6, (used on 20-mm and 40-mm mounts).

Checks and adjustments outlined are to be made only by regularly assigned maintenance personnel aboard ship.

Caution: Except as outlined on the following pages and as expressly noted in the "Trouble Chart", no adjustment or repair of the gun sight should be made except by specially trained personnel at qualified repair stations.

Daily Checks

Before making daily checks, if the gun sight is provided with standby wiring, and has been connected to the ship's current for 30 minutes, it will be necessary to wait for only three minutes after turning on the power switch before using the sight. If standby wiring is not provided, or has not been connected, it will be necessary to wait for 30 minutes to allow the sight to reach operating temperature.

The following checks and tests should be made at least once each day, and every time the sight is placed in operation:

1. Check the air pressure gage on the power unit. The pointer should be within the green sector of the dial.

2. Check the reticle brightness by turning the reticle dimmer knob first to one, then to the other bright (BR) position. In each case, the reticle should come up to maximum brightness. If it does not, inspect the reticle lamp, and replace it if necessary. Then, set the reticle to the required brightness.

3. Set both spot knobs on zero detent.

4. Check reticle movement. Set the range knob at the maximum value. Swing the sight in train at a rapid rate until the reticle reaches the end of its travel. Then, hold the sight stationary and watch the reticle return to its central position. The reticle movement must be smooth and steady. Repeat the same test in the other direction in train, and in both directions in elevation. If the reticle movement appears to be jerky or irregular in any of these directions, the gun sight must be removed and sent to a gun sight repair base for adjustment.

If the above checks have been satisfactory the sight is ready for use. Set the range knob at the standby position, (400 yards).

Periodic Checks

Air Pressure Regulator: Check the sight air pressure at least once every two weeks, or after every 200 hours of operation. Attach a portable test gage (BuOrd 325723—2) to the air pressure regulator test connection. This connection can be reached by removing the plug shown in figure 107. Be sure the gage is correct by checking it against a master gage. Check the pressure delivered from the power unit to see that it is correct.

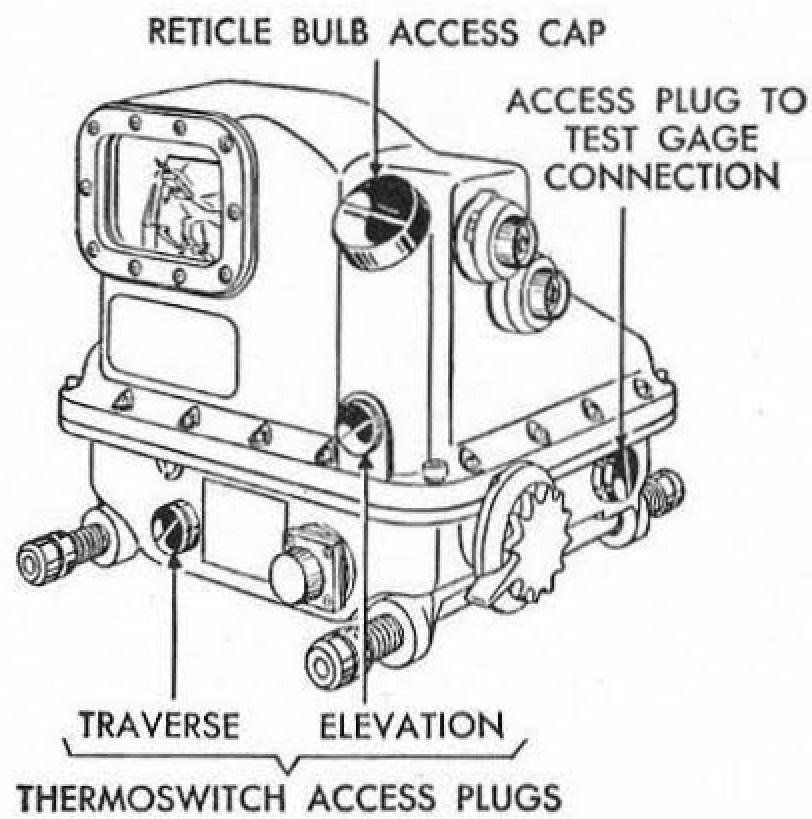

Figure 107.—Gun Sight Mk 14 Access Plugs, Rear and Right Side.

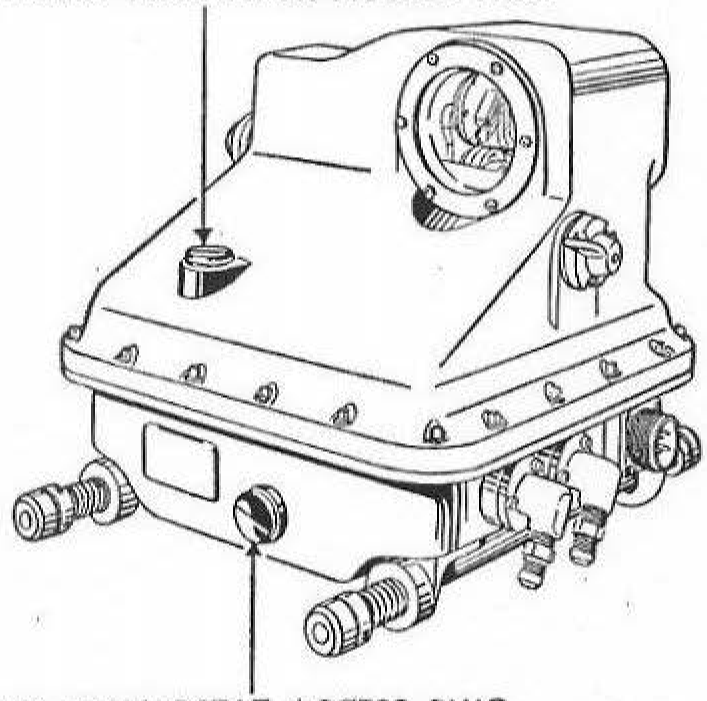

Figure 108.—Gun Sight Mk 14, Front Access Plugs.

The correct pressure is 2¼ p.s.i. (31 in. water at 68° F.) When the pointer is in the green sector of the gage, the pressure is correct. If it is not, check hoses, air drier, and filter for restrictions. If no restriction is found, the air pressure regulator must be adjusted.

To reset the regulator, proceed as follows:

1. Remove the access plug (See fig. 108).

2. Loosen the hexagonal locknut a the top of the regulators.

3. If air pressure is low, turn the adjusting screw (fig. 109) clockwise; if air pressure is high, turn the screw counterclockwise.

4. Tighten the locknut and replace the access plug, making sure that the gasket is pulled up airtight.

Air Filter: The air filter should be cleaned once each month.

1. Remove the three screws securing the air inlet elbow at the sight.

2. Remove the elbow; take out the wire mesh filter, and remove any accumulated dirt or other foreign matter.

3. Replace the filter and inlet elbow, making sure the gasket is pulled up airtight.

Lubrication: Once each week, clean and grease with vaseline the two support rods on which the sight is mounted. Also apply vaseline to the shock absorber springs. This will minimize corrosion, and will prevent the support rods from freezing to the sight case and the gun sight bracket in cold weather.

Grease the threads lightly with vaseline at all electrical cable connections.

Apply a light coat of vaseline to the shaft of the

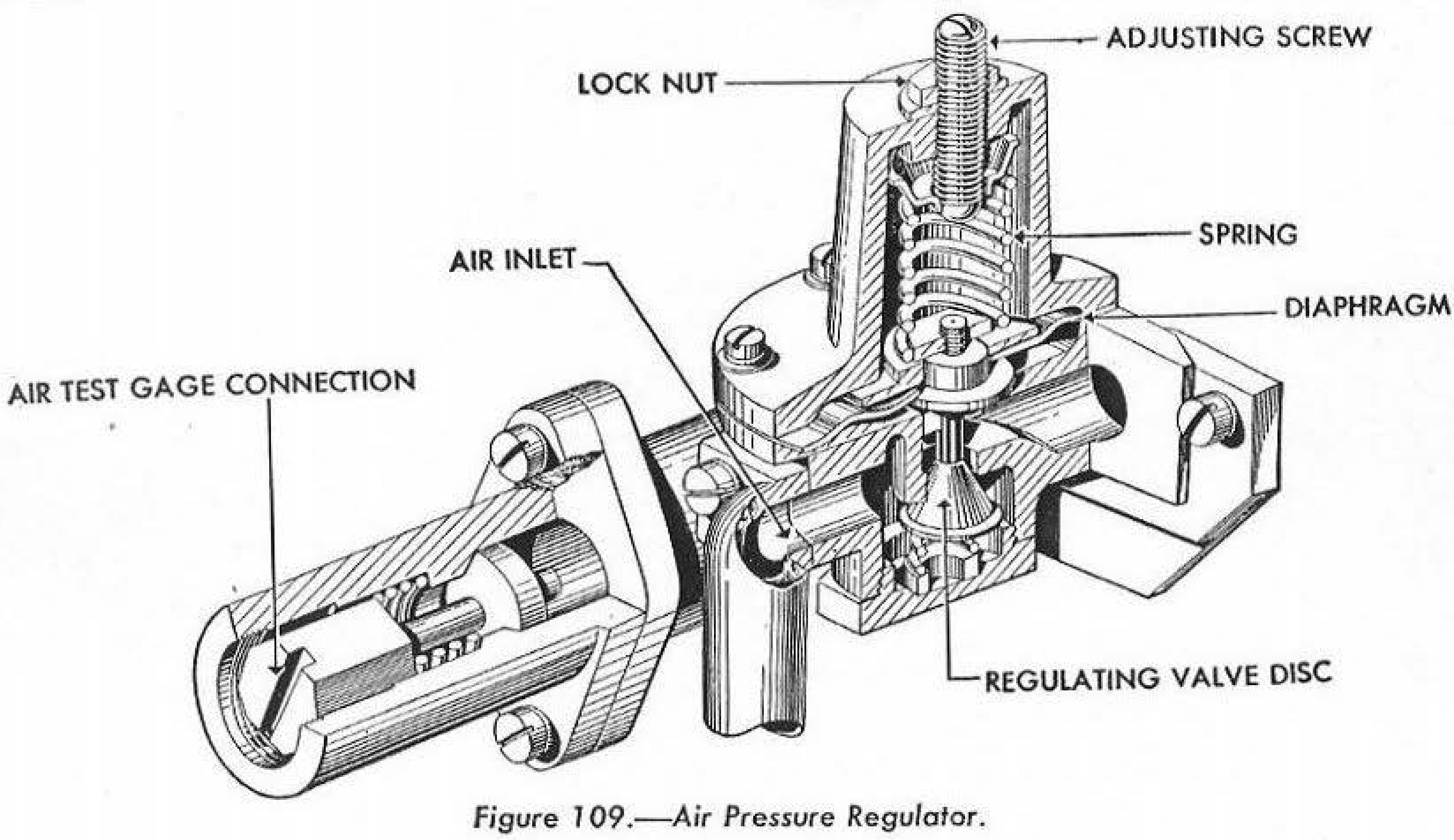

Figure 109.—Air Pressure Regulator.

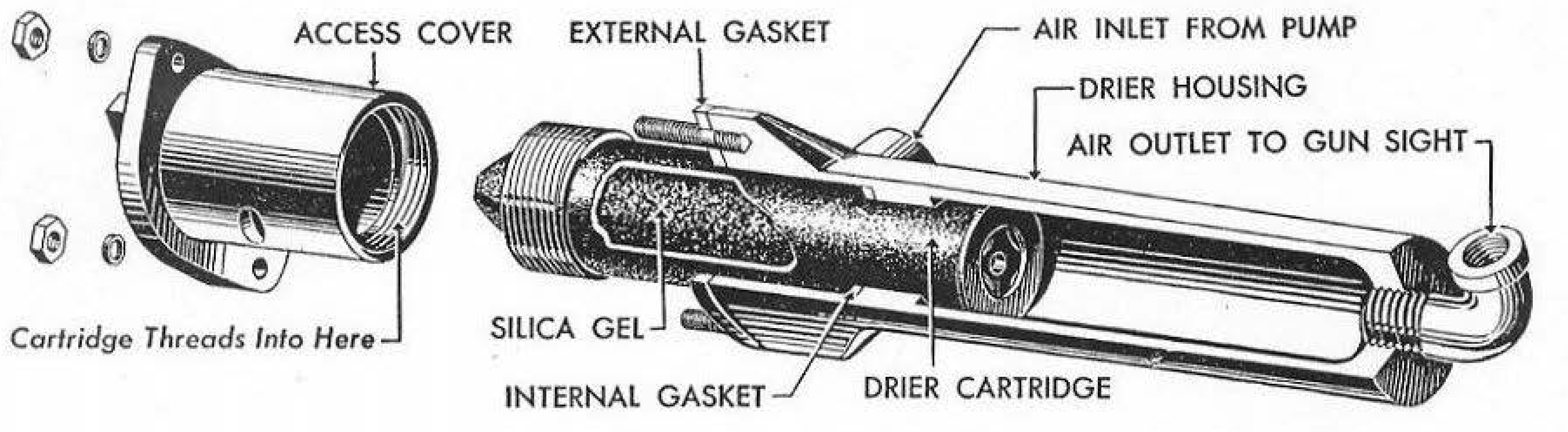

Figure 110.—Air Drier, Exploded View.

power unit cut-out switch at the point where it passes through the stuffing box.

Remove the cap and adjustment screw of the by-pass valve in the air pump head. Apply a thin coating of vaseline to the threads of both the screw and the cap. After replacing the adjustment screw, start the power unit and check the gage pressure. If the pressure is incorrect, adjust the by-pass valve.

All internal parts of the sight were adequately lubricated during assembly, and need no further lubrication. No lubrication should be attempted except during overhaul at a service station.

Air Drier: Once each week, remove the drier from its housing on the power unit for the purpose of observing the condition of the silica gel.

To remove the drier, first take off the two nuts holding the access cover on the drier, and remove the cartridge from its housing (fig. 110).

The color of the silica gel indicates whether or not it needs replacing. If the silica gel is blue, it is still dry and need not be replaced. If the silica gel has changed to a pink color, the material is wet and should be activated. In the latter case, unscrew the cartridge from the access cover and renew it with a spare, dry cartridge.

When renewing the drier, check the condition of the internal and external gaskets, and renew them if necessary. Make sure that the internal gasket is correctly placed in the drier housing, so as to make an airtight joint when the access cover is put in place.

Silica gel cartridges which have been removed because of saturation should be stored in a dry place until they can be activated.

To activate the silica gel, place the cartridges in an oven heated to between 275° and 300° F. The oven temperature should never be allowed to rise above 300° F., or the drier may be damaged. The cartridge should be left in the oven from four to five hours, or until the silica gel regains its blue color. The activated cartridges should immediately be placed in airtight containers and stored until needed.

At times, silica gel turns brown when being activated. This may be caused by carbonization of accumulated salt or oil. Such a condition will not impair the dehydrating properties of the material, but may make its color change indications unreliable. Cartridges in this condition should be refilled with silica gel at a repair station.

Pump Diaphragm: Approximately every two months, the air pump diaphragm should be inspected, and renewed if necessary. This operation can be accomplished by loosening the two wing nuts on top of the pump head, and disengaging the two anchor bolts from the forks on the head; the pump head can then be lifted off.

The diaphragm may be removed after unscrewing the piston screw in the center, and removing the piston cap (See fig. 111). The diaphragm should be thoroughly inspected and, if found in good condition, used again. If the diaphragm shows signs of excessive wear, or a possible break through, it should be discarded and a new diaphragm installed from the spare parts box. This can be done properly only if the pump is at the top of its stroke. Care should be exercised in replacing the piston cap and screw to avoid pinching the diaphragm.

Piston Screw Washer: The thin rubber washer (BuOrd No. 325380-8) under the head of the piston screw should be renewed whenever the diaphragm is replaced. This washer rests on the countersunk face of the piston cap. Above it is a thin metal washer, and above the metal washer is a lock washer. The metal washers should not require replacement.

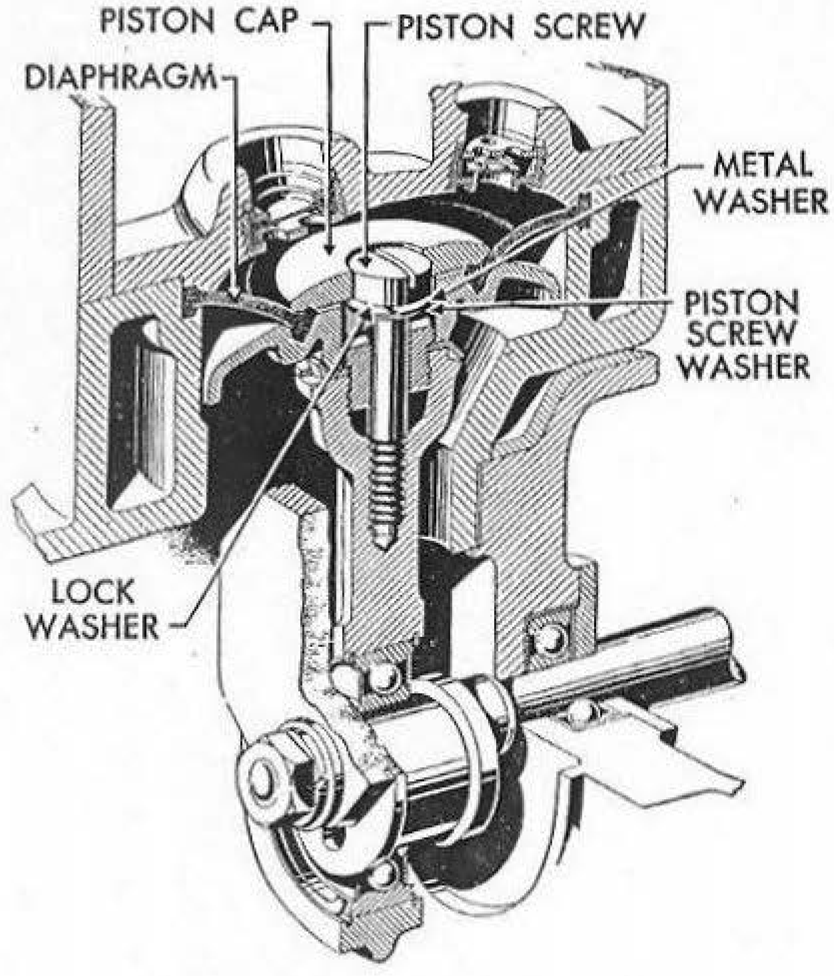

Figure 111.—Air Pump Details.

Miscellaneous Adjustments and Replacements

Thermoswitch Adjustment: Should the characteristic time test indicate that it is necessary to adjust a gyro unit thermoswitch, proceed as follows:

1. Remove the access plug at the rear of the sight. The plug for the traverse gyro is at the left and that for the elevation gyro at the right (fig. 107). A small pencil-type flashlight can be directed into the access hole to illuminate the adjusting shaft.

2. Figure 112 shows a thermoswitch adjusting shaft. If the characteristic time is too short, turn the adjusting shaft clockwise to decrease the temperature of the gyro unit. If the characteristic time was too long, turn the shaft counterclockwise to increase the temperature.

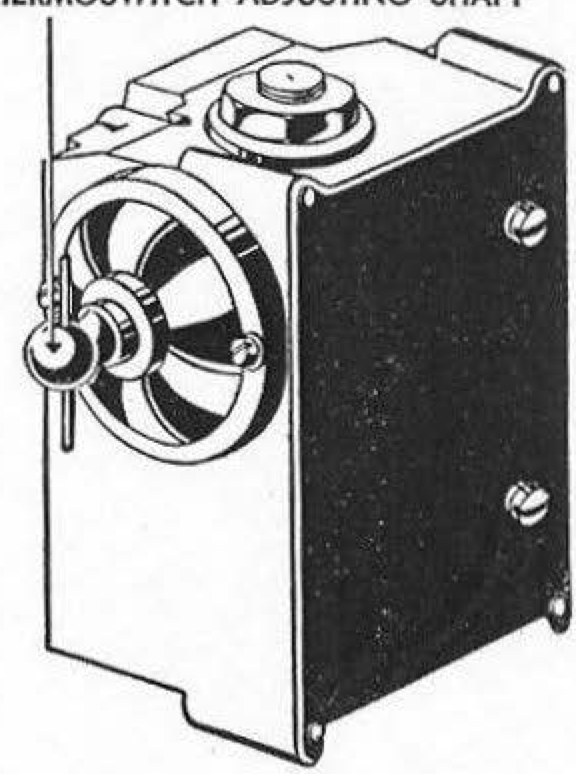

Figure 112.—Thermoswitch.

3. Make the adjustment with the thermoswitch adjusting wrench provided with each Calibration and Training Fixture, turning the shaft only about ⅛ turn, a little at a time.

Caution: When using this wrench be careful not to mark or burr the range adjustment gears.

4. When the thermoswitch setting has been completed, replace the access plug, warm the sight for at least 30 minutes and conduct a characteristic time test.

Air Thermostat: The setting of the air thermostat can vary somewhat without appreciably affecting the efficiency of the sight. Since no method of measuring air temperature in the gun sight will be available aboard ship, it is recommended that no attempt be made to adjust the air thermostat. Removing the access plug (fig. 108) will expose the thermostat adjusting screw. Turning the screw clockwise will raise the air temperature.

Reticle Lamp: Removal of the reticle lamp access cap (fig. 107) will expose the reticle lamp spring and cap assembly. To replace the lamp, remove this assembly from its housing (fig. 113) as follows:

1. Push down on the assembly cap (fig. 114), and turn it counterclockwise as far as it will go and lift the assembly from the housing.

2. Remove the reticle lamp from its base by push-

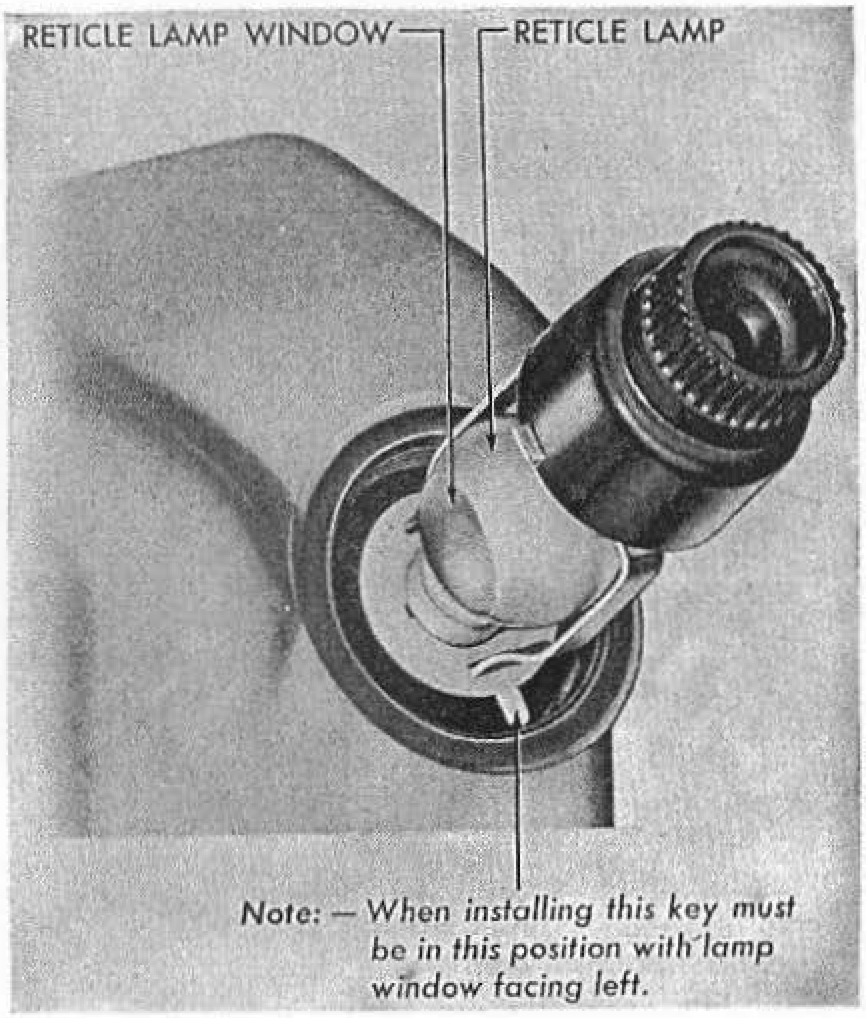

Figure 113.—Reticle Lamp Removal.

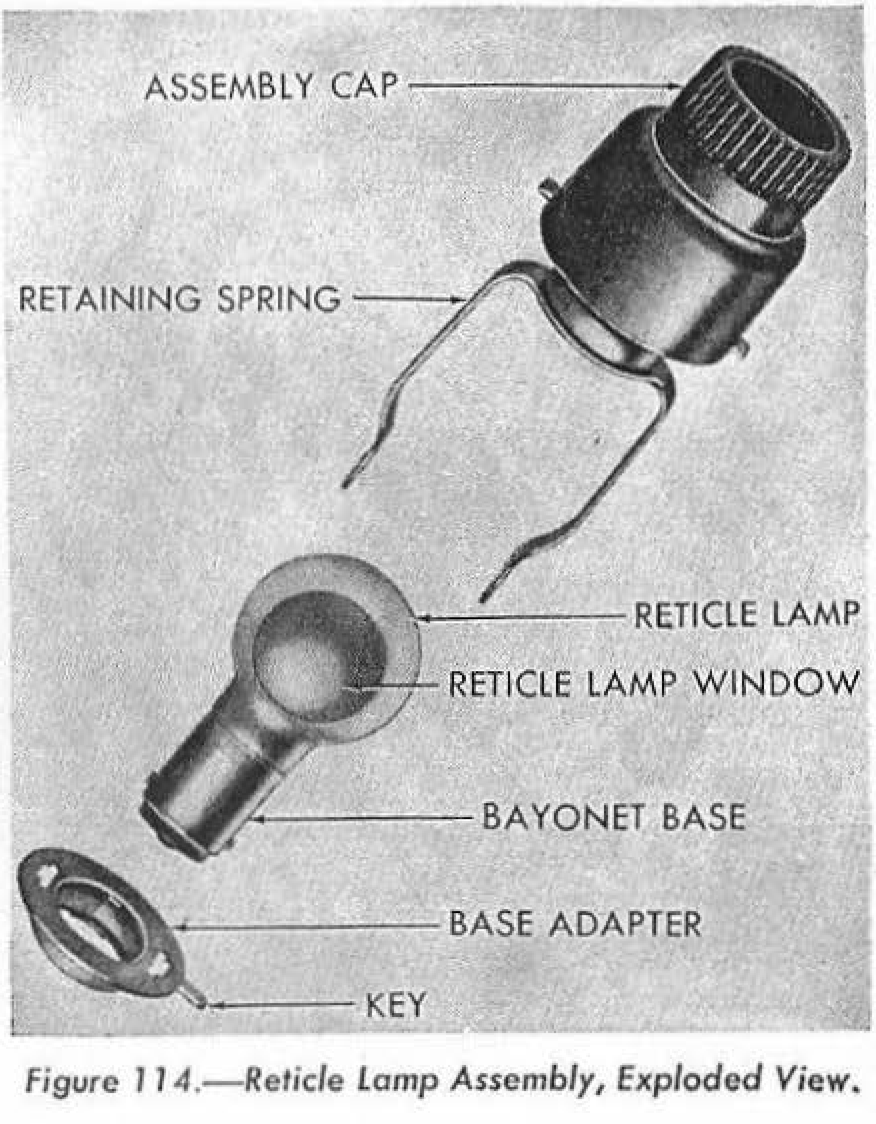

Figure 114.—Reticle Lamp Assembly, Exploded View.

ing the lamp down against the retaining spring, turning it counterclockwise and lifting it out.

3. When placing a new lamp in the assembly, take care that the window of the lamp is facing 90° clockwise from the key on the base adapter. The correct position of the window is shown in figure 113.

4. When replacing the spring and cap assembly, locate the key on the lamp base so that it will slide into the corresponding groove on the lower side of the lamp socket; then, push down on the assembly cap and turn it clockwise as far as it will go.

5. Inspect the gasket on the reticle lamp access cap and renew it if necessary. Secure the access cap, making sure that the gasket is taken up airtight.

Air Pump Bypass Valve: If the air pump is not at the proper value, the discharge pressure can be corrected by adjusting the bypass valve as follows: (fig. 115).

1. Remove the cap over the adjusting screw in the pump head, and loosen the locknut.

2. To increase the discharge pressure, turn the adjusting screw clockwise. To decrease the pressure, turn the screw counterclockwise.

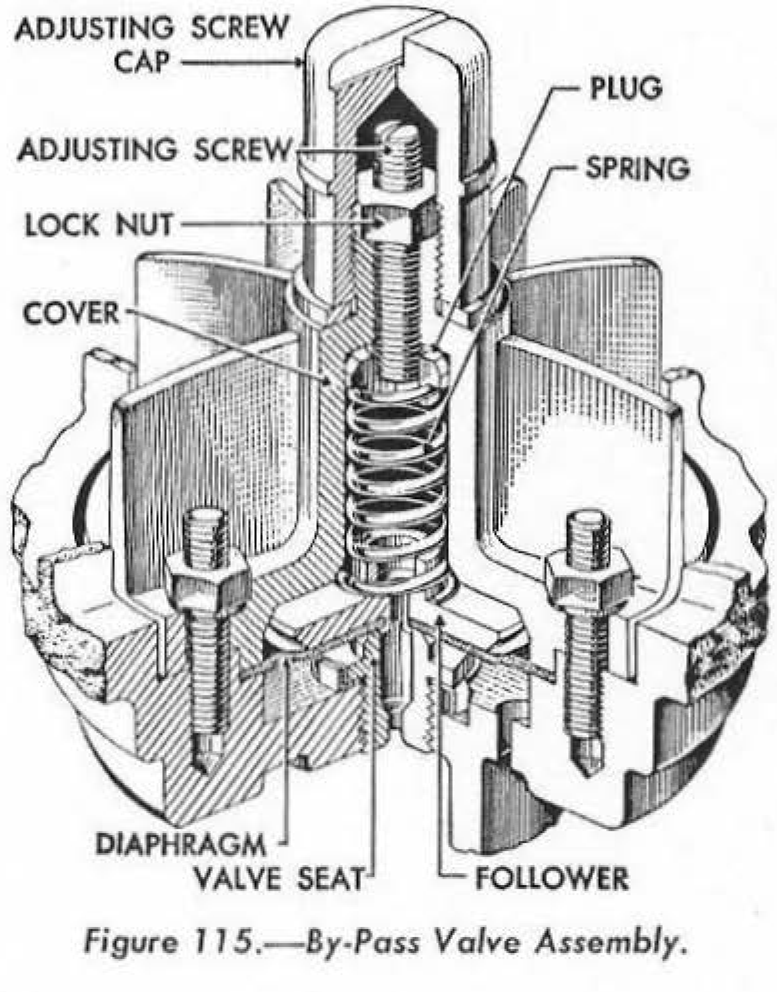

Figure 115.—By-Pass Valve Assembly.

3. Tighten the locknut and replace the cap.

Note: Before making any adjustment to the bypass valve, make sure that troubles 4a to 4h on the Trouble Chart do not exist.

Bypass Valve Diaphragm: The diaphragm in the bypass valve is subject only to slight stress, and should have a long life. However, if it needs renewal, proceed as follows:

Remove the four hexagon nuts securing the cover over the bypass valve (fig. 116), and lift off the cover. This will expose the diaphragm assembly, spring, and plug, all of which can be lifted off the pump head. The diaphragm assembly (BuOrd No. 325357–2) consists of a synthetic rubber disc riveted to a metal follower. Place the spring on the new assembly ,and secure the plug on the spring. Then, replace the cover. The cut-out switch should now be turned on, and the power unit pressure checked. If necessary, adjust the bypass valve setting to deliver proper pressure.

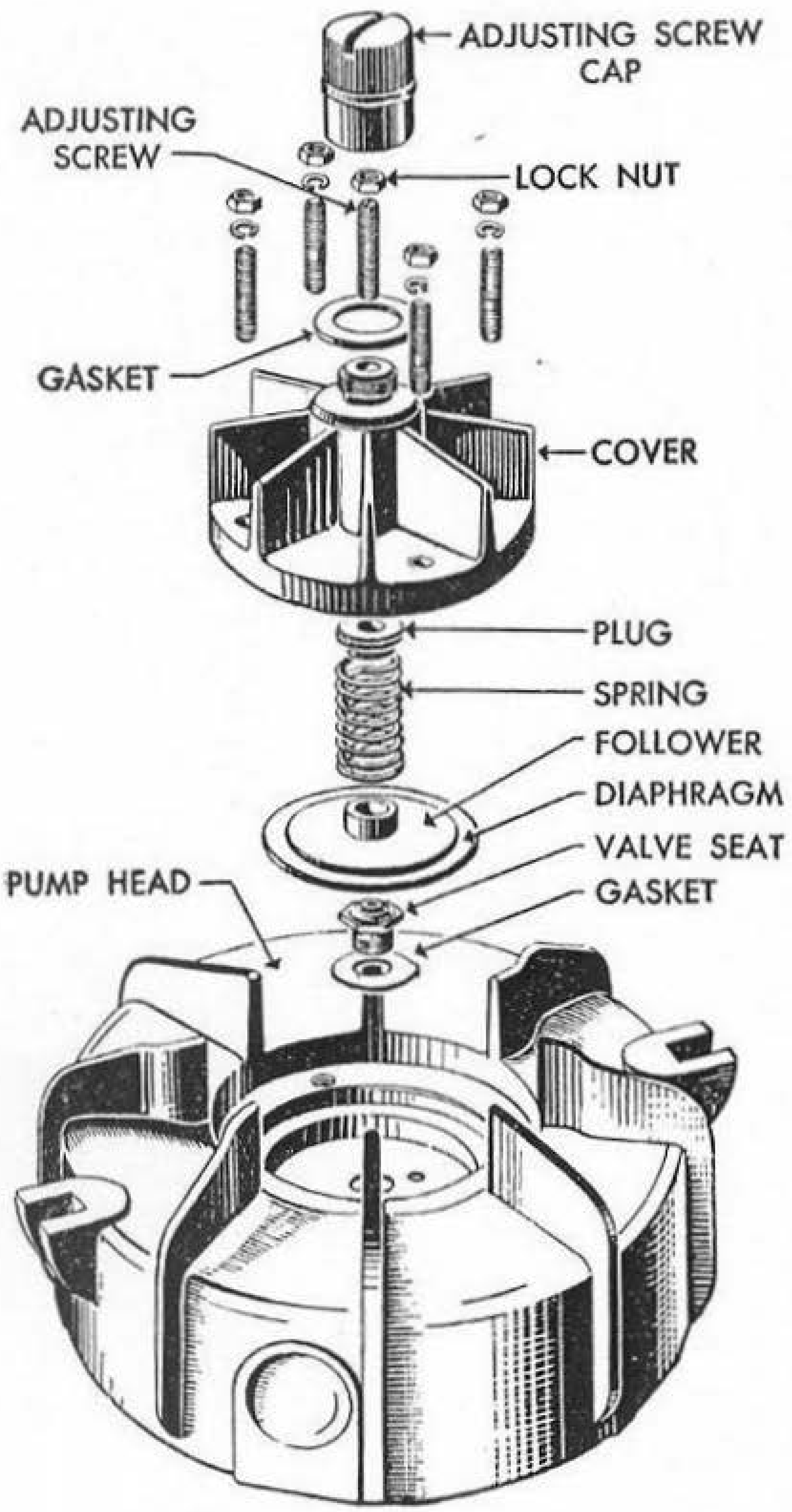

Figure 116.—By-Pass Valve Exploded View.

Piston Clearance: If the piston cap strikes the cylinder head, the diaphragm and follower piston should be removed, and the piston spacer replaced with a thinner one. If the piston spacer unit consists of a number of spacers, removal of one or more may correct the difficulty. Spanner wrenches of the proper size for removal of the follower piston are supplied only to tenders and repair stations where, the power unit should be sent for this adjustment.

Air Pump Valves: If valve leakage is suspected, first examine the output valve while it is in place in the pump head. The valve disc must rest evenly and tightly against its seat under pressure of the valve spring. It should have only a very slight sidewise movement. If this movement is excessive, the disc may slide to one side and allow leakage. Sidewise movement can be observed by pressing a pencil eraser against the disc. The valves are in a crimped casing, and cannot be repaired; if defective, they must be replaced.

Valve Replacement: To remove the output valve, unscrew it with a pin-type spanner wrench. Insert the renewal valve over a new lead gasket. Assemble the pump and place it in operation for a few minutes to allow it to warm up. Then, remove the head again, and drive the valve more tightly into place. Reassemble, and check for operation. Spanner wrenches, particularly designed for the purpose, are supplied only to repair stations and tenders. Adjustment of individual valves should be done only by tender or repair station personnel.

If leakage still exists, remove the inlet valve and inspect it in the same manner as the outlet valve. If it is defective, renew it as outlined above.

Caution: Whenever a valve is removed, whether or not it is renewed, a new lead gasket must be used for reassembly.

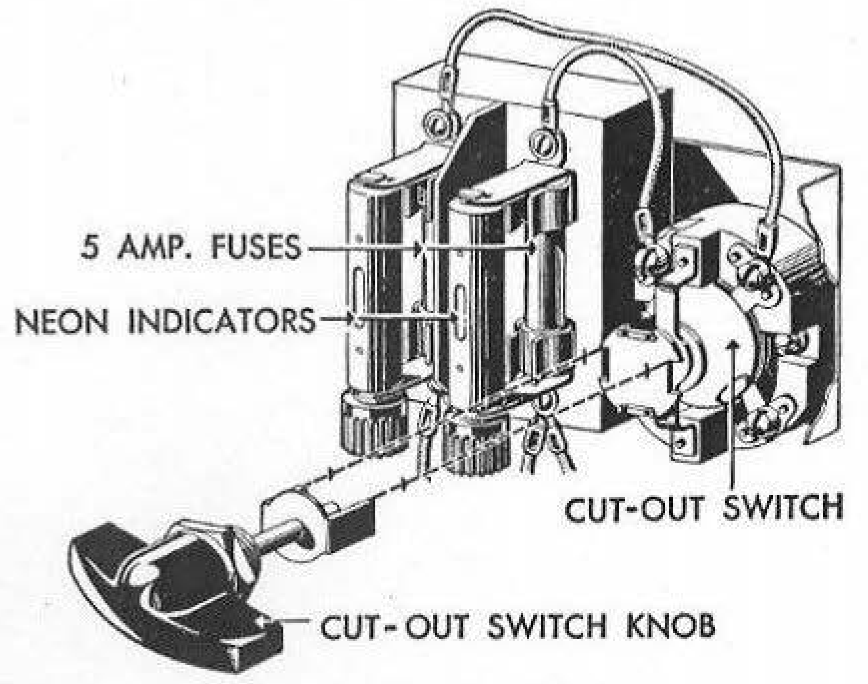

Figure 117.—Fuse Block.

Head Reassembly: Before replacing the pump head, see that the intake and exhaust port gaskets are in place between the head and housing. Set the pump head in place so that the index pin which protrudes from the head fits into the corresponding hole in the pump housing on the side near the pressure gage. Re-engage the anchor bolts in the forks, checking to see that the washers are above the forks. Tighten the wing nuts evenly.

Bearings: All bearings in the power unit are grease-sealed and should not be dismantled.

If the electric motor becomes overheated, the connecting rod bearing (running on the eccentric) may become hot and lose its lubricant. If the motor runs at abnormally high temperatures, the motor and connecting rod bearing should be replaced at a gun sight repair base.

Fuses: Access to the fuses and neon indicators (fig. 117) is accomplished by removing the crankcase cover on which the power unit cut-out switch is mounted. This cover should be removed only for replacement of fuses, or for internal servicing. The field service tool, attached to the power unit, is used to loosen the four hexagon nuts on the cover. For removing fuses, a special fuse puller is provided in the spare parts box.

Caution: Whenever any part of the power unit is opened, all air passages and spaces available must be inspected and any dirt or other foreign matter removed.

Fogged Windows and Mirrors

Fogged windows and mirrors are caused by moisture in the air supply, or by oil film. Cleaning usually requires removal of the front and rear windows, and should be done at a repair station. If this is not practicable, and shipboard servicing is imperative, the following procedure is recommended:

1. Before removing the windows, attempt to clean them by replacing the drier cartridge. Put the

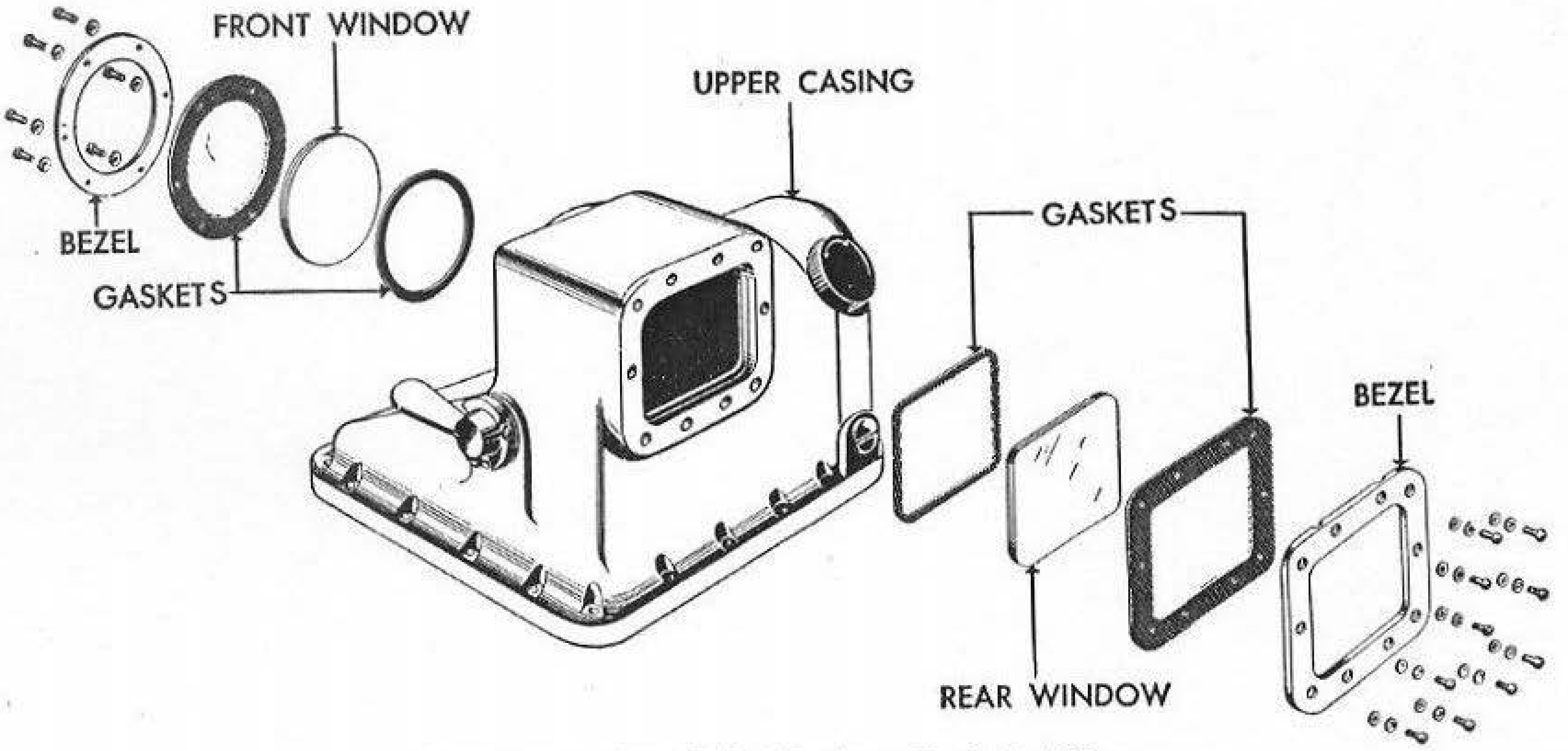

Figure 118.—Gun Sight Windows, Exploded View.

power unit and sight in operation, and allow air to circulate for at least one hour. If this fails to clear the windows and mirrors, the windows must be removed for cleaning.

2. The sight is first removed from the gun or director and taken to a place where the air is clean and dry.

Caution: Damp salt air must never be permitted to enter the sight.

3. Take out the screws around the windows (fig. 118); dismount the bezels (metal frames) and gaskets, and remove the windows.

4. Wash the windows with a clean solution of soap and water; then, rinse them with clean water and wipe them dry with soft, lintless cloth.

5. The elevation mirror (transparent mirror) should be cleaned with a highly volatile petroleum distillate, such as petroleum ether, applied with a soft, lintless cloth, lens tissue, or a camel's hair brush. Extreme care must be taken to see that the mirror is not thrown out of adjustment. Because of its extremely delicate mounting, the elevation mirror should never be cleaned aboard ship except in extreme emergency. The mirror must not be removed from its supports or turned on its pivots.

Caution: Cleaning of the elevation mirror should be done in a warm place, so that the damping fluid will not become too viscous. Cold damping fluid holds the shaft rigid, and will cause distortion of the shaft if any torque is accidentally applied.

6. The traverse mirror must never be cleaned on board ship. Do not drop cleaning fluid onto the traverse mirror. If cleaning is necessary, the sight should be sent to a gun sight repair station.

7. When replacing the windows after cleaning, be sure that the gaskets and bezels are set up airtight. Reinstall the sight, and allow it to warm up for 30 minutes. Then, carry out all performance tests as outlined in chapter 8.

Note: The installation of standby wiring frequently results in the sight being heated to operating temperatures for long periods of time. In new sights this may cause the windows to fog. Cleaning them a few times should eliminate this difficulty.

TROUBLE CHART

Trouble	Cause	Remedy
1. Pump does not start when switch is turned on at power unit.	a. No current is supplied to power unit.	a. Check ship's supply circuit. Check for open circuit in cable or broken cable, and repair as necessary.
	b. Fuse in pump crankcase is blown.	b. Renew fuse.
	c. Starting switch in power unit is defective.	c. Renew switch.
2. Pump starts, but does not reach sufficient speed to disconnect motor starting winding, with consequent overheating.	a. Centrifugal switch sticks.	a. Adjust switch.
3. Pump starts, but reticle lamp does not light (when dimmer is turned up).	a. Reticle lamp is burned out.	a. Replace lamp with spare.
	b. Connection in cable connecting lamp to sight is broken.	b. Check cable connections, and test cable.
	c. Transformer is burned out.	c. Check voltage across "B" and "C" prongs in upper receptacle on power unit.
4. Pointer on power unit pressure gage not within green sector on dial.	a. Pressure hose leaks.	a. Check hose fittings.
	b. Air drier access cover leaks.	b. Check gasket, and tighten cover.
	c. Return hose from sight to pump is restricted.	c. Check for kinks.
	d. Pump diaphragm is defective.	d. Renew diaphragm.
	e. Rubber bushings between head and body of pump are defective.	e. Renew bushings; they should protrude 1/32 in., when pump head is removed.
	f. Bypass valve diaphragm in head of unit is defective.	f. Obtain replacement diaphragm from repair station, and replace.
	g. Intake or output valve in head is defective.	g. Renew valve.
	h. Setting of bypass valve is incorrect.	h. Reset bypass valve.
5. Pressure reading (as checked with portable gage) is less than the value indicated by green sector of dial.	a. Pump is not delivering at required pressure.	a. See remedies under **4** above.
	b. Pressure hose leaks.	b. Check connections at power and sight.
	c. Sight air filter screen is clogged.	c. Remove and clean screen.

TROUBLE CHART (continued)

Trouble	Cause	Remedy
	d. Power unit air drier is restricted.	d. Remove and clean.
	e. Air pressure regulator setting is incorrect.	e. Reset regulator.
6. Power unit vibrates excessively.	Piston cap strikes cylinder head.	Adjust according to instructions.
7. Switch on power unit does not turn readily.	Where shaft passes through leather packing in cover, salt and dirt have accumulated.	Remove cover. Release allen setscrew. Remove knob from shaft; then remove shaft from cover. Clean shaft and leather packing; then lubricate shaft with vaseline. Replace parts.
8. Characteristic Time outside limits.	Thermoswitch is set for temperature too high or too low.	Reset thermoswitch.
9. Sticky reticle or excessive "dead zero."	Mirror system or gyro has friction.	Gun sight must be overhauled at repair station.
10. Excessive range shift in train.	Range spring system of train gyro unit is out of adjustment.	Gun sight must be adjusted at repair station.
11. Incorrect amount of superelevation.	Range spring adjustment of elevation gyro unit is faulty.	Gun sight must be adjusted at repair station.
12. Shaky reticle.	Optical system is loose.	Gun sight must be adjusted at repair station.
13. Reticle shifts away from target as operator's head is moved slightly in front of sight window.	Colimating lens is out of adjustment.	Gun sight must be adjusted at repair station.

TRAINING DEVICES

Several devices are available to aid in training personnel in the operation of Gun Sight Mk 14. These devices provide practice in the smooth tracking required for successful use of the gun sight, and some of them will permit a degree of practice in range setting. However, these devices merely supplement tracking practice on actual aircraft and firing practice at targets, and can in no way be considered to supplant them. Included in this chapter are brief descriptions of the following devices:

1. Check sight
2. Calibration and Training Fixture Mk 1 Mod 0
3. Demonstration rate gyro
4. Gunnery Trainer Mk 1
5. Gunnery Trainer Mk 3
6. Gunnery Trainer Mk 5

Check Sight

A check sight is available to enable a check to be made on the accuracy of tracking during training. Using this attachment, the instructor sees the reticle and target exactly as it is seen by the gunner during the tracking run.

The check sight consists of a U-frame or box in which is located a clear glass mirror, set at an angle of 45° with the line of sight (figures 119 and 120). Standing to the left of the gun sight, the instructor sees both reticle and target by reflection from the check sight mirror. The gunner looks directly through the mirror and sees the reticle and target exactly as if there were no check sight installed. The check sight may be installed on Gun Sight Mk 14 Mod 15 (figure 121), and tracking accuracy observed by an instructor looking down from above the gun sight.

It is not practicable to use the check sight during firing runs on the 20-mm gun because of excessive vibration, but it may be used effectively on Gun Director Mk 51 Mod 2 during firing runs where large lead angles are not involved.

The check sight is fitted with two hook clamps on its top edge, inserted in the recesses in the top of the rear window bezel ring.

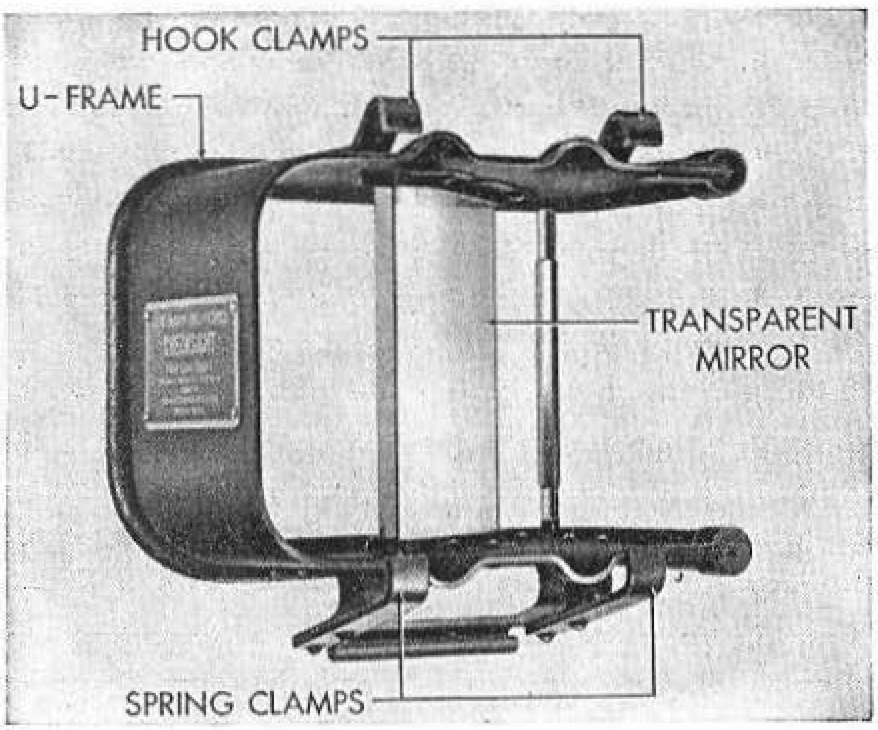

Figure 119.—Check Sight.

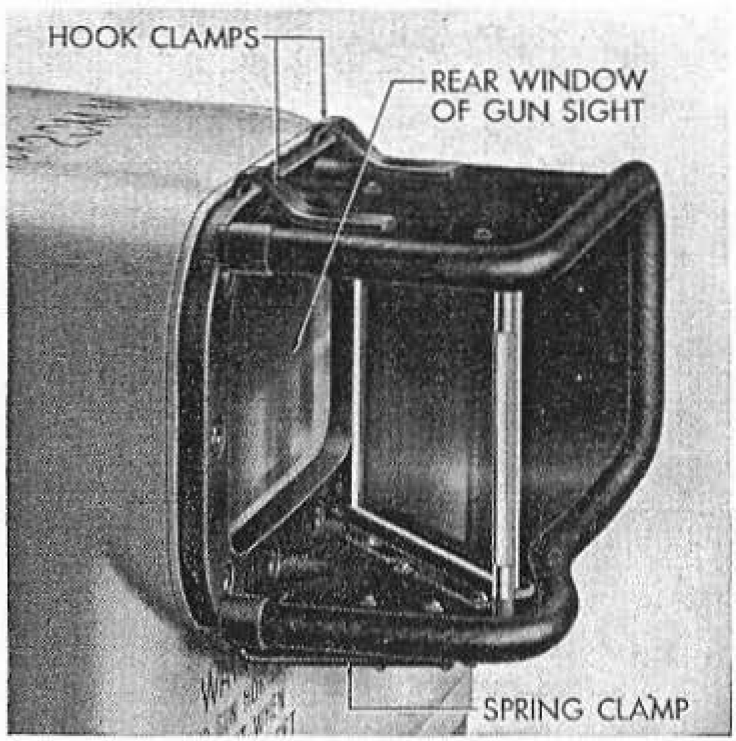

Figure 120.—Check Sight Mounted.

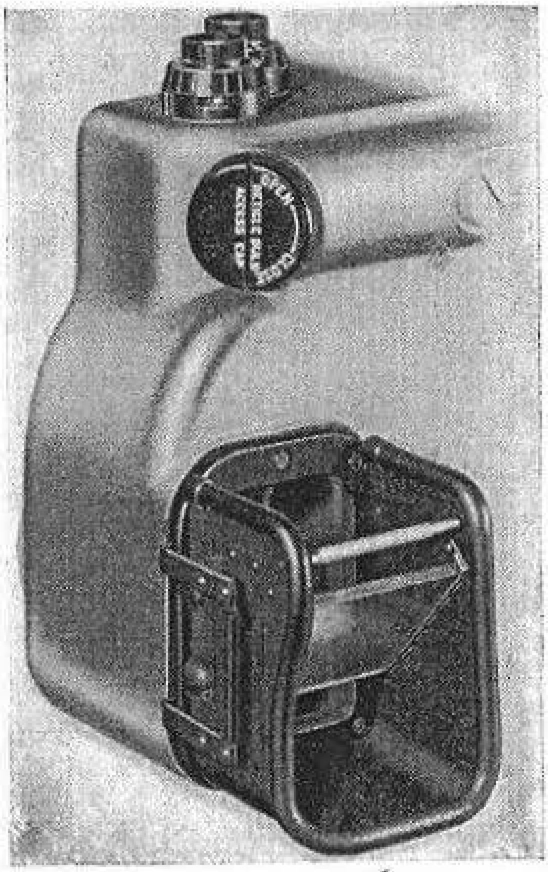

Figure 121.—Check Sight on Mod 15 Gun Sight.

A spring clamp on the bottom edge of the check sight is then snapped into the recesses at the bottom behind the bezel ring. This holds the check sight in place. It is important to locate properly the upper hole clamps in their groove, so the check sight will properly line up with the line of sight.

Calibration and Training Fixture Mk I Mod 0

Calibration and Training Fixture Mk 1 Mod 0 is a framework attached to the gun sight over the front window. (See figure 94.) Instructions for installation appear in chapter 8. It supports a dish-shaped receptacle in front of the sight which may be either the Field Test Scale (described in chapter 8) or a special training scale on which are realistic plane silhouettes against a background of colored sky (figure 122). On this, the target planes are accurately drawn to scale, and their identification and range noted at the edge of the field of view.

A collimating lens is located between the front window and the scale support. Its purpose is to focus the dish at infinity, thereby eliminating parallax, the apparent motion between the reticle and the target.

On the Field Test Scale a number of black dots are spaced at 100-mil intervals, vertically, horizontally, and at 45° angles in each quadrant. Tracking practice can be accomplished with this scale by requiring the gunner to operate the gun at an angular rate which will hold the reticle centered on a designated dot.

To hold the reticle at a fixed distance from center, the gun sight must be moved smoothly and continuously to establish a definite and constant lead angle. The magnitude of this angle must be proportional to the distance of the designated dot from the optical axis of the system. The reticle will remain on the designated dot only if the proper angular rate is steadily maintained. Combined with the use of the check sight, this demonstrates the effect of uneven operation of the gun and improper body motion, and affords a simple method of checking the pointer's understanding of the principles of operating the gun sight.

To maintain continued interest in such practice, the field test scale can be replaced by the training scale which shows realistic targets and background. This not only gives practice in tracking, but at the same time gives the impression of tracking at different ranges.

It is recommended that the range setter be used in conjunction with this practice, and that he be required to set changes in range during the practice runs. This will more nearly approximate conditions during an actual run, so that the gunner will become familiar with the action of the reticle when range is changed.

There are two major drawbacks to the use of the Calibration and Training Fixture for training purposes. One drawback is that because the fixture is actually installed on the gun sight, it is not independent of the motion of the ship as would be true of an actual target. Thus, no practice is given in taking out roll and pitch of own ship. The other

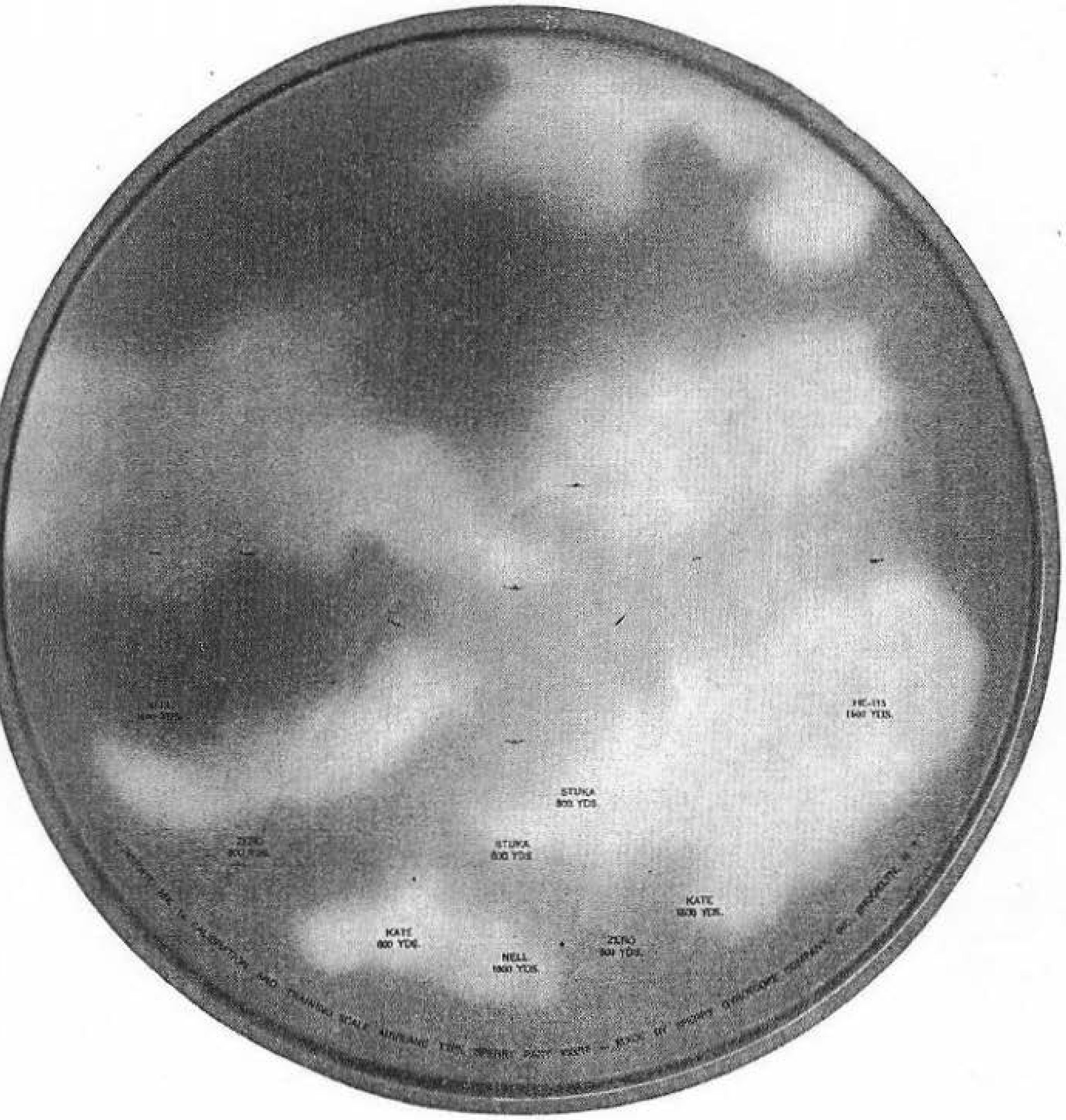

Figure 122.—The Training Scale.

drawback is that the direction of slewing the gun to get on target must be opposite that necessary with an actual target.

If the target plane on the training scale is approaching from the right side of the scale center, normally the gun would have to be slewed right to reach it, but here it is necessary to develop a lead angle to the right to make the reticle reach the target. This will require establishing the required angular rate to the left. The reverse will be necessary for a target apparently approaching from the left. Thus it can be seen that one must lead off in the "wrong" direction to hold the reticle on the target. Once the reticle is on target, the direction of tracking is correct for incoming targets.

Since the primary purpose of the training fixture is to develop muscular coordination required to accomplish accurate tracking, it is believed that this will not do serious "damage" to the training of new personnel, particularly if "dry" tracking of actual targets is interspersed frequently. Co-ordination of body motion is the foundation of smooth tracking which is the heart of successful operation of Gun Sight Mk 14.

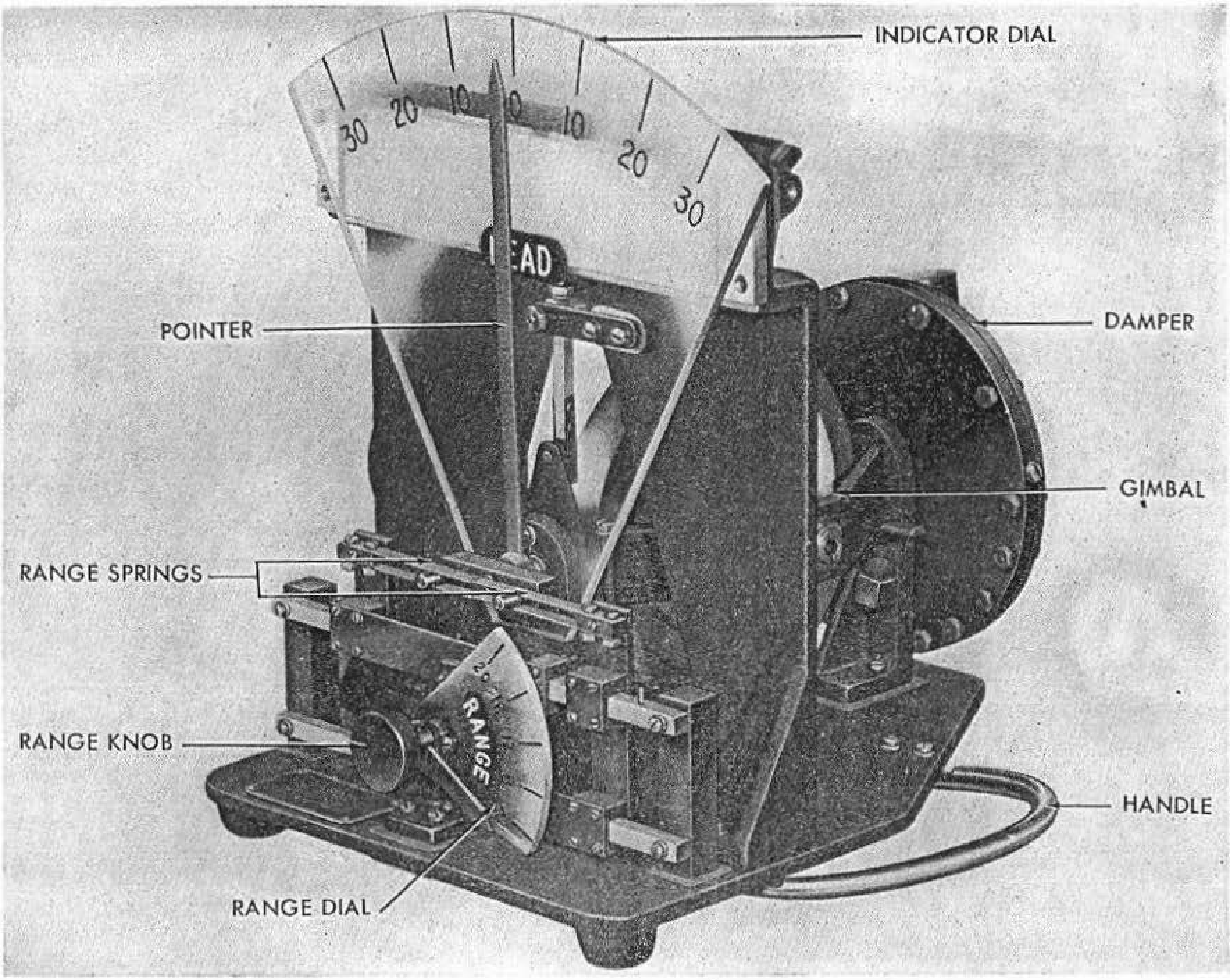

Figure 123.—Demonstration Rate Gyro, Front View.

Demonstration Rate Gyro

To present visually the action of a rate gyro in measuring angular rates, a demonstration rate gyro has been designed and produced in small quantities.

It consists of a gyro rotor mounted in a gimbal and attached to a portable base (figs. 123 and 124). The gyro can be spun at a fairly high speed by wrapping a cord around the spin axle of the gyro and pulling it off rapidly. Cantilever restraining springs are attached at the forward end of the gyro, and a damping disc and superelevation weight at the other end. A pointer and scale are provided to indicate the angle of precession.

The limits of precession are not restricted to 2½° as in the gun sight gyro, 30° on either side being allowed for demonstration purposes.

A reticle lamp, reticle, and two mirrors are provided to simulate the optical system of the gun sight. The first mirror is controlled by the precession of the gyro, and the second is adjustable by hand to throw the reticle image on the ground glass of the scale.

The tension of the restraining springs can be adjusted by a range knob to illustrate the change in angle of precession with change in range.

To operate the gyro as a traverse gyro, the rotor is first started spinning. Then, holding the entire

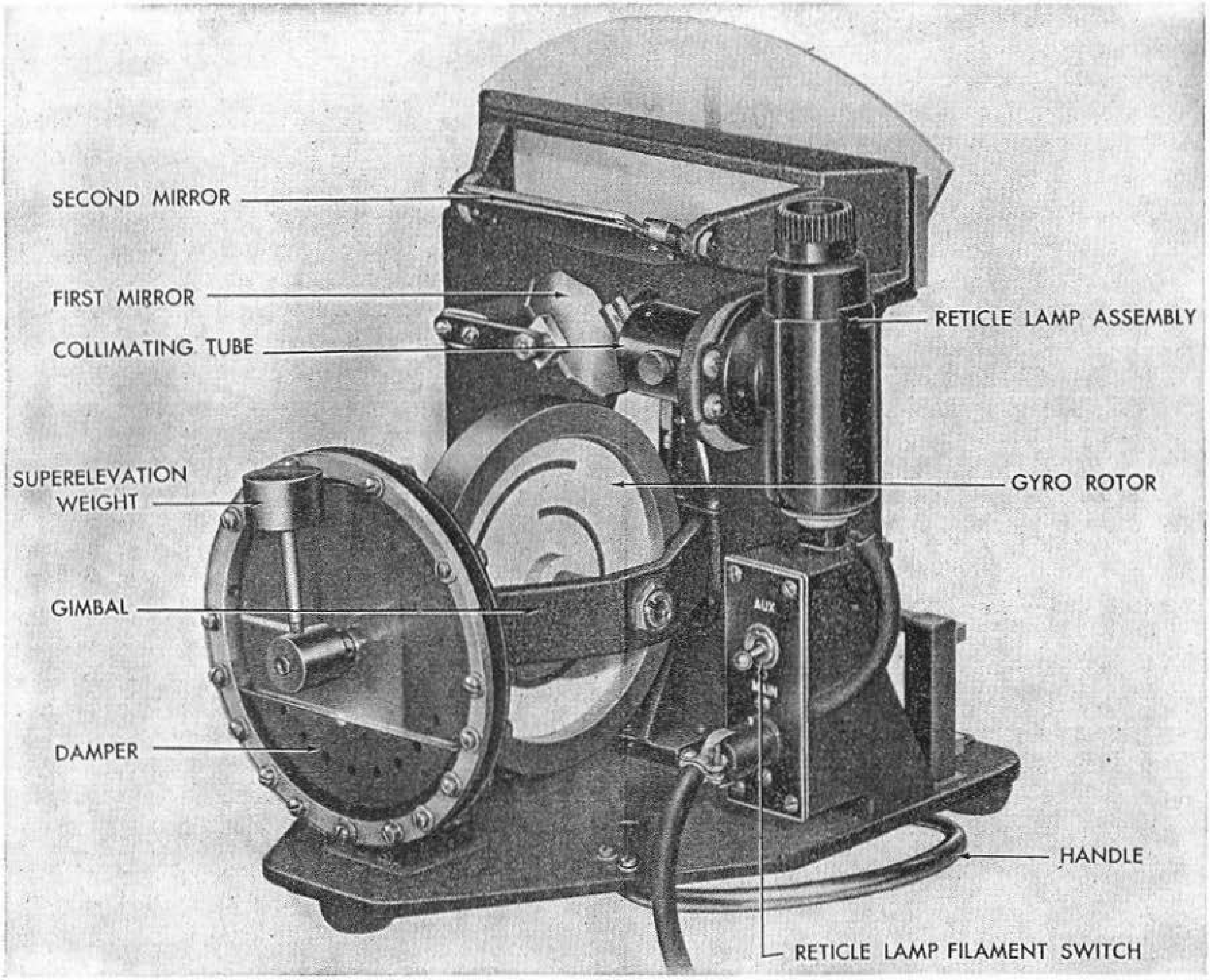

Figure 124.—Demonstration Rate Gyro, Rear View.

assembly by the two handles, the demonstrator turns his body to apply an angular rate in traverse. From the scale it can be seen that the amount of gyro precession varies with the rate at which the body is turned.

To demonstrate the action of the elevation gyro, the demonstration unit can be turned on its side, and the entire unit given an angular rate by using the shoulders as a pivot point.

The action of the superelevation weight can be best studied with the gyro rotor not spinning. Changing the range setting will illustrate the change in tilt produced by the superelevation weight with a change in range. Elevating the unit from horizontal to 90 degrees will show how superelevation varies with the angle of elevation.

Gunnery Trainer Mk I

While Gunnery Trainer Mk 1 (formerly Machine Gun Trainer Mk 1) was originally designed to provide training in the use of the 50 cal. antiaircraft machine gun, Ordalt 2013 provides a means of installing 20-mm shoulder yokes and a trigger assembly and an adapter, to permit use of Gun Sight Mk 14 on the trainer gun.

Detailed information on Gunnery Trainer Mk 1 appear in OP 973 and in NAVORD OD's 2013, 2165, and 2166.

Three-dimensional motion picture equipment projects target scenes on a screen and reproduces battle noises through a loud-speaker. The pointer under training operates a special trainer gun which, when the firing key is pressed, projects a spot of light on the screen at every third shot, to simulate tracers. By wearing special polarizing glasses, the pointer sees the battle scene and tracers in three dimensions.

Provision is made for automatic counting of rounds fired and hits scored. NAVORD OD 2166 provides for installation of an interval timer, the purpose of which is to simulate the actual intervals required to empty a 20-mm magazine and reload the gun.

Gunnery Trainer Mk 1 is designed for shore use where space is available for its installation.

Gunnery Trainer Mk 3

Gunnery Trainer Mk 3 is a motion picture device used in conjunction with actual directors and 20-mm mounts to provide training in the use of Gun Sight Mk 14 and 20-mm Sight Mk 4. Detailed information on this trainer appears in OP 1200.

Realistic target scenes are projected upon a screen, and combat noises are reproduced by means of dual 16-mm sound motion picture projectors. One projector presents the battle scenes with appropriate sound effects, and the other projects a spot of light on the screen to indicate the proper point of aim, shows the correct range for each target, and carries a sound track of gun fire which is heard when the gun or director is fired.

A photoelectric cell, mounted parallel to the gun sight, receives reflected light from the point of aim spot on the screen when the gun is correctly aimed. An infra-red dowser can be operated by the instructor so that the point of aim spot is invisible without affecting operation of the scoring system. One dial registers the number of rounds fired, and another dial registers the number of hits made.

There are eight modifications of Gunnery Trainer Mk 3. Mods 1, 2, 3, 4, and 7 are designed for shore installations where sufficient clearance is available for the installation of an inclined overhead screen as well as a vertical screen. Mods 5 and 6 are for shipboard use where there is not enough clearance to permit the use of the overhead screen. Pertinent data regarding the various Mods of Gunnery Trainer Mk 3 are given in table 7.

Gunnery Trainer Mk 5 Mod 1

Gunnery Trainer Mk 5 Mod 1 is a modification of Gun Sight Mk 14 Mod 8, altered to provide training in the use of Gun Sight Mk 14. It provides for the projection of a synthetic target into the field of view and has an automatic scoring device which gives an indication of the accuracy of tracking. It can be used wherever a Gun Sight Mk 14 can be installed, thus providing for training either with Gun Director Mk 51 Mod 2, or with a 20-mm antiaircraft mount. For detailed information on Gunnery Trainer Mk 5 Mod 1, see OP 1263. A course and control box attached to the top of the altered Gun Sight Mk 14 Mod 8 provides for the projection of a spot of light into the optical system of the sight to simulate a target, and also carries counters which record the number of shots fired and hits scored.

By means of an additional transparent mirror placed in the line of sight, the simulated target is caused to move through any of five previously determined courses, each of which lasts for approximately 20 seconds.

A range dial indicates to the range setter the correct range for any instant during each course, thus providing him with practice in smooth operation. Variations from the five basic courses can be made by setting ranges which differ from those shown on the range dial.

By means of a switch, it is possible to stop the motion of the simulated target at any point in its course, thus providing training in tracking at constant angular rates similar to that available with the Training Scale. An optional time delay of two seconds in scoring may be cut in with a switch to simulate the solution time which would be required when using an actual Gun Sight Mk 14.

Gunnery Trainer Mk 5 is particularly adapted to use on shipboard, since no dark room facilities are required, and it may be mounted wherever a Gun Sight Mk 14 can be installed. No greater size of working circle is required for its use with either Gun Director Mk 51 Mod 2, or the 20-mm mount.

Table 7

MODIFICATIONS OF GUNNERY TRAINER MK 3

Mod	Used with	Ship or shore	Space requirements
0			(Experimental)
1.	Two 20-mm Mounts Mk 10, 20-mm Sight Mk 4.	Shore	Height 16½ ft. Width 12 ft. Length 20 ft.
2.	Two 20-mm Mounts Mk 10, Gun Sight Mk 14 Mod 2 or 6.	Shore	Height 16½ ft. Width 12 ft. Length 20 ft.
3.	Two Gun Directors Mk 51 Mod 2, Gun Sight Mk 14 Mod 2 or 6.	Shore	Height 16½ ft. Width 12 ft. Length 20 ft.
4.	Gun Director Mk 51 Mod 2 and 1 20-mm Mount Mk 10, Gun Sight Mk 14 Mod 2 or 6.	Shore	Height 16½ ft. Width 12 ft. Length 20 ft.
5.	Gun Director Mk 51 Mod 2, Gun Sight Mk 14 Mod 2 or 6.	Ship	Height 7 ft. Width 10 ft. (Minimum access width 26 in.) Length 18 ft.
6.	20-mm Mount Mk 10, Gun Sight Mk 14 Mod 2 or 6.	Ship	Height 7 ft. Width 10 ft. (Minimum access width 26 in.) Length 18 ft.
7.	40-mm Mount Mk 4, 40-mm Sight Mk 6.	Shore	Height 16½ ft. Width 12 ft. Length 20 ft.

Note: An adapter is available which permits mounting the carriage cradle and shoulder rest of the 20-mm gun on the director pedestal of Mod 5, permitting training in the use of both gun and director.

For instruction in training with Gunnery Trainer Mk 3 Mods 2 and 3, see NavPers 16040, Drill Manual for Bureau of Ordnance Gunnery Trainer Mk 3 Mod 2, and NavPers 16041, Drill Manual for Bureau of Ordnance Gunnery Trainer Mk 3 Mod 3.

Training Aids

The following information on training aids has been supplied by the Bureau of Naval Personnel. Training aids and suggestions for using them effectively may be obtained from Training Aids Sections and Libraries. Training Aids Utilization Officers should be consulted concerning the selection and utilization of training aids.

Training Films

MN-1549—Operation of Gun Sight Mk 14

Explains construction and operation of Gun Sight Mk 14. Pictures sight mounted on 20-mm gun, but most of film applies equally to sight installation on Gun Director Mk 51. Straight photography, with many close-ups, shows details of construction and use of sight. Uses animation to explain lead angle, fixed range, and types of tracking. Employs simplified and enlarged model to explain and demonstrate action of gyro and function of range handle. Rated as excellent by instructors. Especially good for beginners. Extensively used by the fleet.

SN-1727A—Gun Sight Mark 14—Theory and General Description

Explains the problem sight must solve to secure lead angels in traverse and elevation for guns. Elements of gunnery problem presented through series of diagrams, and simple problem solved. Film explains how movement of traverse elevation mirror within sight alters position of reticle within field of vision. Extensively used by the fleet.

SN-1727B—Gun Sight Mark 14—Underlying Principles of Gun Sight Mark 14—Action of the Gyro Units (Traverse)

Contains series of schematic diagrams illustrating principles of Sight Mk 14 with explanatory comments. Covers theory of gyroscope (traverse) in computing lead angle, rotor and axis-of-rotation response of gyro to rotation, tracking target, and action of precession unit. Rated as excellent by instructors. Extensively used by the fleet.

SN-1727C—Gun Sight Mark 14—Underlying Principles of Gun Sight Mark 14—Actions of the Gyro Units (Elevation)

Series of schematic diagrams illustrating theory of elevation, superelevation, range springs, and range input in Sight Mk 14, with explanatory comments. Covers elevation gyro installation, operation, comparison with traverse gyro, computing angle, and effect of superelevation on train. Supplementary comments by instructor will improve the effectiveness of film. Used by the fleet.

SN-1727D—Gun Sight Mark 14—Mechanical Construction (Sight Unit)

Shows mechanical construction of Gun Sight Mk 14 and explains rotor weights, damping system, air nozzle, gyro casing, gimbal frame, and assembly shaft and mounting. Also shows installation of traverse and elevation and gyro units in sight case. Rated as excellent by instructors. Used by the fleet.

SN-1727E—Gun Sight Mark 14—Mechanical Operation (Power Unit)

Traces flow of air through power unit and gun sight, explaining function of: pump, air drier, filter, heater, pressure regulator, vacuum relief valve, and compound gage. Explains wiring of various units in electrical system. Not highly recommended by instructors; may have some specialized training value to the fleet.

SN-1727F—Gun Sight Mark 14—Mechanical Operation

Outlines duties of handwheel operator, leader, range setter, and gunner. Explains procedure and necessity for warming before operating, adjusting reticle to brightness of sky, tracking target, range setting, and handling of spot knobs. Proper method of securing the gun and sight after use is explained. Rated as excellent by instructors. (Duplicates MN-1549 to some extent.) Used by the fleet.

SN-1727G—Gun Sight Mark 14—Maintenance

Explains procedure for daily checks, how to boresight check, and how to make time test for both traverse and elevation. Proper method of raising and lowering temperature in sight, and procedure for maintenance and replacement of various parts also shown. Used by the fleet.

Other Aids

NavPers 70229R—Gun Sight Mark 14 Chart

Schematic drawing (30 in. x 30 in.) showing mechanical details of Gun Sight Mk 14. Useful to illustrate functional operations of sight.

Gun Sight Mark 14—Operator's Bulletin

Illustrated booklet 45 pages (4½ in. x 7½ in.) containing instructions for operation of Gun Sight Mk 14. Published by Sperry Gyroscope Co., for U. S. Navy.

APPENDIX

GLOSSARY OF TERMS AND DEFINITIONS

Ballistics

Internal: Pertaining to the properties of motion of a projectile while within its gun barrel.

External: Pertaining to the properties of motion of a projectile from the time it leaves the gun barrel until completion of its flight.

Ballistic Correction Angle

The angle applied to the line of fire in traverse or elevation, or both, to correct for the effect of external influences on the trajectory of the projectile.

Bearing

True: The position of an object from own ship, stated in terms of the angle between true North and a line from own ship to the object. The angle is measured in the horizontal plane clockwise from true North.

Relative: The position of an object from own ship, stated in terms of the angle between own ship's bow and a line from own ship to the object. The angle is measured in the deck plane clockwise from own ship's bow.

Cantilever Spring

A flat spring supported at one end only.

Collimate

To render rays of light parallel by use of a lens or other optical system.

Damping

See Smoothing. The result of employment of a damping mechanism.

Deck Plane

The plane in which is contained the deck of own ship. This plane moves with roll and pitch of the ship.

Direct (Undisturbed) Line of Sight

The principle of operation of a gun sight in which the optical reference point of the sight is fixed in its relation to the sight housing, and the axis of the housing coincides with the line of sight.

Gun train and elevation orders are determined external to the sight.

Director Elevation

The elevation of the mechanical axis of the director above the deck plane, measured in a plane perpendicular to the deck plane, and containing that axis.

Director Train

The angle between the fore-and-aft line of own ship and the mechanical axis of the director, measured in the deck plane clockwise from own ship's bow.

Disturbed Line of Sight

The principle of operation of a gun sight in which the optical reference point which determines the line of sight, is caused to lag behind the gun sight housing by amounts equal to lead angles, so that the position of the housing indicates gun train and elevation orders.

Drift

The ballistic deviation of the projectile to the right during its flight, caused by the gyroscopic reaction of the projectile to the effect of air resistance and gravity.

Elevation Plane

Of Target: A vertical plane which includes the line of sight.

Of Gun or Director: A plane perpendicular to the deck plane which includes the line of fire of the gun, or the mechanical axis of the director.

In a disturbed system, the elevation planes of the gun and director are the same, except for parallax. In a direct system, the elevation planes of the target and director both contain the line of sight.

Future Position

The position in space which a target may be expected to occupy after the time of flight of the projectile.

Gimbal

A device for suspending an object in such a manner that it will have freedom of motion in two perpendicular planes. Suspending an object in a gimbal system (two gimbals) permits it to have freedom of motion in three mutually perpendicular planes.

Gun Elevation Order

The angle of elevation of the line of fire above the deck plane, measured in the elevation plane of the gun.

Gun Train Order

The angle between a plane, perpendicular to the deck plane, containing the fore-and- aft axis of the ship and the elevation plane of the gun, measured in the deck plane clockwise from the ship's bow.

Gyroscope

A rapidly spinning wheel, mounted in a gimbal system, which has the property of maintaining its orientation in space, regardless of the position of the gimbal system.

Horizontal Plane

The horizontal plane at any point on the earth's surface is the plane tangent to the earth's surface at that point; or, any plane parallel to that plane.

Lead Angles

Prediction Lead Angle: The angle between the line of sight and a line from the director to the future position measured in the prediction plane.

Elevation Target Lead Angle: The angle of lead in the elevation plane of the gun required because of the component of target motion in elevation.

Traverse Target Motion Lead Angle: The lead angle in the traverse plane required because of the component of target motion in traverse.

Elevation Lead Angle: The lead angle composed of elevation target motion lead angle and ballistic correction angle in elevation.

Traverse Lead Angle: The lead angle composed of traverse target motion lead angle and ballistic correction angle in traverse.

Line of Fire

The line along which the gun is pointed.

Line of Sight

The line from the intersection of the gun sight train and elevation axes to the present position of the target.

Mil

The angle subtended by a chord of one yard length at a radius of 1,000 yards.

Parallax

Horizontal: The horizontal linear distance between the intersection of the gun axes and the intersection of its gun sight axes, whether the gun sight be located on the gun itself or on a director.

Vertical: The vertical linear distance between the intersection of the gun axes and the intersection of its gun sight axes, whether the gun sight is located on the gun itself or on a director.

Optical: The distance between the plane in which the reticle of a gun sight is focused and the plane in which the target lies, or in which the target image is focused. If these two planes do not coincide, movement of the eye will cause apparent relative movement between the reticle and the target.

Pitch

The angle between the horizontal plane and the deck plane measured in a vertical plane containing the fore-and-aft line of the ship. This angle is caused by rotation of the deck plane about its athwartships axis and is positive when above the horizontal plane and negative when below.

Precession

The gyroscopic phenomena because of which a gyro will rotate about one gimbal axis to align its spin axis with the second gimbal axis whenever a torque is applied about the second gimbal axis.

Prediction Plane

The plane containing, at any instant, the line between gun sight and target, and the line tangent to the line of flight of the target at its present position.

Prediction Time

The ratio between the lead angle to future position and the instantaneous angular rate of motion of the target. The ratio has the dimension of time. In practice, an average prediction time for all courses at the same range is used, thus permitting elevation and traverse target motion lead angles to be determined from the product of instantaneous angular rate in each plane and prediction time.

Present Position

The position in space which the target occupies at the instant of firing. It is generally fixed in terms of bearing, elevation, and range.

Range

The linear distance, in yards, between the intersection of the gun sight axes and the target. Present range is the distance to present position; future range is the distance to future position.

Range Rate

The time rate of change of range along the line of sight in yards per second or knots. It is negative when range is decreasing, and positive when it is increasing.

Reticle

The optical reference point within a gun sight which establishes the optical axis of the sight or the line of sight.

Roll

The angle between the deck plane and the horizontal plane, measured in a vertical plane containing the athwartships axis of the ship. This angle is caused by rotation of the deck plane about its fore-and-aft axis; it is positive when above the horizontal plane, and negative when it is below the horizontal plane.

Smoothing

The effect of a mechanism designed to reduce the error caused by introduction of false angular rates of tracking. In a disturbed system, it also has the effect of reducing the amplitude of motion of the reticle which may be transmitted to it by uneven or jerky tracking.

Solution Time

The time required for any error which may exist, at the beginning of steady tracking, to fall to two percent of its initial value. This represents the length of time which a target must be tracked before a solution can be considered accurate enough to commence firing.

Superelevation

The angle of correction, in elevation, which must be applied to the line of fire to allow for the effect of gravity on the projectile during its flight.

Time of Flight

Of Projectile: The time required for the projectile to travel from the gun to the future position of the target.

Of Target: The time required for the target to travel from its present to its future position.

These two times of flight must be equal for a hit to be scored.

Trajectory

The path in space followed by the projectile in its flight from gun to target.

Traverse Plane

A slant plane containing the gun or gun sight trunnion axis. In this pamphlet, the traverse plane is considered as containing also the present position of the target.

Torque

The product of a lever arm distance and a force which causes rotation of an object or system.

Vertical Plane

A plane perpendicular to the horizontal plane.

Yaw

The angle of rotation of the fore-and-aft line of the ship about the vertical axis of the ship, measured in the horizontal plane.

APPLICABLE PUBLICATIONS

The following publications, including, Ordalts relate to Gun Sight Mk 14.

- OD 4369 Part I—Overhaul Manual, Gun Sight Mk 14 Mods 2, 3, 4, 9, 10, and 11
- OD 4369 Part II—Overhaul Manual, Gun Sight Mk 14 Mods 6, 7, 8, 12, 13, and 14
- OD 4424—Gun Director Mk 51 Mod 2
- OD 4429—Gun Sight Mk 14 Mods 2, 3, 4, 9, 10, and 11
- OP 973—Machine Gun Trainer Mk 1
- OP 1200—Gunnery Trainer Mk 3
- OP 1263—Gunnery Trainer Mk 5 Mod 1
- NAVORD OD 1186—Mounting Pads for 20-mm Mount
- NavPers 16040—Drill Manual for Bureau of Ordnance Gunnery Trainer Mark 3 Mod 2
- NavPers 16041—Drill Manual for Bureau of Ordnance Gunnery Trainer Mark 3 Mod 2

PARTS LIST

The following list (Table 8) includes Bureau of Ordnance Numbers for the major units of Gun Sight Mk 14 equipment as shipped for each mod. Table 9 is a list of overall sizes and weights of the various units as packed for shipment.

Table 8

GUN SIGHT MK 14 EQUIPMENT

	Bureau of Ordnance Numbers		
	For 20-mm gun	For 1.1-in. gun	For 40-mm gun
Gun Sight Mk 14 Mod 6	325713- -1 or 325713-A-1	———	———
Gun Sight Mk 14 Mod 7	———	325713- -1 or 325713-A-1	———
Gun Sight Mk 14 Mod 8	———	———	325715- -1 or 325715-A-1

Each of the above BuOrd numbers covers the complete Gun Sight Assembly and the following additional parts:

	For 20-mm gun	For 1.1-in. gun	For 40-mm gun
Air Hose—2 (Sight to Power Unit)	325559- -1	325412- -2	———
Electric Cable (Sight to Power Unit)	325559- -2	325412- -1	325412- -1
Electric Cable (Power Unit to Source)	325352- -1	———	———
Boresight Tube Assembly	325916-1	325407- -3	325407- -3
Gun Sight Carrying Case	325916- -1	325951- -1	325941- -1
Power Unit	325351- -1 or 325351-A-1	325351- -1 or 325351-A-1	325351- -1 or 325351-A-1
Accessories	325416- -1	———	———
This number includes the following items:			
Gun Sight Bracket and attaching hardware	325341- -1	———	———
Gun Sight Bracket, detail	325342- -1 or 325345- -1	———	———
Power Unit Bracket, detail	325417- -1	———	———
Cable and Hose Supporting Bracket	325560- -1	———	———
Spare Parts Box and Parts	325728- -1	325739- -1	325730- -1

GUN SIGHT MK 14 EQUIPMENT (continued)

	Bureau of Ordnance Numbers		
	For 3-in. 50 cal. guns	For 5-in. 25 cal. guns	For 5-in. 38 cal. guns
Gun Sight Mk 14 Mod 12	325962- -1 or 325962-A-1	———	———
Gun Sight Mk 14 Mod 13	———	325963- -1 or 325963-A-1	———
Gun Sight Mk 14 Mod 14	———	———	325964- -1 325964-A-1

Each of the above BuOrd numbers covers the complete Gun Sight Assembly and the following additional parts:

Air Hose (2) (Sight to Power Unit)	325412- -2	325412- -2	325412- -2
Electric Cable (Sight to Power Unit)	325412- -1	325412- -1	325412- -1
Boresight Tube Assembly	325407- -3	325407- -3	325407- -3
Gun Sight Carrying Case	325951- -1	325951- -1	325951- -1
Power Unit	325351- -1 or 325351-A-1	325351- -1 or 325351-A-1	325351- -1 or 325351-A-1
Spare Parts Box and Parts	325861- -1	325809- -1	325813- -1

	For 40-mm gun
Gun Sight Mk 14 Mod 15	326147-1

The above BuOrd number covers the complete Gun Sight Assembly and the following additional parts:

Air Hose (2) (Sight to Power Unit)	326152-5
Electric Cable (Sight to Power Unit)	326152-1
Electric Cable (Source to Power Unit)	326164-1
Boresight Tube Assembly	325407-3
Gun Sight Carrying Case	326153-1
Power Unit	325351-1
Spare Parts Assembly	326167-2
Spare Parts Box	326168-1

Table 9

GUN SIGHT MARK 14—WEIGHTS AND OVER-ALL DIMENSIONS

Mod 6

	Weight (lb.)	Length (in.)	Width (in.)	Height (in.)
Equipment, Complete, in Carton	236	48	22¼	21
Gun Sight, Complete, in Carton	63½	21¾	20⅞	19⅜
Gun Sight, Less Carton in Case	54	16 7/16	15⅛	14
Gun Sight Only	35	14¼	13⅞	11⅛
Boresight Tube Only	½	11	9/16	9/16
Pump, Complete, in Carton	58	20 13/16	11 9/16	16⅜
Pump, Less Carton	47½	15 5/16	9¼	14 7/16
Accessories, Complete, in Carton	64	21¼	7	25⅜
Pump Bracket Only	35¼	20½	5½	24
Sight Bracket Only	12	8 11/16	10⅜	10 11/32
Cable Bracket Only	8½	13¼	4 5/32	10 7/32
Hardware (3 bags)	2½	......	......	......
Hoses and Cables, Complete, in Carton	8	21¼	9 5/16	5⅜
Hoses and Cables Only	5¾	......	......	......
Ship's Spares Box, Complete	23	21¼	9 5/16	8⅜

Mods 7, 8, 12, 13, 14 and 15

Equipment, Complete, in Carton (Includes Items 1, 2, 5, 7 only)	172	38¼	21⅝	20½
Hoses and Cables, in Carton	7¼	21¼	9 5/16	5⅜
Hoses and Cables, less Carton	5	......	......	......

SPARE PARTS LIST

The following spare parts are delivered with each Gun Sight Mk 14 unit for shipboard use.

Table 10
GUN SIGHT MK 14 SPARE PARTS

Name of piece	No. of pieces	Package No.	BuOrd Dwg. No.	Piece No.	Sperry No.
Lamp Base Assembly	1	4a–3	325967	–2	204668
Washer	3	5–11	325303	–2	40951
Gasket—Receptacle	3	5–14	325353	–2	195815
Screw-Rheostat Knob	1	6–4	325426	–3	194817
Lamp—Reticle	6	6–14	325554	–3	202077
Gasket—Rear Window Retainer	1	7–5	325651	–2	203654
Window—Rear	1	7–6	325651	–3	203666
Window—Front	1	7–7	325651	–4	203667
Gasket—Front Window Retainer	1	7–9	325652	–2	203637
Gasket—Front Window	1	7–10	325652	–3	203635
Gasket—Rear Window	1	7–11	325652	–4	203626
Gasket—Access Plug	4	7–12	325652	–6	203603
Gasket—Valve Access Plug	1	7–13	325652	–7	203605
Gasket—Filter Seal Retainer	1	7–14	325652	–9	203631
Gasket—Range Seal Retainer	1	7–15	325656	–6	203724
Cap—Upper Casing	1	8–2	325663	–1	203750
Plug—Access	1	8–4	325667	–1	203607
Plug—Valve Access	1	8–5	325667	–2	203606
Lever—Filter	1	9–2	325673	–4	203630
Screw—Filter Lever	1	9–4	325674	–4	203628
Filter—Air	1	10–12	325701	–5	203749
Gasket—Air Outlet	2	10–16	325702	–3	203748
Knob—Rheostat	1	11–3	325703	–2	203839
Gasket—Seal Retainer	2	11–8	325709	–1	203832
Gasket—Cap	2	11–9	325709	–2	203655
Knob—Elevation	1	12a–3	325736	–1	204819
Knob—Deflection	1	12a–4	325736	–2	204820
#6 (.138) -32 Brass Hex. Machine Screw Nut	16	12a–8	325843	–2	225725
#4 (.112) —40 x ½ Fil. Hd. S. S. Machine Screw	6[1]	13–11	12–z–36	–574	......
#4 (.112) —40 x ½ Fil. Hd. S. S. Machine Screw	3[2]	13–11	12–z–37	–423	......
#6 (138) —32 x ½ Fil. Hd. S .S Machine Screw	3	13–16	12–z–36	–453	......

TABLE 10 (continued)

Name of piece	No. of pieces	Package No.	Bu Ord Dwg. No.	Piece No.	Sperry No.
#8 (.164) —32 x 7/16 Fil. Hd. S. S. Machine Screw (cut to fit)........	8	14–3	12–z–36	–483	......
#4 (.112) Steel Lockwasher...........	6[1] 9[3]	14–14	12–z–22	–246	0164–5
#6 (.138) Steel Lockwasher	3	14–15	12–z–22	–247	0164–7
#8 (.164) Steel Lockwasher...........	8	14–16	12–z–22	–248	0164–8
#6 (.138) Internal Shakeproof Steel Lockwasher	16	15a–3	12–z–22	–352	......
Intake Valve Assembly................	1	16–4	325355	–4	196375
Discharge Valve Assembly.............	1	16–5	325355	–5	196381
Dryer Assembly	3	17–14	325893	–1	......
Gasket—Housing Port	6	18–2	325353	–3	195816
Gasket—Housing Cover	2	18–3	325354	–1	195814
Diaphragm—Piston	3	18–4	325354	–2	195819
Screw—Piston	2	18–5	325354	–4	195821
Gasket—Valve	2	20–8	325369	–1	196384
Gasket—Dryer Collar	12	20–15	325371	–7	196408
Gasket—Dryer Cage	4	20–16	325372	–1	196409
Washer—Neoprene Diaphragm	6	22–6	325380	–8	198374
Washer—Steel Diaphragm	2	22–7	325381	–2	198375
Fusetron—5 Amperes	6	23–3	325901	–1	......
Bracket—Knob	2	23–4	325901	–2	......
Bracket—Clip	2	23–5	325901	–3	......
Indicator—Fuse	2	23–6	325901	–4	......
¼-28 Steel Hex. Machine Screw Nut...	6	25–8	12–z–9	–241	......
¼-Steel Lockwasher (Dryer Head-Pump)	6	25–15	12–z–22	–251	0164–11
5/16 Steel Lockwasher................	2	25–16	12–z–22	–252	0164–12
Knob—Range, for Mod 6.............	1	27–8	325706	–1	805336
Knob—Range, for Mod 8.............	1	27–9	325706	–2	805338
Knob—Range, for Mod 7.............	1	27–10	325717	–1	805351
Knob—Range, for Mod 12...........	1	.....	......	....	......
Knob—Range, for Mod 13...........	1	.....	......	....	......
Knob—Range, for Mod 14...........	1	.....	......	....	......
Knob—Range, for Mod 15...........	1	.....	......	....	......

[1]Mod 6

[2]Mods 7, 8, 12, 13, 14 and 15

[3]Mods 7, 8, 12, 13, 14 and 15

Safety Precautions

1. When securing Gun Sight Mk 14, always secure director at zero elevation, or 20-mm gun mount at 5° elevation.

2. When cycling, swing the sight rapidly enough to bring the reticle against the stops, but not so rapidly as to damage the mirror linkage.

3. In mounting Gun Sight Mk 14, a breather must be provided either at the power unit or in the base of the gun sight.

4. In making hose connections, tighten fittings only enough to prevent leaks; excessive tightening will damage the conical end surfaces of the fittings.

5. Only qualified personnel at gun sight repair ships will be permitted to accomplish adjustments or repairs which require removal of the upper case of the gun sight.

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