NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
AMES RESEARCH CENTER

OPERATING MANUAL

HANDHELD SPACE SEXTANT

GFAE TYPE NO.
EG 25100

KOLLSMAN TYPE NO.
A41580 00 001

Kollsman Instrument Corporation

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4 OPERATING MANUAL 9
3 HANDHELD SPACE
SEXTANT 4

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Prepared by

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INTRODUCTION

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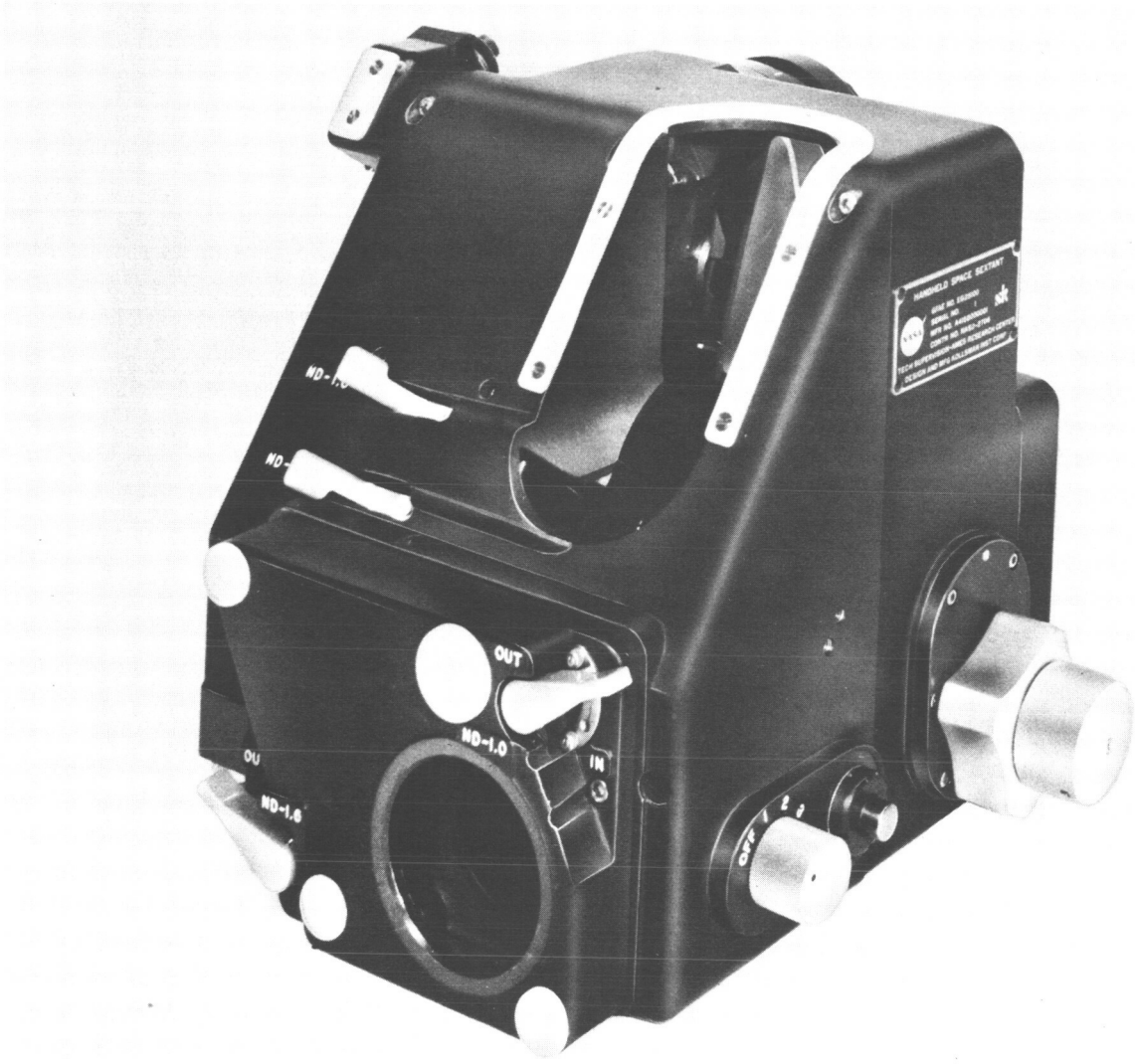


Figure 1.1 Handheld Space Sextant

SECTION II
DESCRIPTION

2.1 GENERAL

2.2 The Handheld Space Sextant is designed to give an accurate indication of the angle between two optical lines of sight for the navigation and guidance of manned spacecraft. The instrument can be used to measure the angular separation of opposite lunar limbs, the angles between a star and lunar limb or landmark, or the angle between a star and an orbiting vehicle. The general configuration is shown in Figure 2.1, Outline Drawing, Handheld Space Sextant. The general characteristics of the instrument are summarized in Table 2.1.

TABLE 2.1 GENERAL CHARACTERISTICS

Characteristic	Normal Eye Relief Eyepiece	Long Eye Relief Eyepiece
Size (L x W x H)	$6\frac{63}{64}$ x $7\frac{1}{4}$ x $6\frac{3}{64}$	$6\frac{51}{64}$ x $7\frac{1}{4}$ x $6\frac{3}{64}$
Weight	6 lbs. 2 ozs.	5 lbs. 14 ozs.
Magnification	8.0X	4.6X
Field of View	7°	7°
Exit Pupil	4 mm	7 mm
Eye Relief	18 mm	2.35 in.
Diopter Adjustment	-3 to +5	-3 to +3
Resolution	7 seconds	7 seconds
Image	Erect	Erect
Range	76°	76°

2.3 DETAILED

2.4 Optical information representing the view through the fixed line of sight field is imaged in the focal plane through a plate beamsplitter, objective and prism-mirror erecting system. The view through the scanning line of sight field is reflected through an articulated scanning

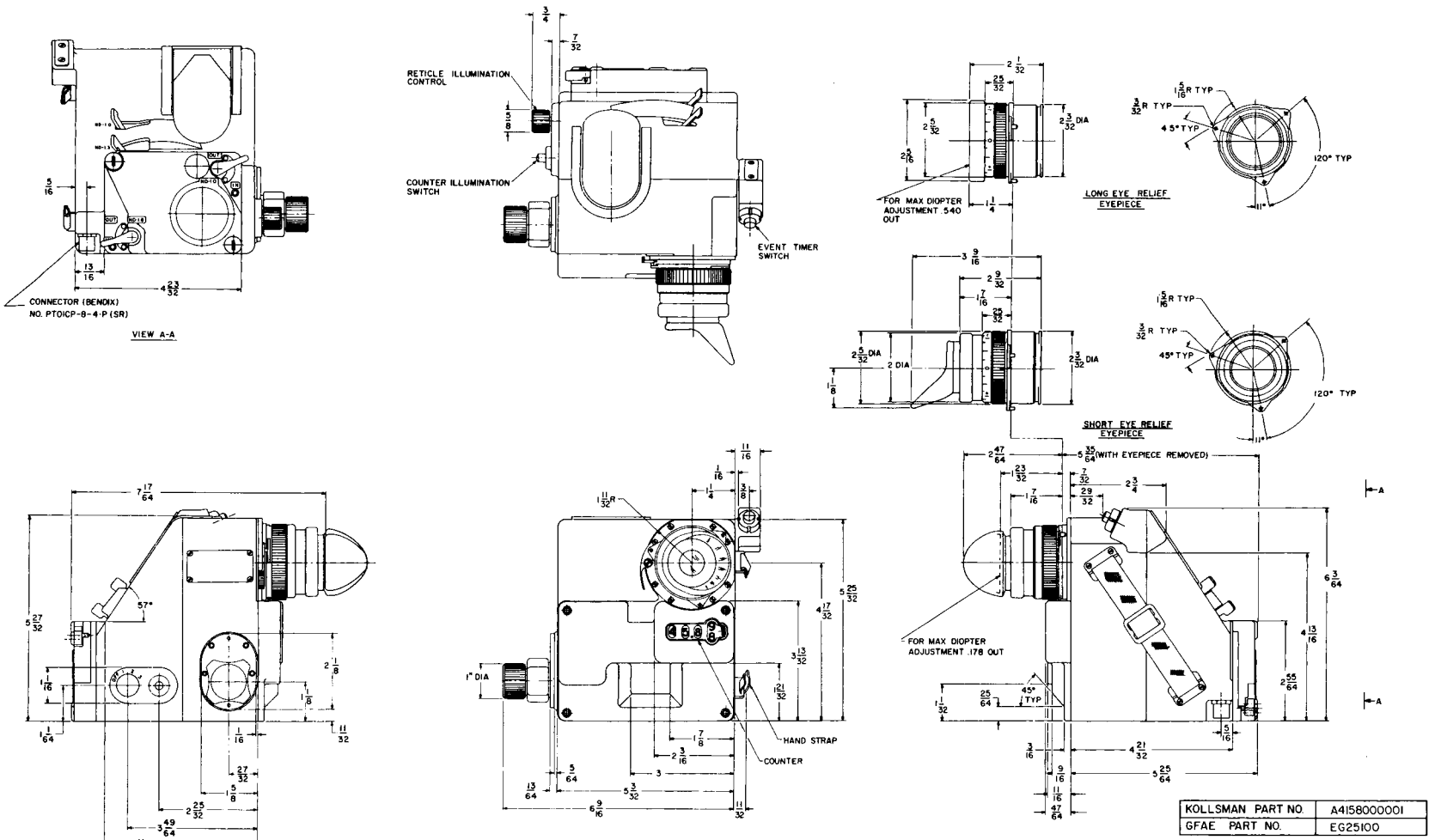


Figure 2.1 Outline Drawing, Handheld Space Sextant

mirror, then combined with the fixed line of sight field in the beamsplitter, and imaged by the same objective and erecting system in the focal plane. The operator, by observing the focal plane through the eyepiece and adjusting the scanning mirror, can introduce superposition of the fixed and scanning fields of view and thus, establish the angular separation of the fields.

2.5 The sextant is equipped with interchangeable eyepieces to permit use with and without a spacesuit helmet and visor. The optical system when the normal eye relief eyepiece is used provides a 8 power magnification with a true field of 7°. The normal eye relief eyepiece is adjustable over a range of -3 to +5 diopters. With the long eye relief eyepiece in place, the magnification is 4.6 power with the same true field. The long eye relief eyepiece is adjustable over a range of -3 to +3 diopters. In both cases, the image is erect. The wide field facilitates the location and identification of celestial bodies. The exit pupil when the normal eye relief eyepiece is used is approximately 4 mm. With the long eye relief eyepiece in place, the exit pupil enlarges to 7 mm.

2.6 The data readout is a mechanical counter located on the front face of the instrument on which the angle between the scanning line of sight and the fixed line of sight is indicated in degrees and thousandths of a degree. The drive shaft is directly coupled to the last drum such that a full revolution of the shaft will advance the counter six arc minutes. The marking of the last drum is in .001 degree increments or 3.6 seconds of arc.

2.7 The scanning control is used to control the angular rotation of the scanning line of sight. It is a two speed knob located on the left hand side of the instrument and is geared such that a full revolution of the coarse knob advances the scanning mirror 2-1/2° (equivalent to 5° of motion of the scanning line of sight). The fine control advances the mirror 1° in optical motion. Internal to the knob is a series of tongued washers which build up to provide mechanical stops to scanning mirror motion. These washers are preselected to provide 38° of mirror angular travel.

2.8 The energy source for the illumination system is self-contained in the form of a dual cell rechargeable nickel-cadmium battery. The battery supplies 2.5 volts nominal to illuminate a pair of reticle lamps and counter illumination lamps. Batteries are easily interchanged by unscrewing retaining screws located on the underside of the instrument.

2.9 A adjustable fabric strap is attached to the right side of the instrument to facilitate steady holding during operational use.

2.10 A time-mark button is attached to the right side of the instrument to provide a timing pulse for experimental measurements.

2.11 Two filters are provided to reduce the amount of light transmitted through the fixed line of sight. The filters may be inserted seperately or in combination into the fixed line of sight. The ND-1.0 filter is used to reduce the light intensity of the fixed line of sight, relative to the scanning line of sight, by a factor of 10. The ND-1.6 filter reduces the intensity by a factor of 40. The purpose of these filters is to permit viewing of images of widely varying intensities, such as a star and a lunar landmark. Two filters are also provided in the scanning line of sight for the same purpose of light attenuation. The ND-1.0 filter is used to attenuate the light by a factor of 10. The ND-1.3 filter reduces the intensity by a factor of 20. Through appropriate selection of filter combinations, measurements of bodies of widely varying intensities can be accomplished in either line of sight.

SECTION III
OPERATION

3.1 PART A – PRINCIPLES OF OPERATION

3.2 GENERAL

3.3 The operation of the Handheld Space Sextant is best described by considering it as three seperate systems, the mechanical system, optical system and electrical system.

3.4 MECHANICAL SYSTEM

3.5 The mechanical configuration of the instrument (Figure 5.1) can be considered as six seperate assemblies:

- sextant mechanism assembly
- scanning mechanism assembly
- front housing assembly
- Fixed line of sight (FLOS) filter assembly
- eyepiece assemblies
- rear cover assembly

3.6 The sextant mechanism assembly (Figure 5.2) contains the mounting structure for the scanning mechanism assembly, the porro/mirror erecting and objective lens system, the readout mechanism and its associated gearing, and the scanning controls and their related gears.

3.7 The scanning mechanism assembly (Figure 5.3) is a seperate assembly consisting of the scanning mirror, sector gear, worm shaft, and spur gear assembly, and the scanning mechanism mount. The mirror is constructed of beryllium and plated with a .005 inch thick electroless nickel (Kanigen) coating. The reflecting surface is aluminized and optically polished and lapped to 1/6 wavelength flatness. A high efficiency enhanced reflection coating is then applied to the mirror surface for environmental protection and to increase the reflection characteristics of the component. The completed mirror is assembled to a highly accurate sector gear to permit precise registering of mirror scanning position. The sector gear is constructed of hardened stainless steel with the non-cumulative tooth spacing accuracy controlled to 50 millionths of an inch. The combined mirror/gear assembly is mounted in the scanning mount assembly and rotates on highly precise ball bearings. The bearings are preselected to match each individual gear shaft and spacers are machined at assembly to provide the proper

pre-load. The wormshaft is located at right angle to the axis of the scanning mirror and the center distance between the worm axis and the gear axis is closely controlled. The wormshaft is fabricated from hardened stainless steel and the deviation from the true helical path held to less than 50 millionths of an inch over the meshing area. Pinned to the wormshaft is a precision spur gear which is used to transmit the mirror position to the readout mechanism and also to position the mirror. A constant compression spring is used to spring load the sector gear against the wormshaft to reduce the backlash transmitted to the readout gear train.

3.8 The readout mechanism and its associated gearing are also located in the sextant mechanism assembly. The readout mechanism is a mechanical-type counter with a geneva drive mechanism and displays the angle between the fixed and scanning lines of sight in degrees and thousandths of a degree. A printed circuit board assembly containing two miniature incandescant lamps connected in parallel is used to illuminate the counter and mounts directly to the counter housing. The readout gearing is designed to produce a full rotation of the input drum of the counter corresponding to six minutes of motion of the line of sight.

3.9 The scanning control assembly is a dual speed knob used to position the scanning mirror. Both the fine and coarse control are mounted concentric to the same shaft and geared such that a full revolution of the coarse control advances the mirror 2-1/2° (equivalent to 5° of line of sight motion). The fine control is geared such that a full revolution is equivalent to 1° of line of sight motion. The system gearing configuration is shown in Figure 3.1, Gear Train Schematic.

3.10 The sextant mechanism assembly also contains the major elements of the optical system telescope. The objective lens assembly is mounted in a threaded barrel to facilitate infinity adjustment. The erecting system, consisting of a porro prism and dual reflecting mirrors are mechanically attached to the central rib of the mechanism housing. Adjustable clamping of the porro prism facilitates alignment of the objective lens central axis with the center of the image plane. The reticle and eyepiece mounting flange complete this assembly. The reticle contains two vertical crosshairs to assist in instrument alignment during measurements.
The reticle lines are edge illuminated by a pair of parallel-connected miniature incandescent lamps mounted in a printed circuit board assembly. The eyepiece mounting flange is used to locate the position of both eyepiece assemblies and securely lock them in place in the instrument.

3.11 The front housing assembly (Figure 5.5) consists of three main subassemblies; the beamsplitter assembly, the scanning line of sight (SLOS) filter assembly, and the electrical assemblies. The beamsplitter is a thin cylindrical glass component specially coated on each surface for the desired optical characteristics. The surface adjacent to the scanning mirror is coated

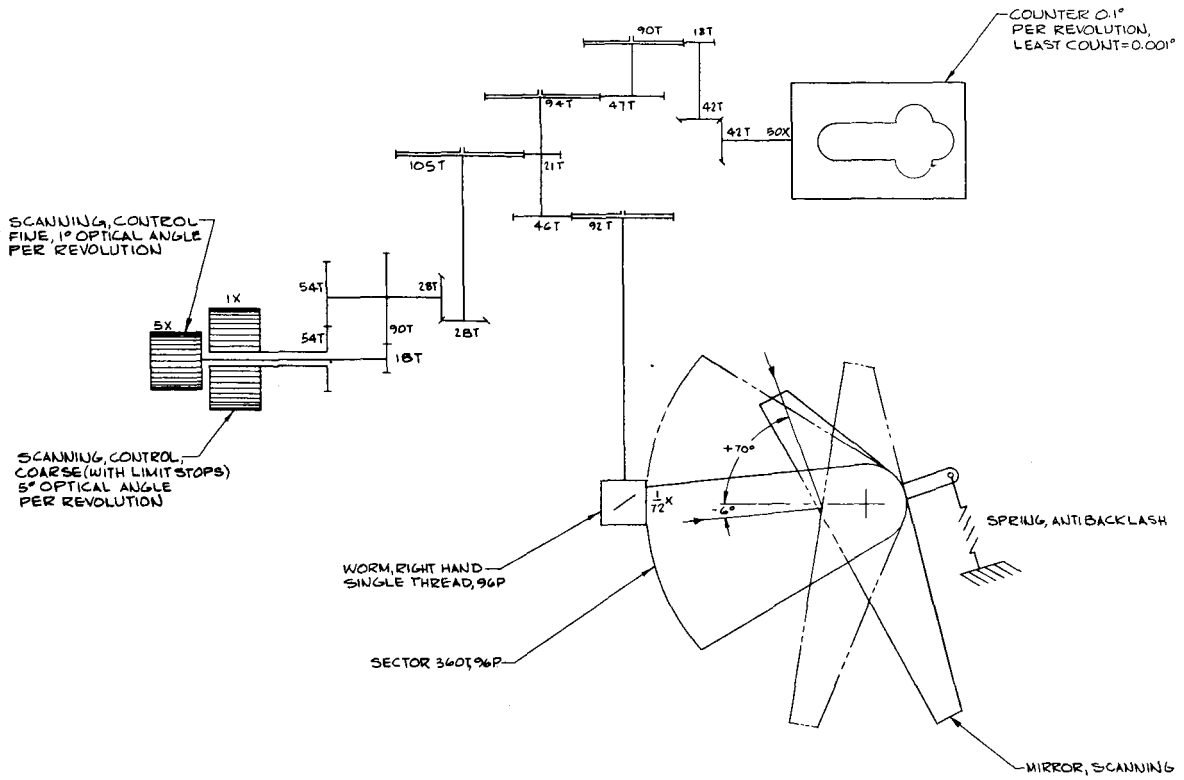


Figure 3.1 Gear Train Schematic

with a high efficiency partially reflective coating designed to transmit and reflect equal intensities of illumination over the visual spectrum. The opposite surface is coated with a high efficiency multi-layer anti-reflection coating to minimize ghosting in the optical path.

3.12 The SLOS filter assembly contains two neutral density type filters which may be inserted into and out of the scanning line of sight. Detent mechanisms are provided to lock the filters in the appropriate position.

3.13 The major portion of the electrical controls are mounted on the front housing. The reticle illumination and data readout controls are located on the left side panel of the housing. The momentary contact time-mark switch is mounted on an extension on the upper right portion of the housing. The battery is mounted in a circular aperture on the underside of the housing. The battery is enclosed by a circular plate mounted to the housing by three machine screws. A printed circuit board containing three resistors used to adjust the level of reticle illumination is also mounted to the front housing assembly.

3.14 The FLOS filter assembly attaches to the front housing assembly and provides the front surface of the instrument. The assembly contains two neutral density type filters which are insertable into the fixed line of sight. Detent mechanisms are provided to lock the filters in

the appropriate position. The assembly also contains protective bumpers to prevent accidental damage to the spacecraft window.

3.15 Two eyepiece assemblies are provided with the instrument to permit operation with and without the spacesuit visor in place. Both assemblies are mounted in flanges which permit insertion into the main body of the instrument through a one-third turn, positive locking bayonet mount. A spring-loaded latch assembly located on the sextant mechanism assembly provides the positive locking action. Each eyepiece contains its own focusing mechanism and a diopter scale. The normal eye relief eyepiece contains a rubber eyeguard contoured to fit comfortably against the eye of the operator. The long eye relief eyepiece contains a flexible circular eyeguard which adjusts to the curvature of the spacesuit visor.

3.16 The rear cover assembly completes the back end of the instrument and provides an aperture to permit viewing of the data readout. The aperture is protected by a glass window and metallic mask which exposes a limited portion of the counter dials.

3.17 An adjustable fabric hand strap mounted across the front housing and sextant mechanism housing assemblies on the right side of the instrument is provided to facilitate steady holding during the use of the instrument.

3.18 OPTICAL SYSTEM

3.19 Functionally the Handheld Space Sextant is divided into two optical systems; the telescope and the sextant optical system. (See Figure 3.2.)

3.20 As in any telescope, the essential optical elements are an objective lens with the function of forming an image of object space at the principal focus, and an eyepiece through which the observer views the image. The objective lens is an air spaced doublet mounted in its own cell to facilitate infinity adjustment.

3.21 The principal eyepiece is a 25.4 millimeter focal length, wide angle eyepiece of the Erfle variety. This lens provides the desirable combination of wide field of view and reasonable eye relief. The normal eye relief eyepiece provides instrument magnification of 8.0X.

3.22 The second eyepiece which is mechanically interchangeable with the first is necessary to provide the eye relief required when the astronaut takes sextant readings with his visor in place. The long eye relief eyepiece provides instrument magnification of 4.6X. The instrument field of view of 7°, restricted as it is by the geometry of the porro prism, is, in both cases, the same. Both eyepieces have provisions for focus adjustment.

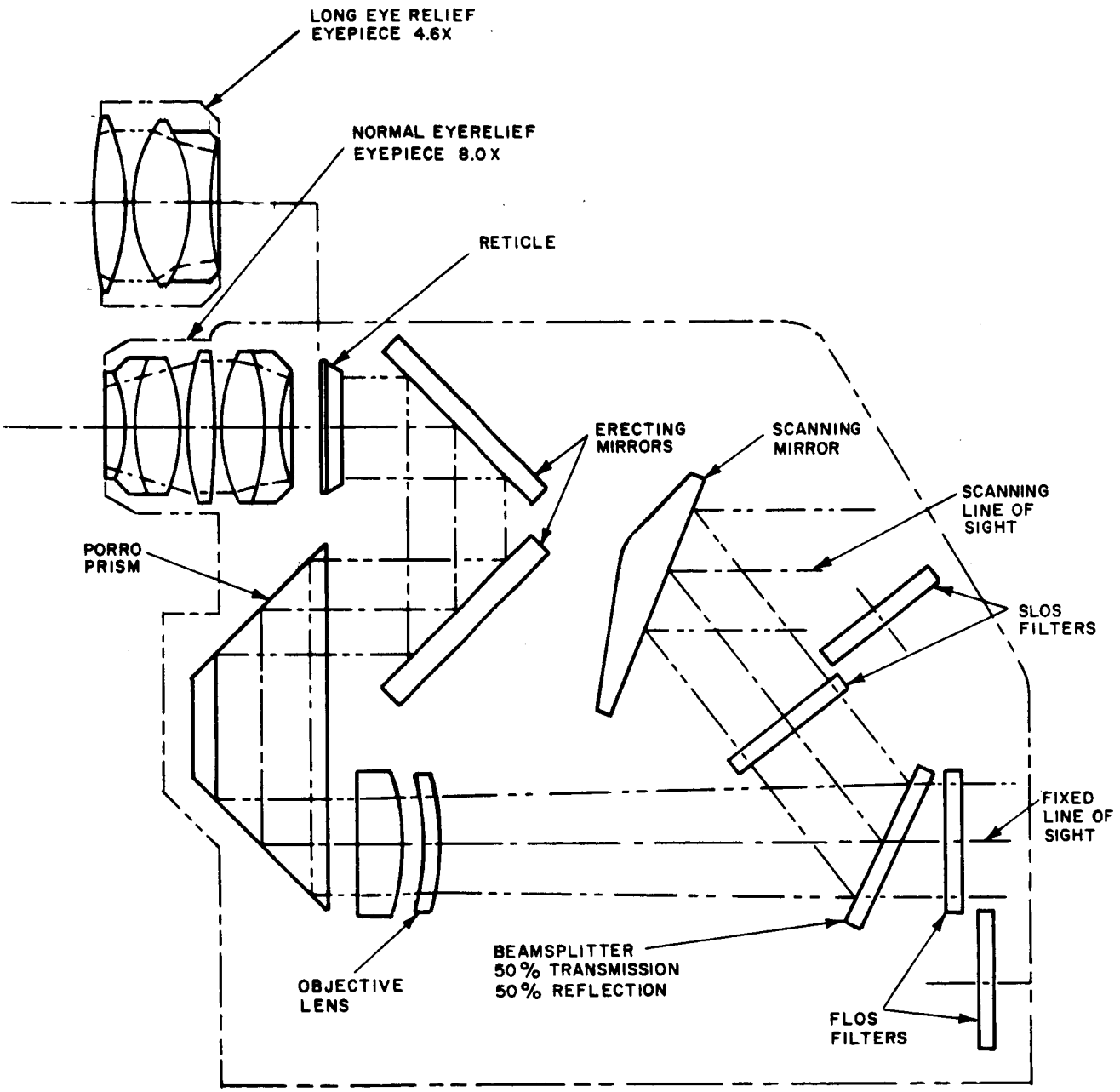


Figure 3.2 Optical Schematic Handheld Space Sextant

3.23 The porro prism and erecting mirrors in the telescope serve a dual function. Most important, they permit packaging of the instrument in a sufficiently small volume to fit between the astronaut's eye and the viewing window. As an added benefit, they serve to erect the image as seen by the astronaut. The chromatic aberration introduced by the erecting system is compensated for in the design of the objective lens.

3.24 An engraved reticle is located at the principal focus of the objective lens. The reticle pattern is so designed to assist the observer to keep the instrument lined up in the proper plane while taking the measurement. Illumination is provided to enable the observer to see the reticle against a dark background. A four position switch is used to control the reticle brightness to conform with the brightness of the objects being viewed.

3.25 In addition to the telescope, the sextant includes the following optical elements: a beamsplitter, a sextant scanning mirror, and selected filters in each line of sight.

3.26 The beamsplitter is of plate construction orientated at 26° to the fixed line of sight. The back surface is semireflecting, containing a vacuum-deposited beamsplitter coating. The coating is of the high efficiency type to minimize light absorption and provides a 50% transmission through each line of sight.

3.27 The scanning mirror is designed to maintain a wide aperture while deflecting the line of sight through a range of 76 degrees. The mirror is constructed of beryllium, plated with electroless nickel (Kanigen), and overcoated with a high efficiency type antireflection coating to reduce the distortion and absorption of the mirror.

3.28 Two filters are provided in each line of sight. The fixed line of sight contains the ND 1.0 and ND 1.6 neutral density filters. The scanning line of sight also includes two neutral density filters (ND 1.0 and ND 1.3). The filters are oriented at assembly to reduce the effect of any out of parallelism of the filters.

3.29 THE ELECTRICAL SYSTEM

3.30 The electrical system for the handheld sextant provides illumination for viewing the data readout counter and illumination of the reticle lines such that they are easily discernible in a darkened environment. The schematic diagram of the illumination circuit for the handheld sextant is shown in Figure 3.3. The energy source for the illumination circuit is self-contained and consists of a dual cell space-qualified rechargeable nickel cadmium battery. The battery is connected in parallel to the reticle illumination circuit and counter illumination circuit.

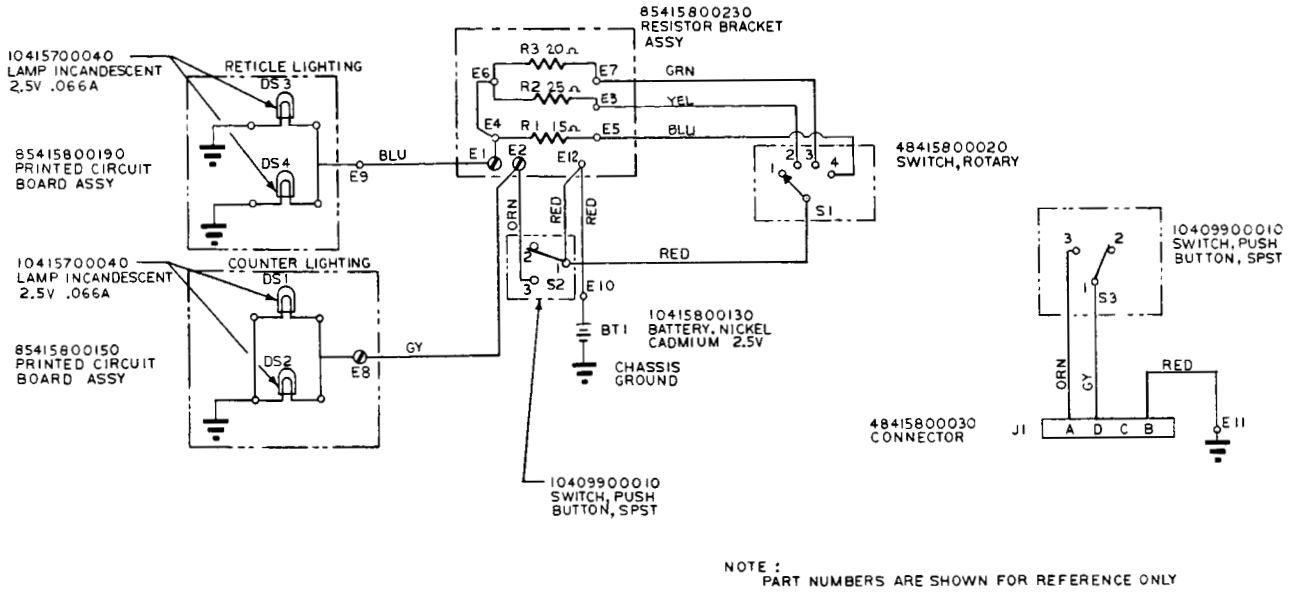


Figure 3.3 Electrical System

3.31 The reticle illumination circuit consists of a parallel pair of lamps and a four position rotary switch. The switch is used to adjust the level of illumination and also has an "OFF" position to open the circuit. Two reticle lamps connected in parallel are used to provide even illumination and increase overall reliability.

3.32 The counter illumination circuit consists of a parallel pair of lamps and a single pole, push-button, momentary contact switch. Actuation of the switch illuminates the counter dials. The lamps are located above and to each side of the dials to provide an even level of illumination.

3.33 The timing circuit consists of a push-button, momentary contact switch and a connector used to interface with the spacecraft time recording system. Actuation of the switch closes a circuit between two external connections thus providing a pulse coincident with the instant the measurement is completed.

3.34 PART B — FLIGHT INSTRUCTIONS

3.35 INSTRUMENT USE

3.36 The following procedure is recommended for use of the space sextant during actual spaceflight. (See Figure 3.4 for location of operating controls.)

a. Select and install the appropriate eyepiece in the instrument. The normal eye relief eyepiece is used when measurements are taken with the instrument positioned directly at the eye of the astronaut. The long eye relief eyepiece is used when measurements are taken with the spacesuit helmet and visor in place.

b. Attach the timing cable to the instrument.

c. Adjust the holding strap to insure positive control of the instrument during measurements.

d. Rotate the eyepiece until the target is in clear focus.

e. Set the reticle intensity to the desired level to produce a visible image by adjusting the reticle illumination control.

f. Depending upon the relative intensitites of the celestial bodies to be viewed, select the proper filter positions.

g. Set the instrument to approximately zero and sight through the instrument eyepiece at a desired target.

h. Adjust the scanning control until the second target enters the instrument field of view.

i. Fine adjust the scanning control until the desired coincidence is obtained. At instant of coincidence, press the MARK button.

NOTE

It is desirable, but not absolutely necessary that coincidence be obtained in the approximate center of the field of view. The parallel reticle lines are an indication of the central field.

j. Record the scanning control value and details of the measurement.

k. Turn off reticle illumination upon completion of measurement series.

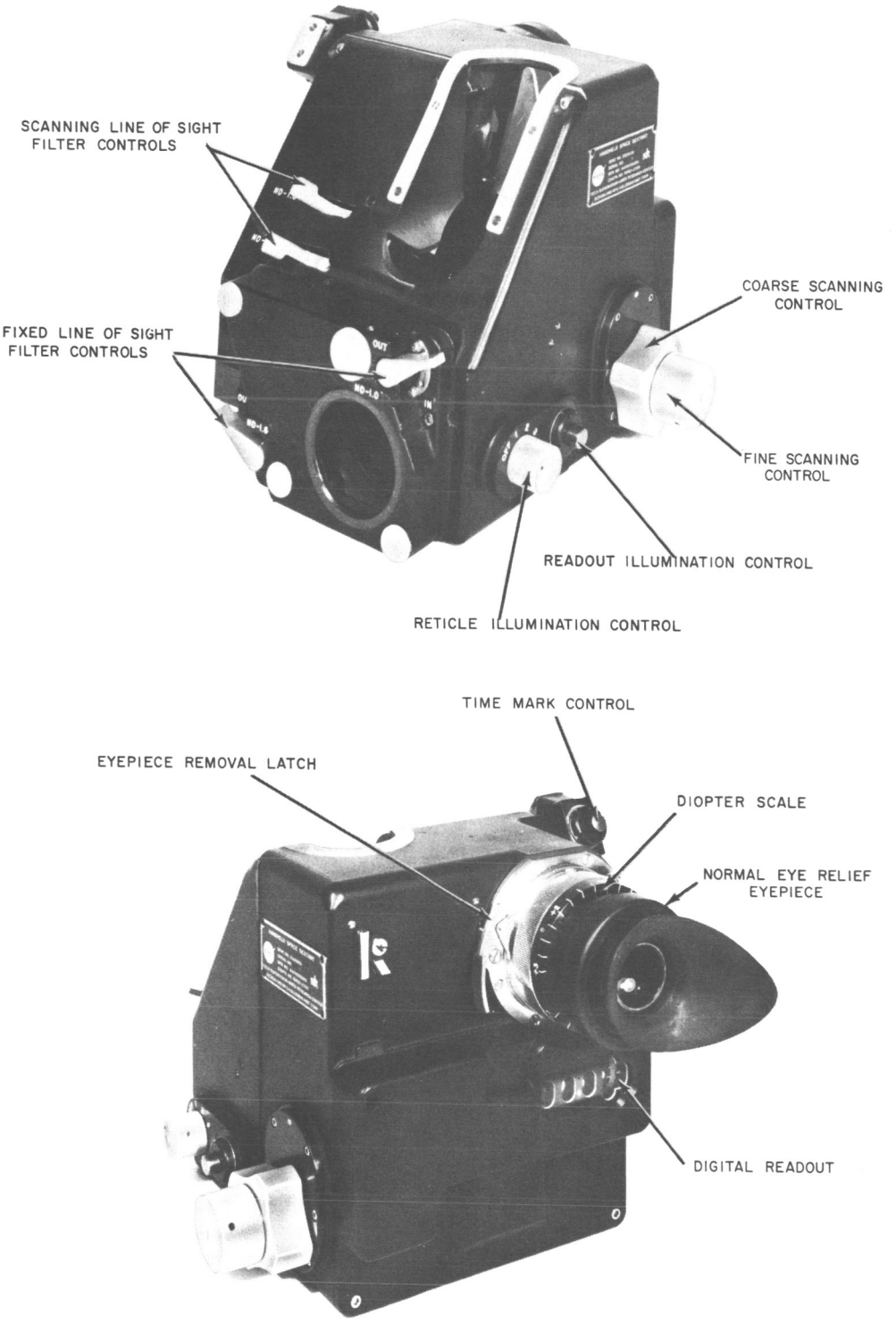


Figure 3.4 Sextant Operating Controls

SECTION IV
PRE-FLIGHT CHECKS AND CALIBRATIONS

4.1 GENERAL

4.2 This section describes those pre-flight checks and calibrations that may be performed in the field using available test equipment.

4.3 CHARACTERISTICS

4.4 The following characteristics of the unit may be verified during a series of pre-flight tests:

- optical characteristics
- electrical characteristics
- mechanical characteristics
- zero alignment
- accuracy
- repeatability

4.5 OPTICAL CHARACTERISTICS

4.6 A visual inspection of the optical system should be conducted to verify that the instrument has maintained its structural integrity.

4.7 If dust particles, smears and/or fingerprints are present on any optical surfaces, the following procedure shall be used to clean the components. Use a syringe bulb to remove large dust particles from the optical surface. Then, prepare cleaning applicators by winding lens tissue around the ends of orangewood sticks. Apply distilled acetone, with an eye dropper, evenly across the length of the lens tissue on the orangewood stick. Place the applicator lens tissue on the edge of the optical component with a minimum amount of pressure. Move the applicator slowly across the optical component in one direction from the starting edge to the opposite edge. Replace lens tissue after every move across the optical component. Repeat until all foreign matter, except for a slight film residue, has been removed from the optical component.

Repeat the above using isopropyl alcohol as a cleanser to remove the acetone residue.

4.8 Resolution of the instrument shall be verified by viewing the resolution pattern of a coordinate autocollimator (Davidson Optronics, Coordinate Autocollimator, Model D652-102, or equivalent) through the instrument eyepiece. A dioptometer or similar magnification telescope should be used to magnify the pattern image. The least discernible resolution pattern shall not exceed 15 seconds.

4.9 The additional optical parameters listed in Table 2.1 do not require verification since they are design parameters and are fixed by the mechanical construction of the unit.

4.10 ELECTRICAL CHARACTERISTICS

4.11 The following electrical characteristics may be verified prior to flight operation:

- operation of the energy source (Para. 4.12)
- operation of the redundant reticle lighting circuit (Para. 4.17)
- operation of the counter illumination control (Para. 4.18)
- operation of the reticle illumination rheostat (Para. 4.19)
- operation of the timing circuit (Para. 4.21)

4.12 The energy source for the electrical circuits is a dual cell rechargeable nickel-cadmium battery. Voltage output of the battery should be verified immediately prior to the flight. If the open circuit voltage of the battery exceeds 2.80 volts, it can be assumed that the cell is fully charged. If the open circuit voltage (OCV) is less than 2.80 volts, the following procedure shall be observed to insure properly charged batteries.

4.13 If the OCV is less than 2.0 volts, the battery requires three (3) charge-discharge cycles to insure maximum life. If the OCV is between 2.0 and 2.2 volts, the battery requires at least two (2) charge-discharge cycles. If the OCV is between 2.2 and 2.8 volts, the battery requires at least one (1) charge-discharge cycle.

4.14 Constant current charging is recommended for sealed nickel-cadmium batteries. The ten (10) hour charge rate of 130 milliamperes for 10 hours should not normally be exceeded. Charging at rates higher than the ten hour rate does not cause catastrophic failure, however, it will materially reduce the battery life if continued over a long period of time. It is recommended that the battery be charged at the 13 hour rate which is 13 hours at 100 milliamperes at an ambient temperature of 70° F.

4.15 Discharge should be accomplished at the ten hour rate or a current drain of 100 milliamperes. Discharge should continue until the OCV of the battery drops to 2.2 volts.

4.16 Use of the Battery Charger and Test Unit, GFAE No. EG 25104, is recommended to properly prepare the batteries for use.

4.17 The useful life of the batteries is a function of the storage time after charging. Table 4.1 gives the remaining percent of capacity when a fully charged battery is placed in storage at 70° F at a 50% relative humidity.

TABLE 4.1

Time in Storage (Days)	10	20	30	60	90	120	150
Capacity Remaining (%)	82%	77%	75%	73%	70%	68%	66%

4.18 A pair of miniature lamps connected in parallel are used to illuminate the reticle cross-hairs. Confirm that both lamps are operating properly through the following procedure. With fully charged battery installed in the instrument, rotate the reticle illumination control to its fully clockwise position. Remove the eyepiece and observe the illumination level. Both lamps should provide the same level of illumination.

4.19 The counter illumination circuit should be checked by depressing the control button and observing the illumination projected on the counter dials. By viewing through the counter mask observe also that both lamps are lighted when the control button is pressed.

4.20 The reticle illumination rheostat switch should be checked by observing the reticle through the instrument eyepiece in a darkened environment. Clockwise rotation of the rheostat knob should result in increased reticle illumination. No light shall be visible when the knob is in the "OFF" position.

4.21 Operation of the timing circuit can be verified by checking continuity across pins D and A when the time mark button is depressed. Release of the button should open the circuit. Use the Test Cable, GFAE No. EG 25105 to simplify this procedure.

4.22 MECHANICAL CHARACTERISTICS

4.23 The following characteristics of the unit may be verified:

- scanning mirror movement
- operation of scanning control
- operation of filter levers

4.24 Proper motion of the scanning mirror may be confirmed by rotating the scanning control through its entire range (approximately -6° to +70°) and visually observing the smooth rotation of the scanning mirror.

4.25 During 4.24, the rotation of the scanning control shall be free and unimpeded.

4.26 Rotation of the filter levers shall positively lock each filter in the center of the optical path. There should be a minimum of free play in the control at either detent in each line of sight.

4.27 ZERO ALIGNMENT

4.28 The zero alignment is checked by sighting an infinity target (collimated image) and rotating the scanning control until the images produced by both lines of sight (fixed and scanning) are superimposed in the image plane of the instrument. The images should be observed with the normal eye relief eyepiece and dioptometer or similar magnifier. When the images are superimposed, the data readout shall read approximately 00.000. Zero alignment shall be accomplished by rotating the scanning control in the increasing direction.

4.29 ACCURACY

NOTE

Extreme care and precise test equipment is required to properly verify the accuracy and repeatibility of the instrument.

4.30 The general concept of the accuracy evaluation of the instrument is as follows: a true angle is developed within the test equipment which is representative of the angle between the fixed line of sight and scanning line of sight. This angle is variable within the range limits of the instrument and may be preset at any value. The angle of the line of sights developed by the instrument at the same presetting is compared with the true angle developed by the test equipment to determine the magnitude and direction of the errors.

4.31 The accuracy of the instrument can be conveniently determined through the use of the sextant test stand (Kollsman P/N 10 41580 0400) (See Figure 4.1) and the precision test fixture (Kollsman P/N 01 38690 8201) shown in Figures 4.2 and 4.3.

4.32 The precision test fixture provides a collimated star image referenced precisely to a highly accurate rotary turntable (on the order of an arc second calibrated accuracy) and develops the required true reference angle used in the accuracy evaluation.

4.33 The sextant test stand is a holding fixture for the space sextant and mounts directly on the precision test fixture. The test stand has a three point contact leveling system to insure that the plane of rotation of the sextant scanning mirror is perpendicular to the axis of the rotating turntable. The test stand is equipped with a holding bracket for a dioptometer to aid in increased accuracy measurements through the optical system.

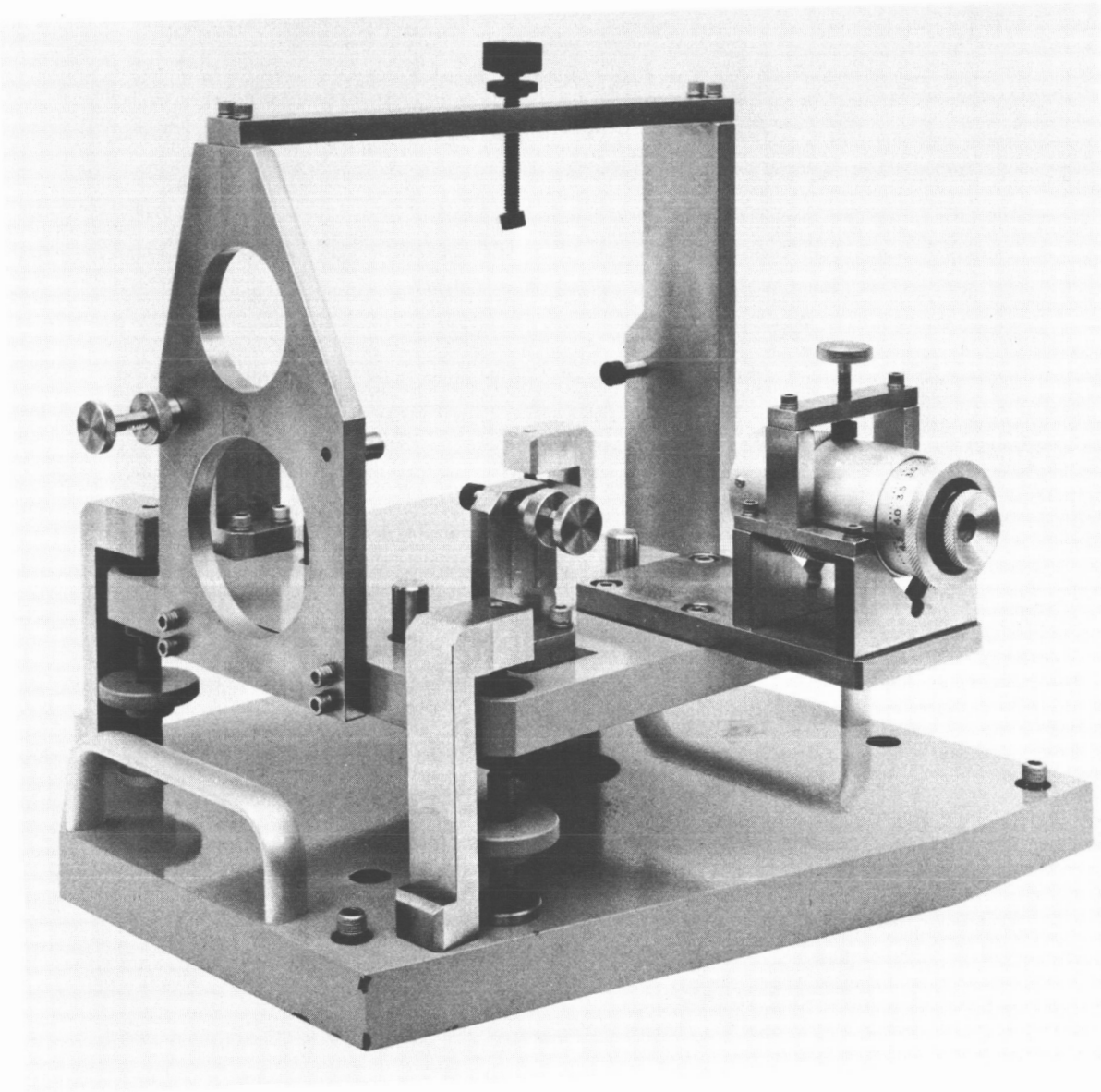


Figure 4.1 Sextant Test Stand

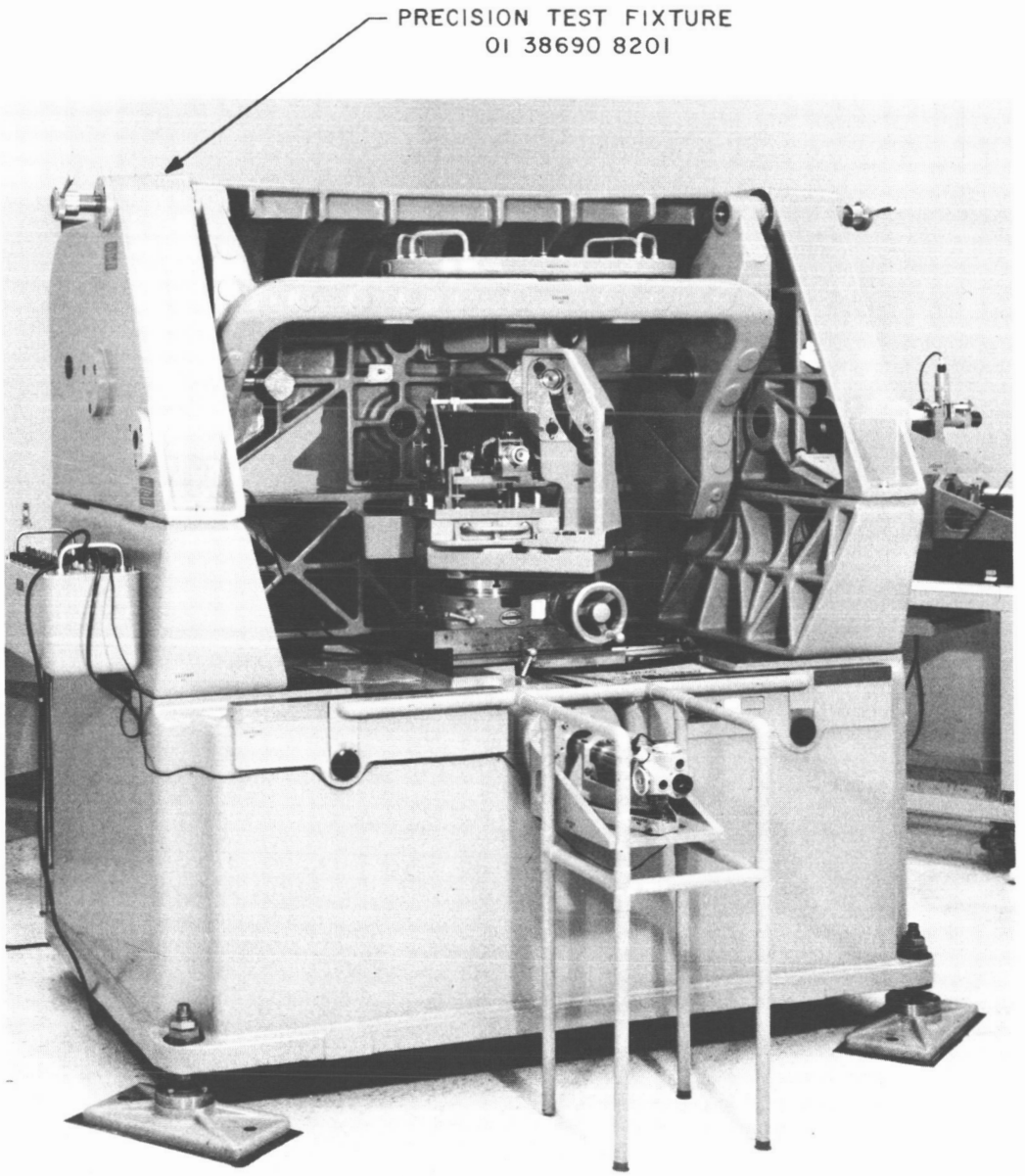


Figure 4.2 Sextant and Test Stand Mounted in Precision Test Fixture

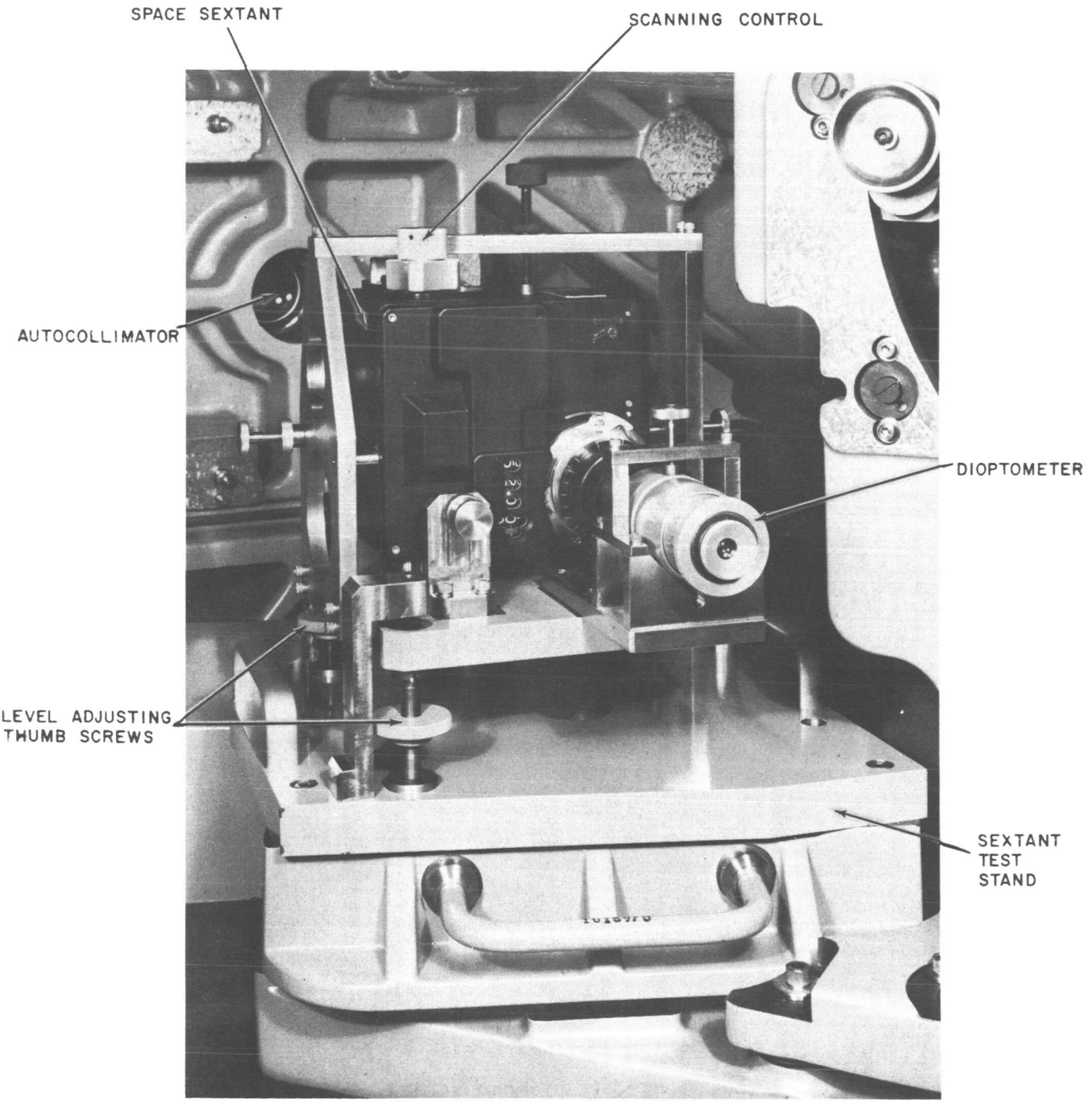


Figure 4.3 Sextant and Test Stand Mounted in Precision Test Fixture
Close-Up View

4.34 The procedure used in evaluating the accuracy is as follows: the instrument is placed on the sextant test stand and the stand is installed in the precision test fixture (See Figure 4.3). The instrument scanning control is set at 0° and the turntable rotated until the image of the collimator appears in the focal plane of the instrument. The table should be adjusted until the collimator image is coincident with the dioptometer reticle. If the zero alignment procedure has been correctly accomplished, the image of the collimator reticle as seen through the scanning line of sight and the image as seen through the fixed line of sight should both appear in the focal plane.

4.35 The plane of rotation of the scanning mirror is now leveled with respect to the turntable rotational axis through the following procedure: the scanning mirror is rotated through its entire range at the same time as the instrument (mounted on the turntable) is rotated in the opposite direction. This has the effect of the scanning mirror tracking the fixed collimator image as the instrument is rotated. If the instrument is not level with respect to the turntable axis, the image will be observed to deviate from the horizontal as seen through the instrument eyepiece. The leveling system of the test stand should be adjusted to correct this condition.

4.36 Accuracy is determined through the following procedure: a zero reference is developed by recording the turntable azimuth value at the point at which the collimator image as seen through the scanning line of sight is coincident with the dioptometer reticle and the counter setting reads 0°. The scanning control is then rotated through a discrete angle and the turntable is rotated in the opposite direction until the image of the collimator as seen through the scanning line of sight is again coincident with the dioptometer image. The angle of rotation of the turntable is then compared with the angle of rotation of the scanning mirror to find the instrument error.

4.37 It is recommended that the accuracy be checked in the following manner:

a. A series of readings should be taken in 1° increments over the full range of the instrument with the scanning control always set in one direction (clockwise or counterclockwise).

b. A series of readings in 1° increments should be taken setting the scanning control in the opposite direction of that used in Para. 4.37a.

c. A series of 0.1° increment readings from 32.0° to 33.0° with the scanning control set in the same direction of that used in Para. 4.37a.

4.38 REPEATABILITY

4.39 Dependent upon the accuracy desired, it may be found advisable to develop a calibration curve for the instrument. The calibration curve is a plot of the instrument error (deviation of measured angle from true angle) at any particular scanning control setting. A minimum of three series of readings is sufficient to determine a calibration curve. If a perliminary plot of each series of data indicates a linear relationship, a linear regression analysis can be performed to determine the calibration. The statistical significance of the linear assumption can be determined by calculating the standard deviation of the differences of each data point from the calibration curve.

NOTE

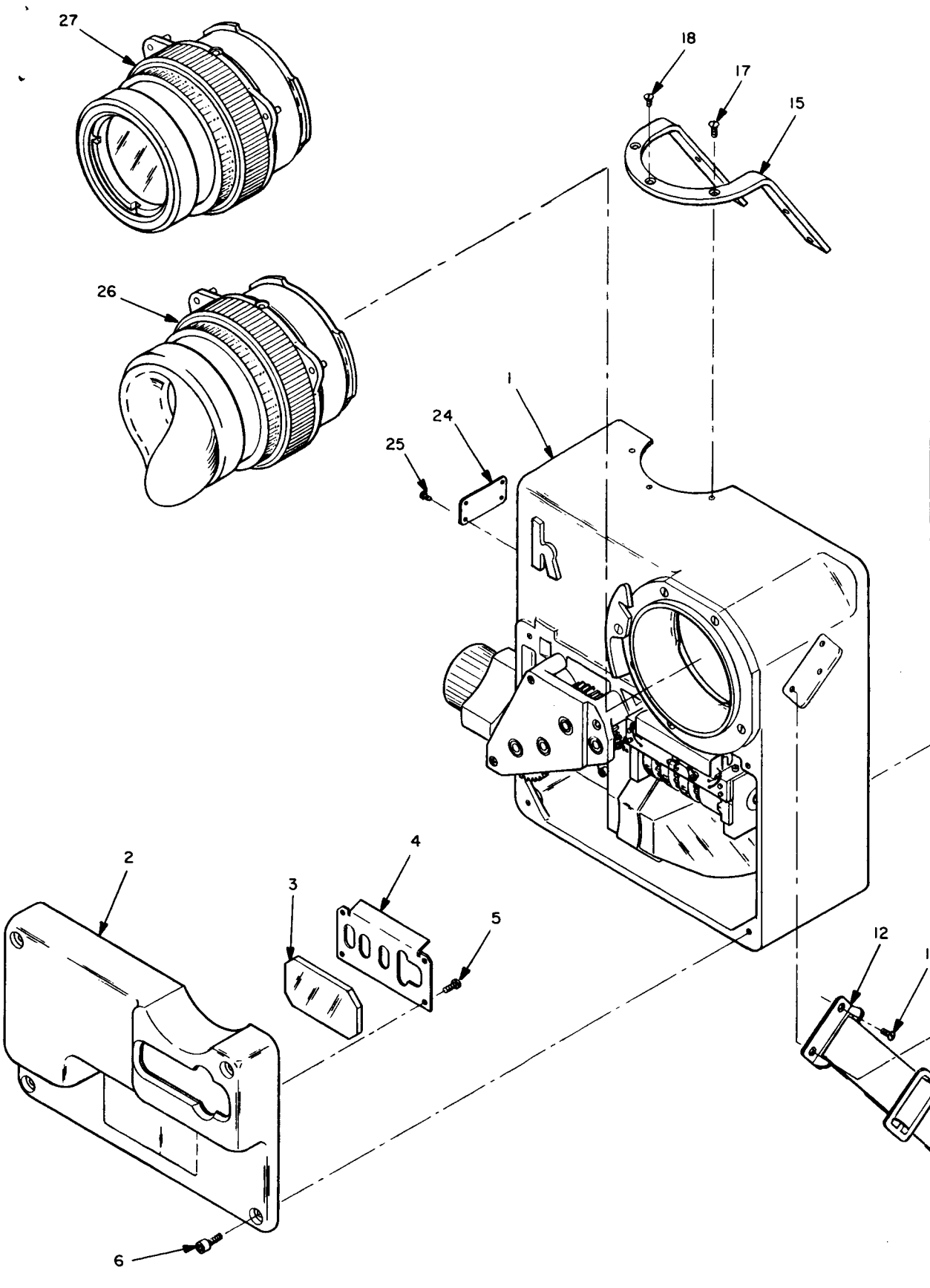
The use of the sextant test stand and precision test fixture is not required to check the accuracy and repeatability of the instrument. Any accurate turntable and collimator may be used if the following conditions are met:

- a positive 90° is established between the axis of rotation of the turntable and the collimator.
- the accuracy of the turntable is well within the accuracy required of the instrument.
- the instrument may be leveled with respect to the turntable rotational axis.

SECTION V

ILLUSTRATED PARTS BREAKDOWN

FIGURE AND INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	UNITS PER ASSY.
		HANDHELD SPACE SEXTANT 88 41580 0000	
5.1-	88 41580 0000	SEXTANT, SPACE, HANDHELD	
-1	85 41580 0400	. MECHANISM, ASSEMBLY	1
	85 41580 0360	. COVER, REAR, ASSEMBLY	1
-2	51 41580 0010	. . COVER, Rear	1
-3	28 41580 0180	. . WINDOW, Counter	1
-4	59 41580 0040	. . MASK, Counter	1
-5	10 41570 0200	. . SCREW, Binding hd.	4
-6	10 41580 0450	. SCREW, Cap, hex socket, self-locking	4
-7	85 41580 0350	. HOUSING, FRONT, ASSEMBLY	1
-8	10 41570 0380	. SCREW, Cap, hex socket, self-locking	6
-9	85 41580 0300	. HOUSING, FILTER, ASSEMBLY	1
-10	10 41580 0450	. SCREW, Cap, hex socket, self-locking	4
-11	46 41580 0020	. BUMPER, Filter housing	2
-12	85 41580 0090	. STRAP, ASSEMBLY	1
-13	10 41580 0020	. SCREW, Flat hd., self-locking	5
-14	61 30205 0208	. SCREW, Flat hd	1
-15	46 41580 0150	. BUMPER	1
-16	46 41580 0140	. BUMPER	1
-17	10 41570 0020	. SCREW, Flat hd., self-locking	8
-18	61 30205 0208	. SCREW, Flat hd.	1
-19	10 41580 0130	. BATTERY	1
	85 41580 0110	. COVER, BATTERY, ASSEMBLY	1
-20	52 41580 0230	. . COVER	1
-21	56 41570 0010	. . SPRING, Washer, wave shape	1
-22	74 36900 0001	. . RIVET, Countersunk	1
-23	10 40990 0230	. SCREW, Flat hd., self-locking	3
-24	81 41580 0010	. PLATE, Identification	1
-25	X-30	. SCREW	4
-26	85 41580 0280	. EYEPIECE ASSEMBLY, Normal eye relief	1
-27	85 41580 0290	. EYEPIECE ASSEMBLY, Long eye relief	1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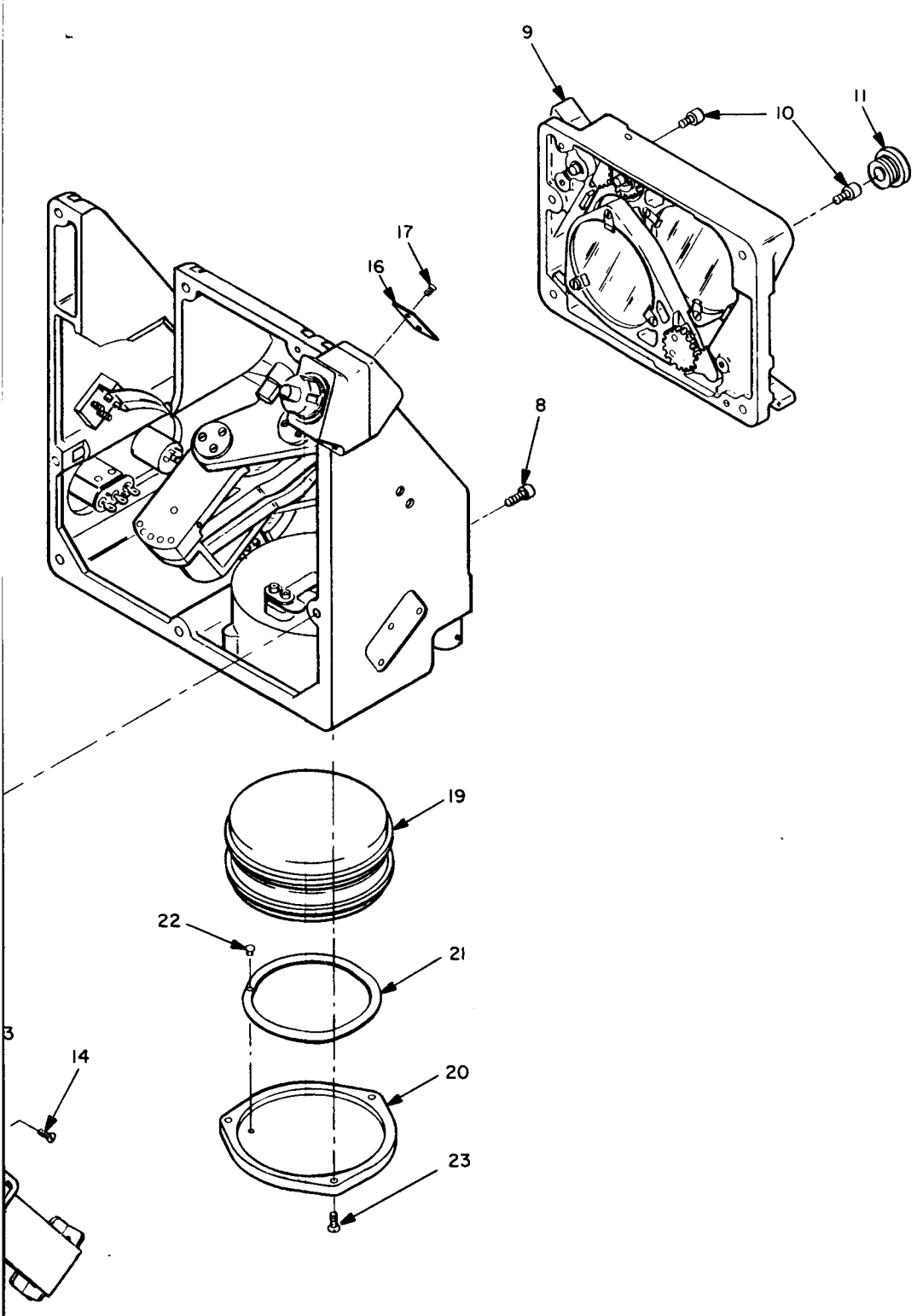
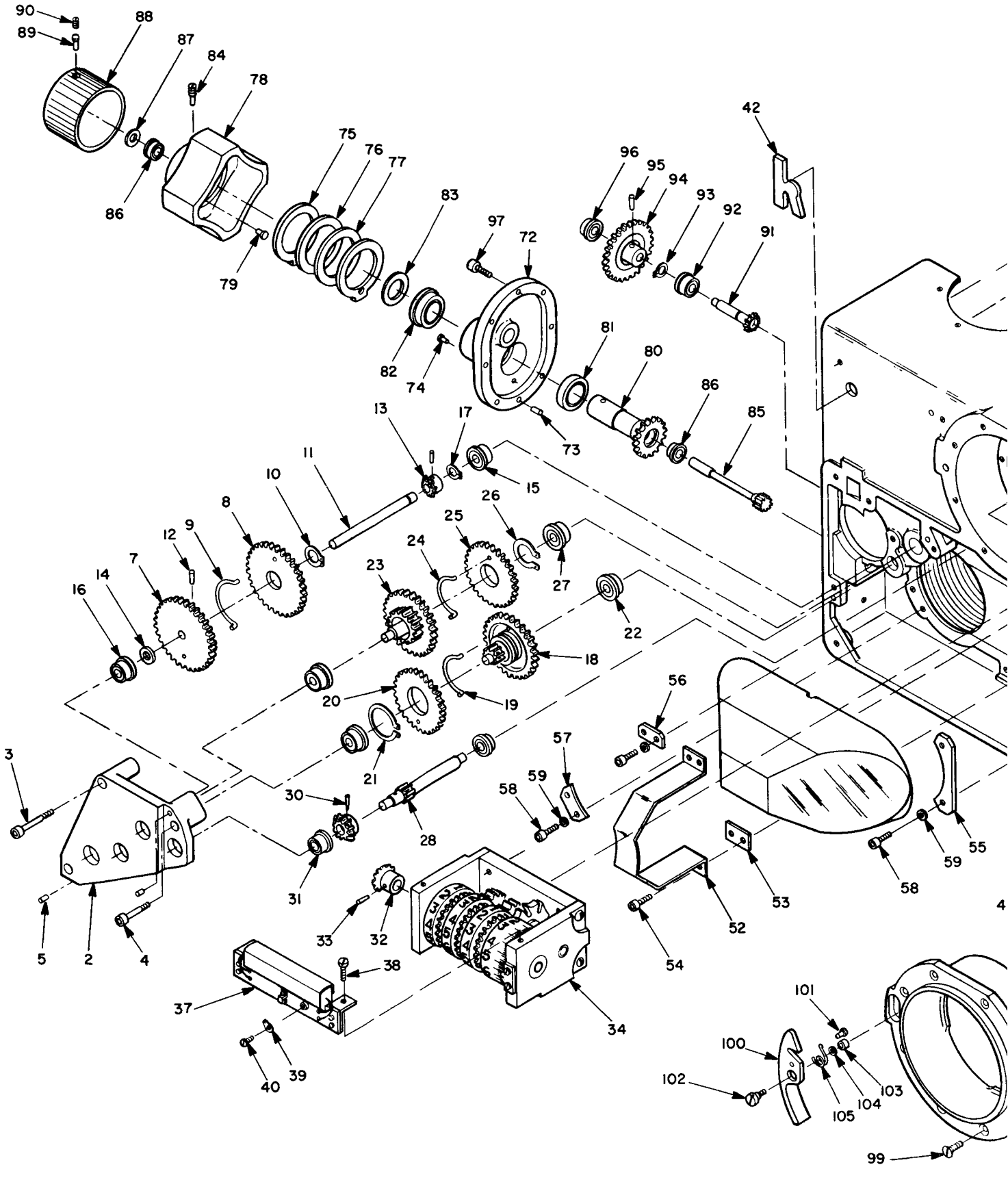


Figure 5.1 Handheld Space Sextant

FIGURE AND INDEX NO.	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY.
		MECHANISM, ASSEMBLY OF	
5.2-	85 41580 0400	. MECHANISM, ASSEMBLY	1
	85 41580 0180	. . HOUSING, MECHANISM, ASSEMBLY	1
-1	51 41580 0060	. . . HOUSING, Mechanism	1
-2	51 41580 0070	. . . PLATE, Gear train	1
-3	10 41580 0440	. . . SCREW, Cap, hex socket hd, self-locking	2
-4	10 41570 0450	. . . SCREW, Cap, hex socket hd, self-locking	1
-5	73 00210 5064	. . . PIN, Dowel	2
-6	73 00210 5086	. . . PIN, Dowel	2
-7	33 41580 0040	. . GEAR, Spur, antibacklash (105T, 96P)	1
-8	33 41580 0030	. . GEAR, Spur, flat (105T, 96P)	1
-9	73 00616 1005	. . SPRING, Antibacklash	1
-10	74 45301 8007	. . RING, Retaining	1
-11	57 41580 0210	. . SHAFT	1
-12	73 00230 5001	. . PIN, Taper	2
-13	33 41580 0090	. . GEAR, Bevel	1
-14	2044-103-8	. . SHIM	1
-15	30 27150 0080	. . BEARING, Ball	1
-16	30 27166 0081	. . BEARING, Ball	1
-17	74 45301 8001	. . RING, Retaining	1
-18	85 41580 0070	. . GEAR, SPUR, ASSEMBLY	1
	35 41580 0070	. . . GEARSHAFT, Spur (21T, 46T, 96T)	1
	33 41580 0100	. . . GEAR, Blank (94T, 96P)	1
-19	73 00616 1004	. . SPRING, Antibacklash	1
-20	33 41580 0080	. . GEAR, Spur, flat (94T, 96P)	1
-21	74 45301 8016	. . RING, Retaining	1
-22	30 27166 0081	. . BEARING, Ball	2
-23	85 41580 0060	. . GEAR, SPUR, ASSEMBLY	1
	35 41580 0030	. . . GEARSHAFT, Spur (47T, 96P)	1
	33 41580 0210	. . . GEAR, Blank (90T, 96P)	1
-24	73 00616 1003	. . SPRING, Antibacklash	1
-25	33 41580 0190	. . GEAR, Spur, flat (90T, 96P)	1
-26	74 45301 8011	. . RING, Retaining	1
-27	30 27166 0081	. . BEARING, Ball, FDS	2
-28	35 41580 0060	. . GEARSHAFT, Spur (18T, 96P)	1
-29	33 41580 0170	. . GEAR, Bevel (42T, 96P)	1
-30	73 00230 5010	. . PIN, Taper	1
-31	30 27166 0081	. . BEARING, Ball	2
-32	33 41580 0150	. . GEAR, Bevel (42T, 96P)	1
-33	73 00230 5020	. . PIN, Taper	1
-34	10 41580 0030	. . COUNTER	1
-35	45 41580 0030	. . SCREW, Shoulder	2
-36	10 41580 0450	. . SCREW, Cap, hex socket, self-locking	2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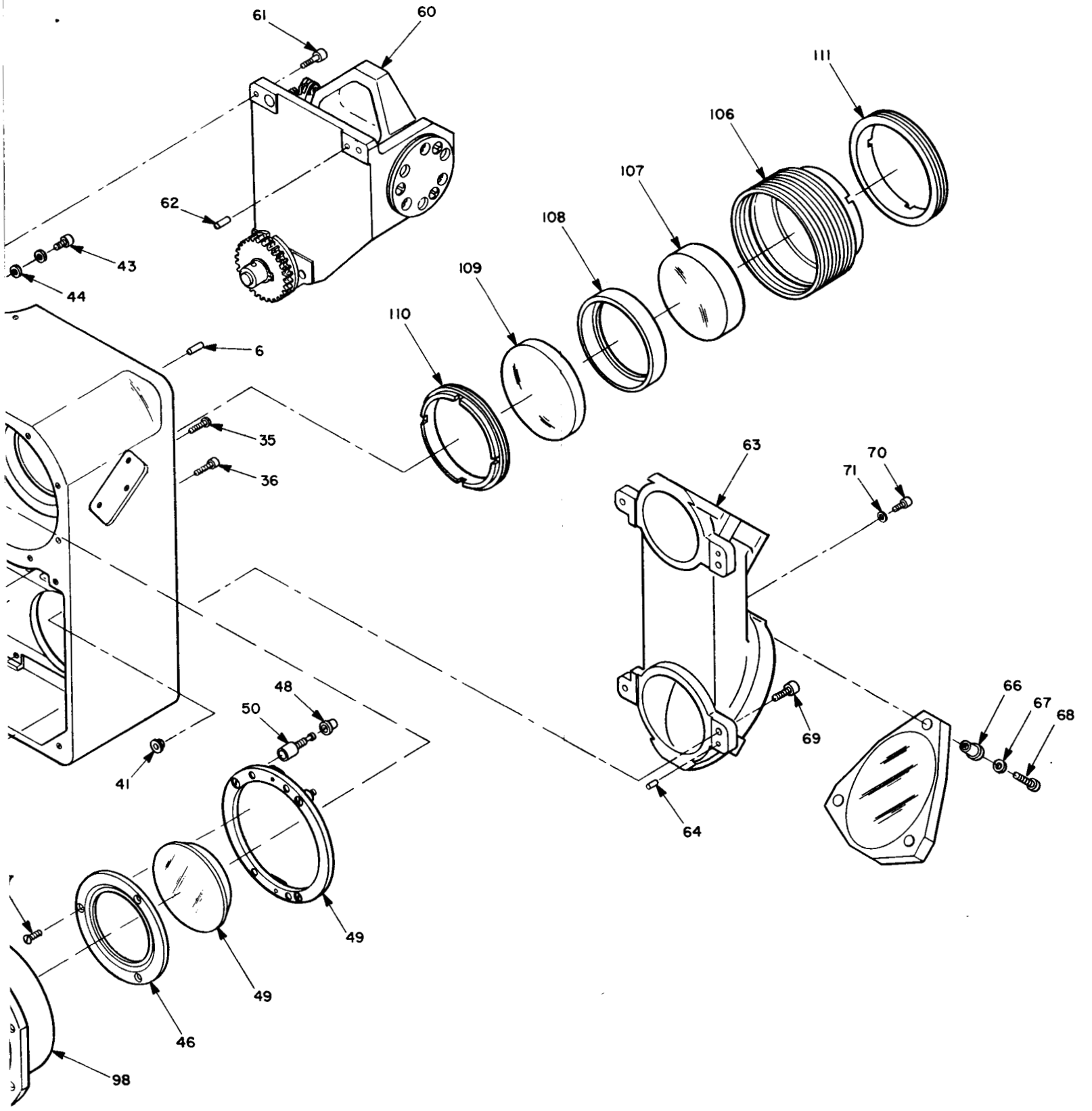


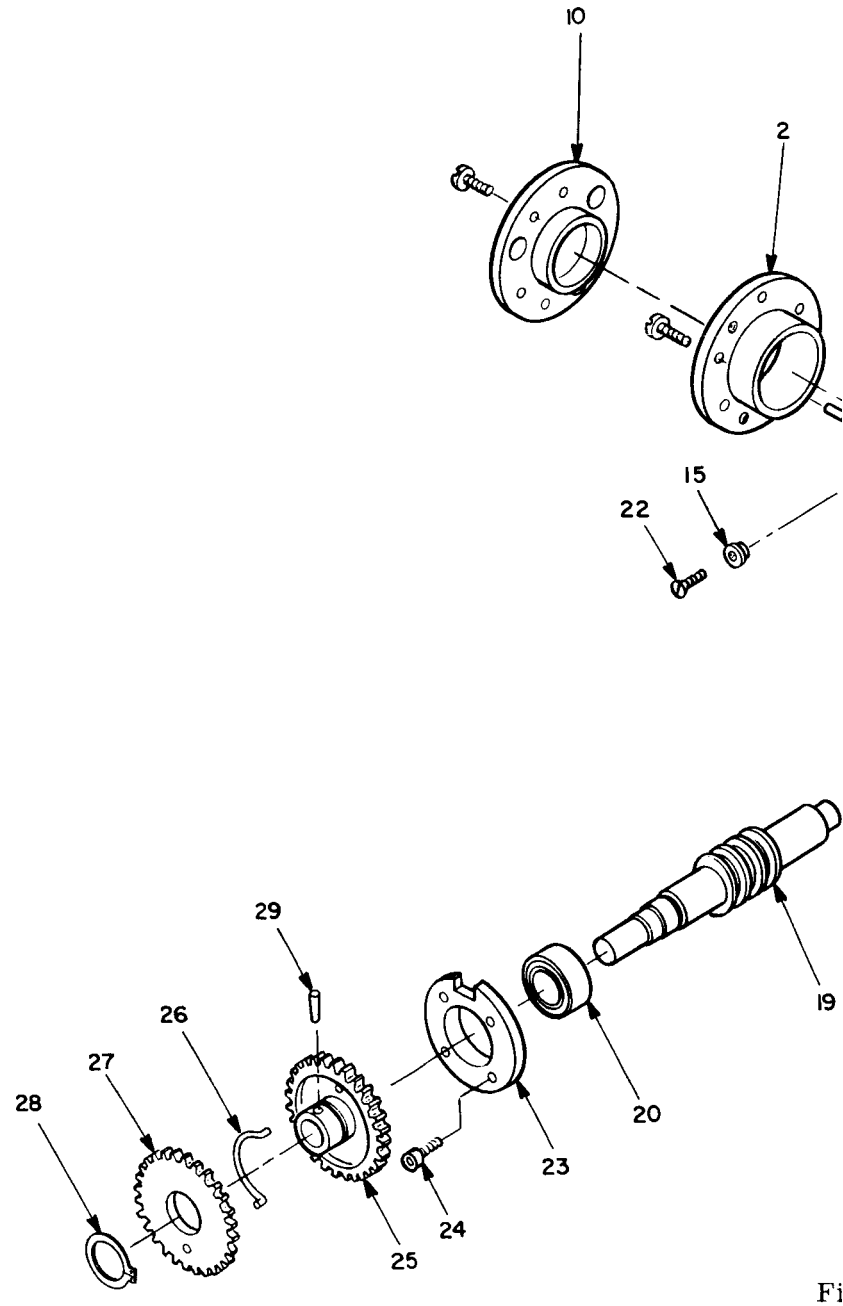
Figure 5.2 Mechanism, Assembly of

FIGURE AND INDEX NO.	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	UNITS PER ASSY
5.2-		MECHANISM, ASSEMBLY OF (Continued)	
-37	85 41580 0150	. . PRINTED CIRCUIT BOARD ASSEMBLY, COUNTER	1
	46 41580 0060	. . . PRINTED CIRCUIT BOARD	1
	59 41580 0020	. . . BRACKET, Angle	2
	10 41570 0170	. . . RIVET	4
	59 41580 0030	. . . CLIP, Wire	1
	10 41570 0170	. . . RIVET	1
	57 41580 0200	. . . BUTTON, Threaded	1
	85 41580 0160	. . . LAMP AND RETAINER ASSEMBLY	2
	46 41580 0050	. . . , RETAINER Lamp	1
	10 41570 0040	. . . . LAMP	1
	59 41580 0120	. . . SHIELD, Light	1
	60 02504 1014	. . . INSULATION Sleeving, Elect (4" long)	As Req'd
-38	10 40980 0160	. . SCREW, Pan head, self-locking	2
-39	56 41570 0030	. . LUG, Wire	1
-40	48 41570 0020	. . SCREW, Pan hd, gold plated	1
	60 51101 2408	. . WIRE, Electrical, (gray) (Awg. 24)	1
-41	46 41580 0130	. . BUSHING, Flanged	1
-42	10 41570 0060	. . TRADEMARK, Metal	1
-43	61 30305 0208	. . SCREW, Round head	1
-44	74 46805 1001	. . WASHER, Flat	2
-45	28 51580 0010	. . RETICLE	1
-46	57 41580 0330	. . RETAINER, Reticle	1
-47	10 41570 0270	. . SCREW, Flat head, self-locking	3
-48	46 41580 0110	. . INSULATOR, Electrical	1
-49	85 41580 0190	. . PRINTED CIRCUIT BOARD ASSEMBLY, RETICLE	1
	46 41580 0120	. . . PRINTED CIRCUIT BOARD	1
	68 10102 2605	. . . TERMINAL Stud	4
	10 41570 0040	. . . LAMP	2
	60 02504 1014	. . . INSULATION Sleeving, elect (2" long)	1
	57 41580 0360	. . . POST	2
	45 41580 0070	. . . SCREW, Captive	2
	45 41580 0080	. . . SCREW, Captive	1
-50	57 41580 0370	. . TERMINAL, Electrical	1
	60 51101 2406	. . WIRE, Electrical (blue) (Awg. 24)	As Req'd
-51	28 41580 0130	. . PRISM	1
-52	59 41580 0070	. . STRAP, Prism	1
-53	56 41580 0020	. . SPACER	As Req'd
-54	10 41570 0320	. . SCREW, Cap, socket hd, self-locking	4
-55	52 41580 0260	. . BLOCK, Alignment	1
-56	52 41580 0240	. . BLOCK, Alignment	1
-57	52 41580 0250	. . BLOCK, Alignment	1
-58	10 41570 0320	. . SCREW, Cap, hex socket, self-locking	6
-59	45 41580 0100	. . WASHER, Flat	6

FIGURE AND INDEX NO.	PART NUMBER	DESCRIPTION	UNITS PER ASSY
		MECHANISM, ASSEMBLY OF (Continued)	
5.2-			
-60	85 41580 0050	. . MECHANISM, SCANNING, ASSEMBLY	1
	85 41580 0040	. . . MOUNT, MIRROR, SCANNING, ASSEMBLY	1
	52 41580 0050	. . . . MOUNT, Mirror, scanning	1
	57 41580 0170	. . . . SUPPORT, Bearing, right	1
	57 41580 0180	. . . . SUPPORT, Bearing, left	1
	10 40980 0160	. . . . SCREW, Pan hd	6
	73 00210 5064	. . . . PIN, Dowel	2
	85 41580 0020	. . . MIRROR AND SECTOR, ASSEMBLY	1
	52 41580 0030	. . . . MIRROR, Scanning	1
	34 41580 0020	. . . . GEAR, Sector	1
	39 41580 0010	. . . . PIN, Dowel	1
	10 41570 0070	. . . BEARING, Ball	2
	57 41580 0300	. . . RETAINER, Bearing, right	1
	57 41580 0310	. . . RETAINER, Bearing, left	1
	45 41580 0090	. . . SPACER	1
	10 41580 0890	. . . SCREW, Mach, pan hd	6
	57 41580 0190	. . . ANCHOR, Spring	1
	73 00210 5044	. . . PIN, Dowel	1
	58 41580 0010	. . . SPRING Helical, tension	1
	39 41580 0020	. . . PIN, Headed	1
	74 45308 1003	. . . RING, Retaining	1
	35 41580 0020	. . . GEARSHAFT, Worm	1
	10 41580 0040	. . . BEARING, Ball, annular, DS, PHR	2
	52 41580 0180	. . . RETAINER, Bearing, front	1
	52 41580 0190	. . . RETAINER, Bearing, rear	1
	10 41570 0400	. . . SCREW, Cap, hex socket	7
	33 41580 0020	. . . GEAR, Spur, antibacklash (92T, 96P)	1
	73 00616 1004	. . . SPRING, Antibacklash	1
	33 41580 0010	. . . GEAR Spur, flat (92T, 96P)	1
	74 45301 8011	. . . RING, Retaining	1
	73 00230 5020	. . . PAN, Taper	1
-61	10 41570 0380	. . SCREW, Cap, hex socket	3
-62	73 00210 5086	. . PIN, Dowel	1
	85 41580 0270	. . SUPPORT, MIRRORS, ASSEMBLY	1
-63	51 41580 0020	. . . SUPPORT, Mirrors, fixed	1
-64	73 00210 5064	. . . PIN, Dowel	2
-65	52 41580 0060	. . . MIRROR, Fixed	2
-66	57 41580 0220	. . . BUSHING, Mirror	6
-67	59 41580 0050	. . . WASHER, Wave	6
-68	10 41580 0420	. . . SCREW, Mach	6
-69	10 41570 0360	. . SCREW, Mach	3
-70	10 41570 0330	. . SCREW, Mach	1
-71	10 41580 0920	. . WASHER, Flat	1
	85 41580 0120	. . KNOB, SCANNING, ASSEMBLY	1
	85 41580 0130	. . . SUPPORT, KNOB, SCANNING, ASSEMBLY	1

FIGURE AND INDEX NO.	PART NUMBER	DESCRIPTION	UNITS PER ASSY
5.2-		MECHANISM, ASSEMBLY OF (Continued)	
-72	52 41580 0150	. . . . SUPPORT, Knob, scanning	1
-73	73 00210 5064	. . . . PIN, Dowel	2
-74	39 41580 0030	. . . . PIN, Headed	1
-75	45 41580 0050	. . . WASHER, Stop	2
-76	79 41580 0201	. . . WASHER, Stop	17
-77	79 41580 0202	. . . WASHER, Stop	5
	85 41580 0140	. . . KNOB, Scanning, coarse, subassembly	1
-78	52 41580 0200	. . . . KNOB, Scanning, coarse	1
-79	39 41580 0030	. . . . PIN, Headed	1
-80	33 41580 0130	. . . GEAR, Spur (54T, 96P)	1
-81	30 25150 0200	. . . BEARING, Ball	1
-82	30 27150 0200	. . . BEARING, Ball	1
-83	70 41580 0301-4	. . . SHIM	As Req'd
-84	45 41580 0060	. . . SCREW, Shoulder	2
-85	35 41580 0050	. . . GEAR, Shaft, spur	1
-86	30 27150 0080	. . . BEARING, Ball	2
-87	2044-103-	. . . SHIM	As Req'd
-88	57 41580 0320	. . . KNOB, Scanning, fine	1
-89	39 41580 0040	. . . PIN, Headed	1
-90	10 41570 0460	. . . SCREW, Set, hex socket, cup point	1
	85 41580 0250	. . GEAR, SHAFT, BEVEL, ASSEMBLY	1
-91	35 41580 0040	. . . GEAR, Shaft, bevel (28T, 96P)	1
-92	30 27150 0100	. . . BEARING, Ball	1
-93	74 45301 8002	. . . RING, Retaining	1
-94	85 41580 0080	. . . GEAR, SPUR, ASSEMBLY	1
	33 41580 0120	. . . . GEAR, Spur (54T, 96P)	1
	33 41580 0160	. . . . GEAR, Blank (90T, 96P)	1
-95	73 00230 5010	. . . PIN, Taper	1
-96	30 27150 0080	. . BEARING, Ball	1
-97	10 41570 0320	. . SCREW, Cap, hex socket, self-locking	6
-98	57 41580 0020	. . FLANGE, Mounting, eyepiece	1
-99	10 41580 0460	. . SCREW, Flat hd, self-locking	8
	85 41580 0200	. . LATCH, ASSEMBLY	1
-100	52 41580 0040	. . . LATCH	1
-101	39 40990 0040	. . . PIN, Headed	1
-102	45 40990 0130	. . SCREW, Shoulder	1
-103	45 40990 0140	. . SPACER	1
-104	2044-103-	. . SHIM	As Req'd
-105	58 41570 0040	. . SPRING, Torsion	1
	85 41580 0210	. . LENS, OBJECTIVE, ASSEMBLY	1
-106	57 41580 0260	. . . HOUSING Lens, objective	1
-107	28 41580 0080	. . . LENS, Concave and convex, objective	1
-108	57 41580 0270	. . . SPACER Lens, objective	1
-109	28 41580 0090	. . . LENS, Double convex, objective	1
-110	57 41580 0250	. . . RING, Locking, objective	1
-111	57 41580 0240	. . RING, Locking, objective	1

FIGURE AND INDEX NO.	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY
		MECHANISM, SCANNING, ASSEMBLY OF	
5.3-	85 41580 0050	. . MECHANISM, SCANNING, ASSEMBLY	1
	85 41580 0040	. . . MOUNT, MIRROR, SCANNING, ASSEMBLY	1
-1	52 41580 0050	. . . . MOUNT, Mirror, scanning	1
-2	57 41580 0170	. . . . SUPPORT, Bearing, right	1
-3	57 41580 0180	. . . . SUPPORT, Bearing, left	1
-4	10 40980 0160	. . . . SCREW, Pan hd	6
-5	73 00210 5064	. . . . PIN, Dowel	2
	85 41580 0020	. . . MIRROR AND SECTOR, ASSEMBLY	1
-6	52 41580 0030	. . . . MIRROR, Scanning	1
-7	34 41580 0020	. . . . GEAR, Sector	1
-8	39 41580 0010	. . . . PIN, Dowel	1
-9	10 41570 0070	. . . BEARING, Ball	2
-10	57 41580 0300	. . . RETAINER, Bearing, right	1
-11	57 41580 0310	. . . RETAINER, Bearing, left	1
-12	45 41580 0090	. . . SPACER	1
-13	10 41580 0890	. . . SCREW, Mach, pan hd	6
-14	57 41580 0400	. . . POST, Spring	1
-15	57 41580 0390	. . . RETAINER, Screw	1
-16	58 41580 0040	. . . FLEXATOR	1
-17	39 41580 0020	. . . PIN, Headed	2
-18	74 45308 1003	. . . RING, Retaining	2
-19	35 41580 0020	. . . GEARSHAFT, Worm	1
-20	10 41580 0040	. . . BEARING, Ball, annular	2
-21	52 41580 0180	. . . RETAINER, Bearing, front	1
-22	10 41580 0460	. . . SCREW, Flat hd, self-locking	1
-23	52 41580 0190	. . . RETAINER, Bearing, rear	1
-24	10 41570 0400	. . . SCREW, Cap, hex socket	7
-25	33 41580 0020	. . . GEAR, Spur, antibacklash (92T, 96P)	1
-26	73 00616 1004	. . . SPRING, Antibacklash	1
-27	33 41580 0010	. . . GEAR Spur, flat (92T, 96P)	1
-28	74 45301 8011	. . . RING, Retaining	1
-29	73 00230 5020	. . . PIN, Taper	1



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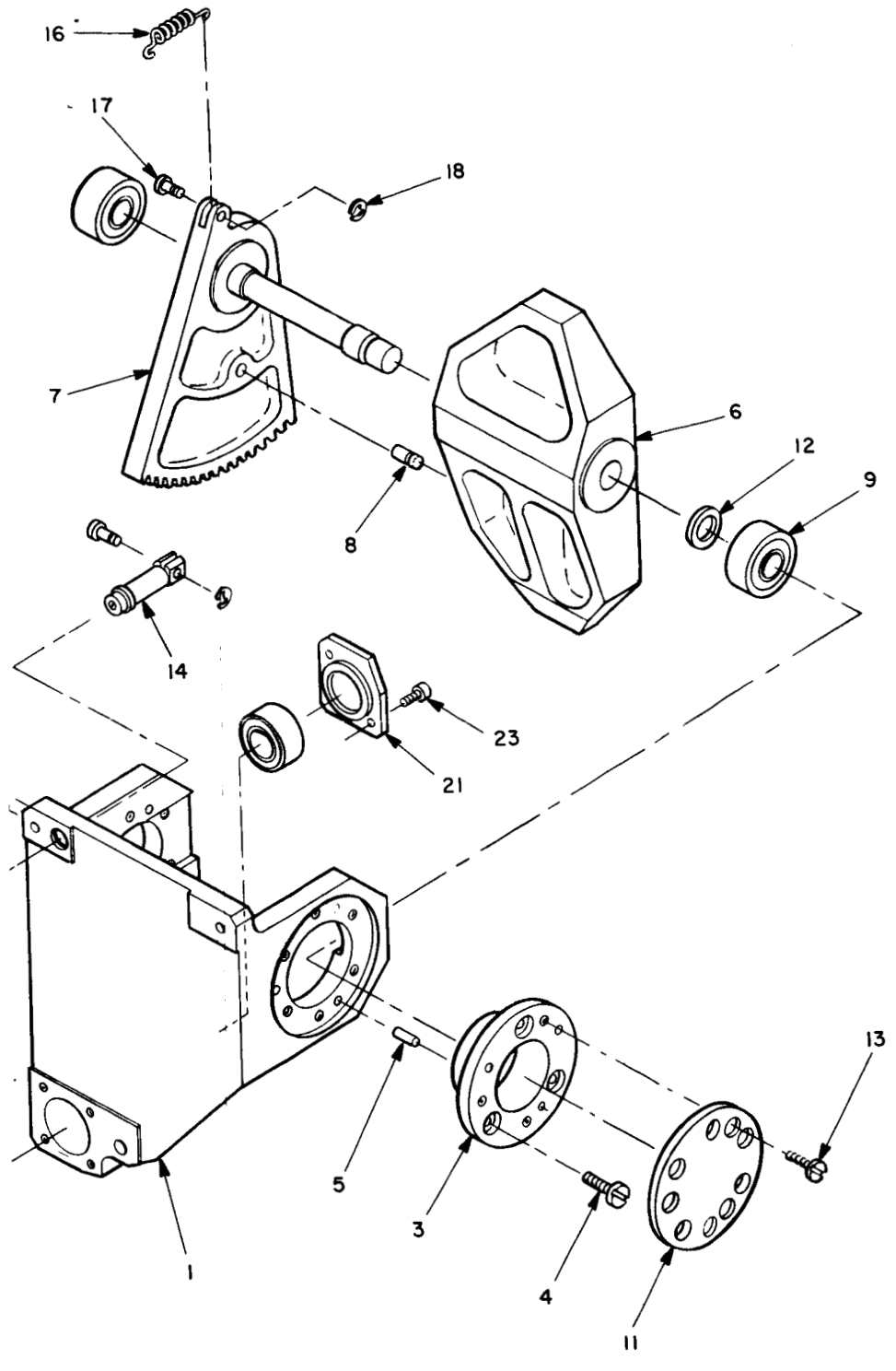


gure 5.3 Mechanism, Scanning, Assembly of

FIGURE AND INDEX NO.	PART NUMBER	DESCRIPTION	UNITS PER ASSY
		HOUSING, FRONT, ASSEMBLY OF	
5. 4-	85 41580 0350	. HOUSING, FRONT, ASSEMBLY	1
-1	51 41580 0080	. . HOUSING, Front	1
-2	59 41580 0090	. . WASHER, Wave	1
-3	57 41580 0350	. . RING, Bearing	1
-4	28 41580 0140	. . BEAM Splitter	1
-5	52 41580 0290	. . CLAMP, Beam splitter	3
-6	10 41570 0490	. . SCREW, Cap, hex socket, self-locking	6
-7	59 41580 0060	. . SPRING, Contact	1
-8	46 41580 0080	. . SPACER, Insulator	2
-9	46 41580 0090	. . RETAINER, Insulator	1
-10	56 41580 0010	. . PLATE, Clamping	1
-11	10 41570 0400	. . SCREW, Cap, hex socket hd, self-locking	2
-12	46 41580 0070	. . INSULATOR, Electrical	1
-13	46 41580 0100	. . INSULATOR, Electrical	1
-14	48 41580 0020	. . SWITCH, Rework	1
-15	-	. . LOCKWASHER	1
-16	-	. . NUT	1
-17	57 41580 0340	. . KNOB	1
-18	10 41580 0470	. . SCREW, Set, hex socket, flat point, self-locking	2
	85 41580 0220	. . HOUSING, SWITCH, ASSEMBLY	1
	85 41580 0370	. . . HOUSING, SWITCH AND PIN, ASSEMBLY	1
-19	51 41580 0040	. . . . HOUSING, Switch	1
-20	73 00210 5021	. . . . PIN, Dowel	1
-21	10 40990 0010	. . . SWITCH, Push button	1
-22	48 41580 0010	. . . WASHER, Key	1
-23	45 41580 0040	. . . WASHER, Flat	1
-24	74 28500 0001	. . . LOCKWASHER	1
-25	45 40990 0030	. . . NUT, Round, switch	1
-26	10 41570 0320	. . SCREW, Cap, hex socket hd, self-locking	2
-27	10 41570 0450	. . SCREW, Cap, hex socket hd, self-locking	2
-28	10 40990 0010	. . SWITCH, Push button	1
-29	74 28400 0001	. . WASHER, Key	1
-30	74 28500 0001	. . LOCKWASHER	1
-31	45 40990 0030	. . NUT, Round, switch	1
-32	45 41570 0050	. . WASHER, Flat	1
-33	48 41580 0030	. . CONNECTOR, Plug, elect rework	1
-34	58 41580 0020	. . SPRING	1
-35	58 41580 0030	. . SPRING	1
-36	10 41570 0320	. . SCREW, Cap, hex socket, self-locking	4
-37	10 41580 0480	. . SCREW, Set, hex socket flat point	4
-38	46 41580 0180	. . BUMPER, Filter	4
	85 41580 0230	. . RESISTOR BRACKET, ASSEMBLY	1
-39	46 41580 0160	. . . BOARD, Mounting	1
-40	10 41580 0490	. . . STANDOFF	4

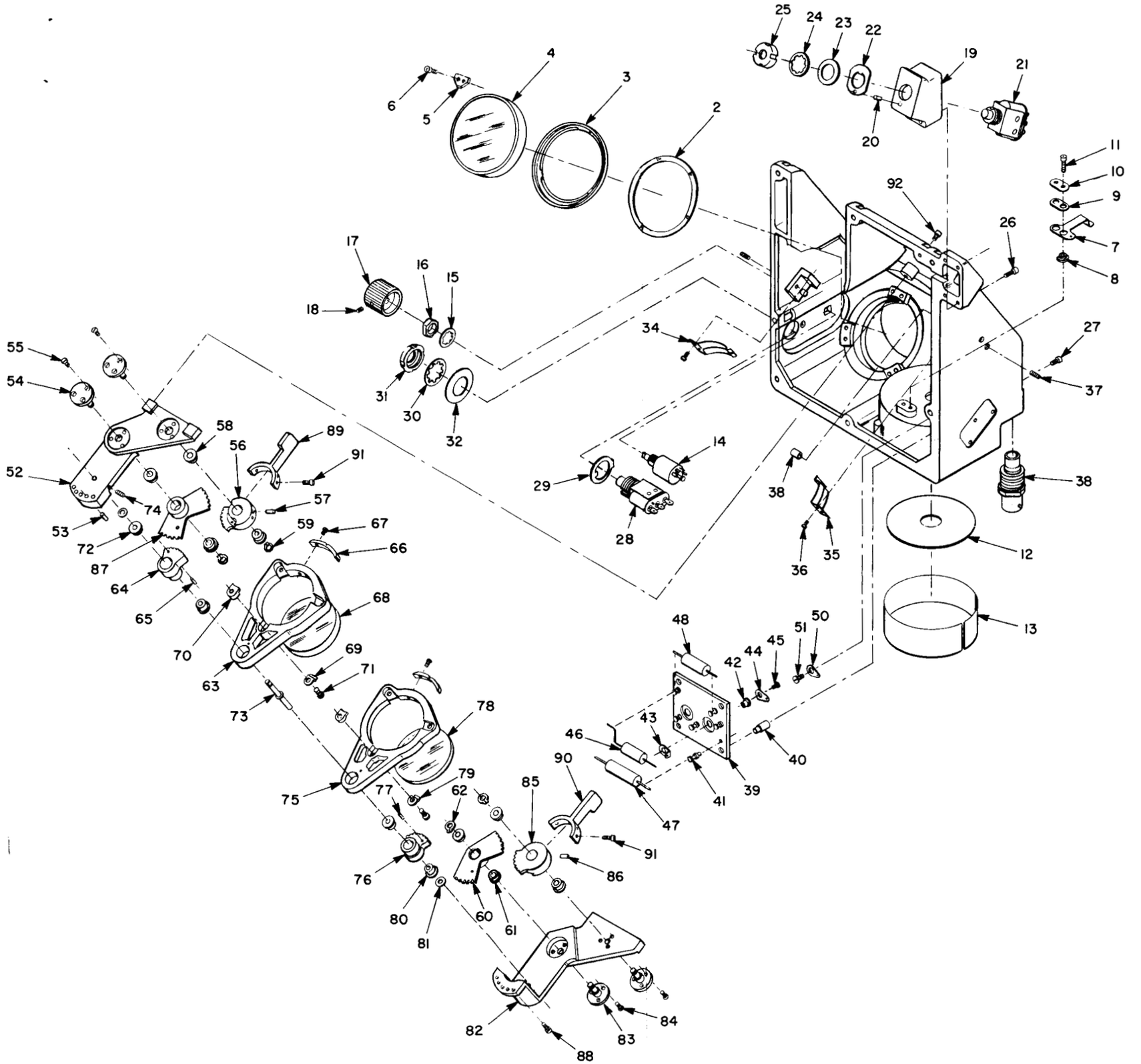


Figure 5.4 Housing, Front, Assembly of

FIGURE AND INDEX NO.	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY
		HOUSING, FRONT, ASSEMBLY OF (Continued)	
5.4-			
-41	68 10102 2607	. . . TERMINAL, Stud	6
-42	57 41580 0200	. . . BUTTON, Threaded	2
-43	56 41580 0030	. . . LUG, Wire	2
-44	56 41570 0030	. . . LUG	2
-45	48 41570 0020	. . . SCREW, Pan hd, gold plated	2
-46	10 41580 0930	. . . RESISTOR	1
-47	10 41580 0950	. . . RESISTOR	1
-48	10 41580 0940	. . . RESISTOR	1
	60 01011 9308	. . . WIRE, Lead (4" long)	As Req'd
	60 02110 1209	. . . INSULATION, Sleeving, electrical (2" long)	As Req'd
-49	10 41580 0890	. . SCREW, Pan hd, self-locking	4
	60 02504 1009	. . INSULATION, Sleeving, electrical	As Req'd
	60 51101 2405	. . WIRE, Electrical (green) (AWG 24)	As Req'd
	60 51101 2402	. . WIRE, Electrical (red) (AWG 24)	As Req'd
	60 51101 2403	. . WIRE, Electrical (orange) (AWG 24)	As Req'd
	60 51101 2408	. . WIRE, Electrical (gray) (AWG 24)	As Req'd
	60 51101 2406	. . WIRE, Electrical (blue) (AWG 24)	As Req'd
	60 51101 2404	. . WIRE, Electrical (yellow) (AWG 24)	As Req'd
-50	56 41570 0030	. . LUG, Wire	1
-51	48 41580 0050	. . SCREW, Pan hd, gold plated	1
	85 41580 0340	. . FILTER, ASSEMBLY OF S. L. O. S.	1
	85 41580 0330	. . . PLATE, FILTER SUPPORT, UPPER ASSEMBLY	1
-52	52 41580 0220	. . . . PLATE, Filter, support, upper	1
-53	73 00210 5065	. . . . PIN, Dowel	2
-54	57 41580 0280	. . . PIN Bearing	2
-55	10 41570 0270	. . . SCREW, Flat hd, self-locking	6
	84 41580 0201	. . . SECTOR GEAR AND PIN, ASSEMBLY	1
-56	34 41580 0080	. . . . GEAR Sector, (60T, 64P)	1
-57	73 00210 5044	. . . . PIN, Dowel	1
-58	30 27150 0080	. . . BEARING, Ball	2
-59	74 45301 8001	. . . RING Retaining	1
-60	34 41580 0060	. . . GEAR, Sector (84T, 64P)	1
-61	30 27150 0080	. . . BEARING, Ball	2
-62	74 45301 8001	. . . RING, Retaining	1
	85 41580 0240	. . . SUPPORT, FILTER, ASSEMBLY	1
-63	52 41580 0160	. . . . SUPPORT Filter, S. L. O. S.	1
-64	34 41580 0100	. . . . GEAR Sector (48T, 64P)	1
-65	73 00210 5045	. . . . PIN, Dowel	1
-66	52 41580 0270	. . . PLATE Detent	1
-67	61 40106 0106	. . . SCREW Flat fillister head	2
-68	28 41580 0170	. . . FILTER	1
-69	59 41580 0080	. . . RETAINER, Filter	3

FIGURE AND INDEX NO.	PART NUMBER	DESCRIPTION	UNITS PER ASSY
		HOUSING, FRONT, ASSEMBLY OF (Continued)	
5.4-			
-70	79 41580 0702	. . . RETAINER, Filter	3
-71	10 40990 0420	. . . SCREW, Pan hd, self-locking	3
-72	30 27150 0080	. . . BEARING, Ball	2
-73	57 41580 0290	. . . SHAFT.	1
-74	10 41580 0410	. . . SCREW, Set, hex socket, cup point	1
	85 41580 0260	. . . SUPPORT, FILTER, ASSEMBLY OF S. L. O. S	1
-75	52 41580 0170	. . . . SUPPORT, Filter, S. L. O. S.	1
-76	34 41580 0070	. . . . GEAR, Sector (48T, 64P)	1
-77	73 00210 5045	. . . . PIN, Dowel	1
	52 41580 0270	. . . PLATE, Detent.	1
	61 40106 0106	. . . SCREW, Flat fill hd.	2
-78	28 41580 0150	. . . FILTER	1
	59 41580 0080	. . . RETAINER, Filter	3
-79	79 41580 0703	. . . RETAINER, Filter	3
	10 40990 0420	. . . SCREW, Pan hd, self-locking	3
-80	30 27150 0080	. . . BEARING, Ball	2
-81	2044-103-	. . . SHIM	As Req'd
-82	52 41580 0210	. . . PLATE, Filter support, lower	1
-83	57 41580 0280	. . . PIN, Bearing	2
-84	10 41570 0270	. . . SCREW, Flat hd, self-locking	6
	84 41580 0202	. . . SECTOR, GEAR AND PIN, ASSEMBLY	1
-85	34 41580 0050	. . . . GEAR, Sector (60T, 64P)	1
-86	73 00210 5044	. . . . PIN, Dowel	1
	30 27150 0080	. . . BEARING, Ball	2
	74 45301 8001	. . . RING, Retaining	1
-87	34 41580 0090	. . . GEAR, Sector (84T, 64P)	1
	30 27150 0080	. . . BEARING, Ball	2
	74 45301 8001	. . . RING, Retaining	1
-88	10 41570 0490	. . . . SCREW, Cap, hex socket, self-locking	3
-89	79 41580 0801	. . LEVER, Filter	1
-90	79 41580 0802	. . LEVER, Filter	1
-91	10 41580 0720	. . SCREW, Cap, hex socket	4
-92	10 41570 0400	. . SCREW, Cap, hex socket, self-locking	4

FIGURE AND INDEX NO.	PART NUMBER	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY
		HOUSING, FILTER, FLOS, ASSEMBLY OF	
5.5-	85 41580 0300	. HOUSING, FILTER, ASSEMBLY OF F.L.O.S.	1
-1	51 41580 0030	. . HOUSING, Filter	1
-2	34 41580 0040	. . GEARSHAFT, Sector (46T, 64P)	1
-3	79 41580 0401	. . WASHER, Flat	2
-4	74 45301 8002	. . RING, Retaining	1
-5	57 41580 0230	. . SHAFT, Flanged	1
-6	61 30205 0210	. . SCREW, Flat hd	3
	85 41580 0310	. . SUPPORT, FILTER, ASSEMBLY OF F.L.O.S..	1
-7	52 41580 0090	. . . SUPPORT, Filter, fixed line of sight	1
-8	33 41580 0050	. . . GEAR, Spur (34T, 64P)	1
-9	73 00210 5044	. . . PIN, Dowel	2
-10	79 41580 0402	. . WASHER, Flat	1
-11	79 41580 0401	. . WASHER, Flat	1
-12	74 45301 8002	. . RING, Retaining	1
-13	28 41580 0170	. . FILTER, Neutral density (1.0)	1
-14	59 41580 0080	. . RETAINER, Filter	3
-15	79 41580 0702	. . RETAINER, Filter	3
-16	10 40990 0420	. . SCREW, Pan hd, self-locking	3
	85 41580 0320	. . SUPPORT, FILTER, ASSEMBLY OF F.L.O.S..	1
-17	52 41580 0100	. . . SUPPORT, Filter, fixed line of sight	1
-18	35 41580 0080	. . . GEARSHAFT, Spur (34T, 64P)	1
-19	10 41570 0270	. . . SCREW, Flat hd, self-locking	3
-20	73 00210 5044	. . . PIN, Dowel	1
-21	79 41580 0401	. . WASHER, Flat	1
-22	79 41580 0403	. . WASHER, Flat	1
-23	74 45301 8002	. . RING, Retaining	1
-24	28 41580 0160	. . FILTER, Neutral Density	1
-25	59 41580 0080	. . RETAINER, Filter	3
-26	79 41580 0701	. . RETAINER, Filter	3
-27	10 40990 0420	. . SCREW, Pan hd, self-locking	3
-28	34 41580 0030	. . GEARSHAFT, Sector (46T, 64P)	1
-29	79 41580 0401	. . SPACER	2
-30	74 45301 8002	. . RING Retaining	1
-31	79 41580 0404	. . WASHER, Flat (.003 Thk)	As Req'd
-32	79 41580 0405	. . WASHER, Flat (.005 Thk)	As Req'd
-33	52 41580 0070	. . PLATE, Index	1
-34	52 41580 0080	. . PLATE, Index	1
-35	10 41570 0320	. . SCREW, Cap, hex socket	4
-36	79 41580 0601	. . KNOB, Filter.	1
-37	48 41580 0040	. . SPRING, Helical	1
-38	74 40000 3004	. . BALL	1
-39	73 00230 5020	. . PIN, Taper	1
-40	79 41580 0602	. . KNOB, Filter	1
-41	48 41580 0040	. . SPRING, Helical	1

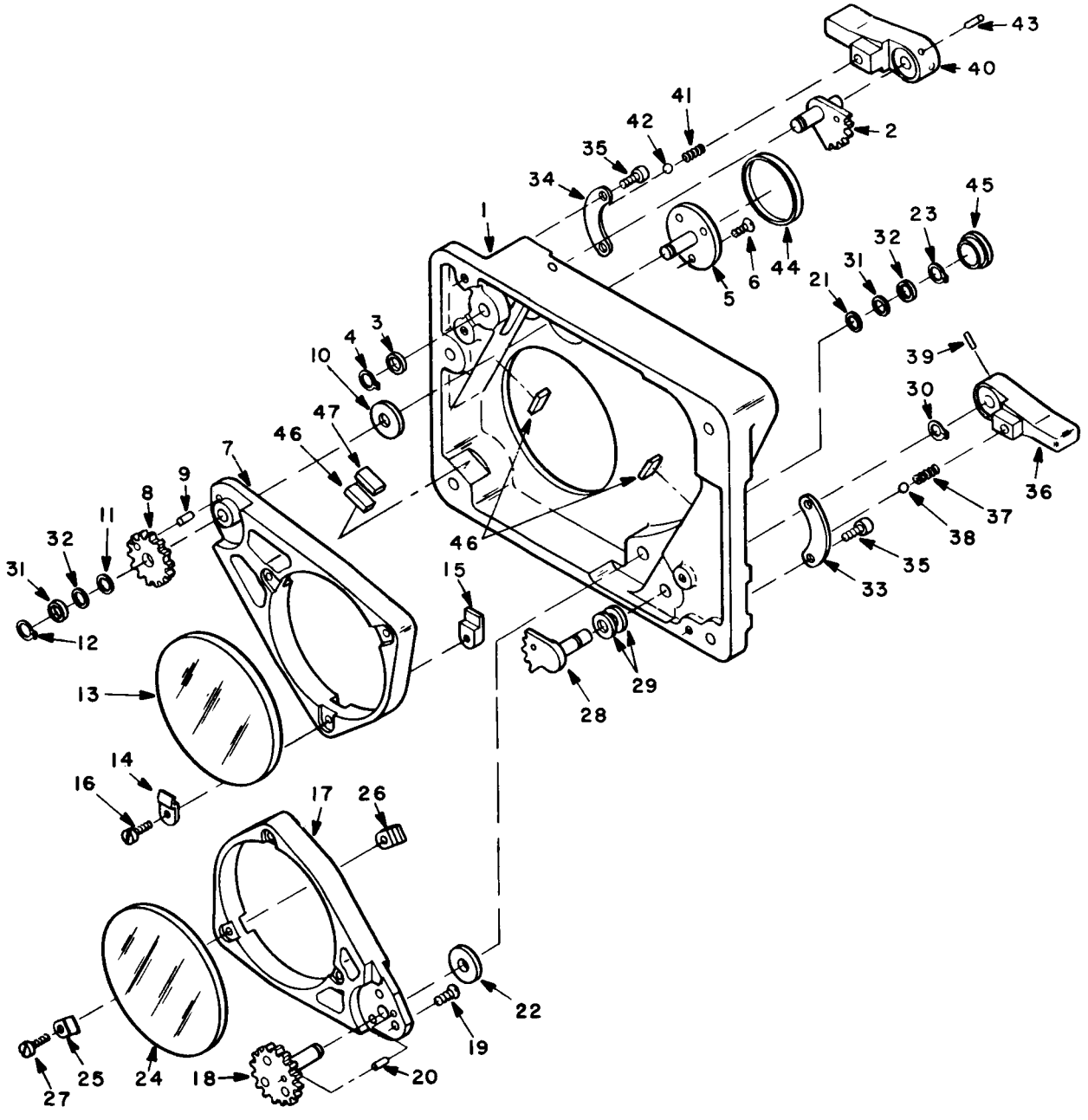
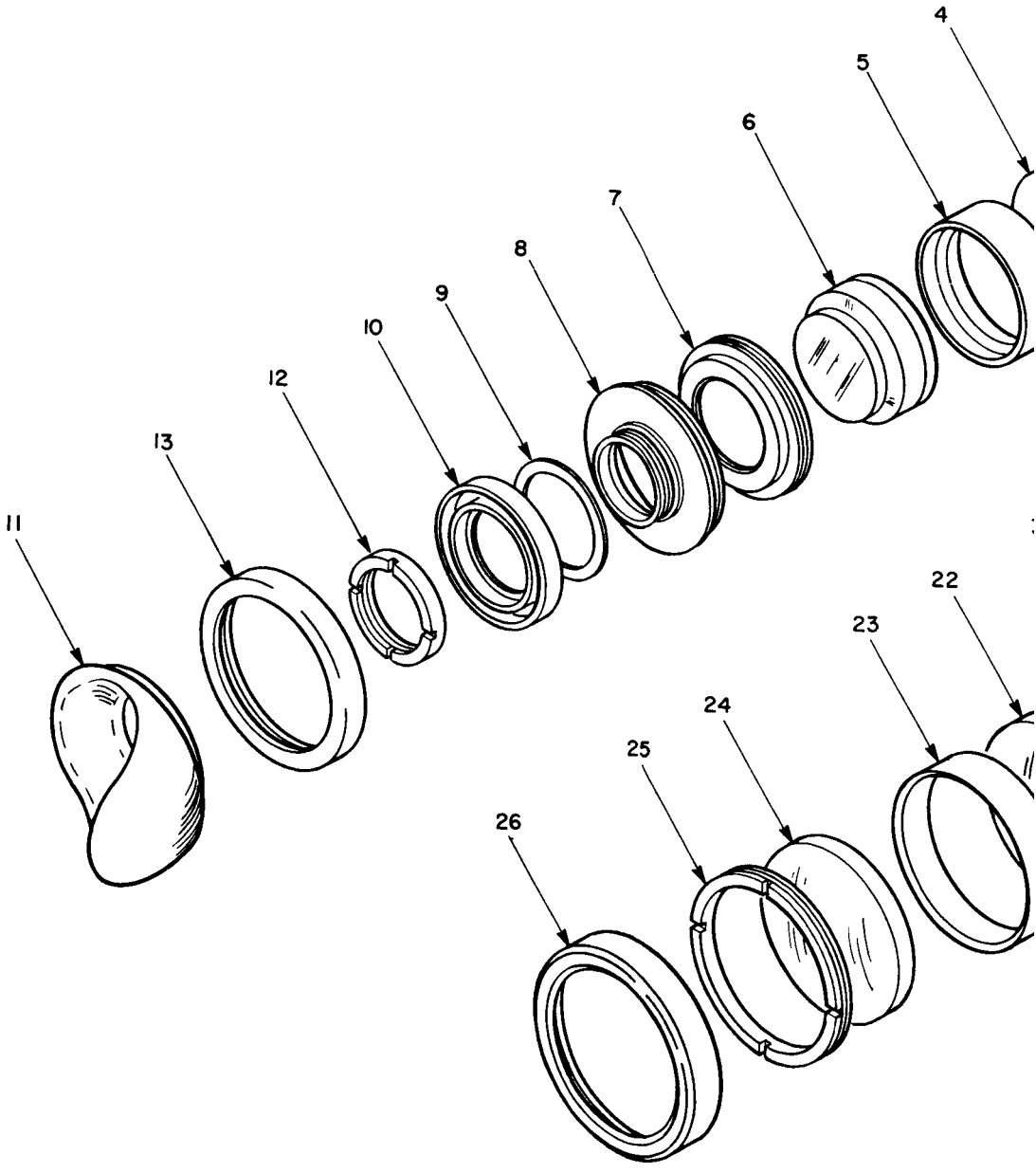


Figure 5.5 Housing, Filter, FLOS, Assembly of

FIGURE AND INDEX NO.	PART NUMBER	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY
			HOUSING, FILTER, FLOS, ASSEMBLY OF (Continued)	
5. 5-				
-42	74 40000 3004	. .	BALL	1
-43	73 00230 5020	. .	PIN, Taper	1
-44	46 41580 0040	. .	CAP	1
-45	46 41580 0030	. .	BUMPER, Filter housing	1
-46	46 41580 0010	. .	BUMPER, Rubber	3
-47	46 41580 0170	. .	BUMPER, Rubber	2

FIGURE AND INDEX NO.	PART NUMBER	DESCRIPTION	UNITS PER ASSY
		EYEPIECE ASSEMBLIES, NORMAL AND LONG EYE RELIEF	
5.6-	85 41580 0280	. EYEPIECE ASSEMBLY, NORMAL EYE RELIEF	1
-1	57 41580 0140	. . HOUSING, Lens, normal eye relief	1
-2	76 41580 0030	. . LENS ASSEMBLY, NORMAL EYE RELIEF	1
	28 41580 0040	. . . LENS, Double concave unsym, normal eye relief	1
	28 41580 0100	. . . LENS, Double convex unsym, normal eye relief	1
-3	57 41580 0030	. . SPACER, Lens, normal eye relief	1
-4	28 41580 0120	. . LENS, Double convex, unsym, normal eye relief	1
-5	57 41580 0060	. . SPACER, Lens, normal eye relief	1
-6	76 41580 0010	. . LENS ASSEMBLY, NORMAL EYE RELIEF	1
	28 41580 0030	. . . LENS, Convex and plano, normal eye relief	1
	28 41580 0110	. . . LENS, Double convex, sym, normal eye relief	1
-7	57 41580 0070	. . NUT, Lens locking, normal eye relief	1
-8	57 41580 0080	. . NUT, Eyeguard retainer, normal eye relief	1
-9	46 41580 0190	. . SHIM, Eyeguard (Mat'l. 60 06010 0118)	As Req'd
	85 41580 0170	. . EYEGUARD, ASSEMBLY	1
-10	57 41580 0040	. . . HOLDER, Eyeguard, normal eye relief	1
-11	26 41580 0030	. . . EYEGUARD	1
-12	57 41580 0150	. . NUT, Eyeguard retainer	1
-13	26 41580 0010	. . GUARD, Eyepiece	1
	84 41580 0101	. . SUPPORT, EYEPIECE, ASSEMBLY	1
-14	79 41580 0101	. . . SUPPORT, Eyepiece	1
-15	39 40990 0030	. . . PIN, Dowel	3
-16	57 41580 0110	. . RING, Engraved, normal eye relief	1
-17	10 41580 0410	. . SCREW, Set, hex socket, cup point	2
-18	74 45302 0131	. . PACKING, Preformed (Parker No. 131)	2
-19	1471B-78	. . SHOE (Mat'l 1471B-78-1)	1
-20	61 40205 0108	. . SCREW, Flat hd	
	85 41580 0290	. EYEPIECE ASSEMBLY, LONG EYE RELIEF	1
-21	57 41580 0130	. . HOUSING, Lens, long eye relief	1
-22	76 41580 0020	. . LENS ASSEMBLY, LONG EYE RELIEF	1
	28 41580 0050	. . . LENS, Double concave, unsym, long eye relief	1
	28 41580 0070	. . . LENS, Double convex, unsym, long eye relief	1
-23	57 41580 0160	. . SPACER, Lens, long eye relief	1
-24	28 41580 0060	. . LENS, Double convex, unsym, long eye relief	1
-25	57 41580 0050	. . NUT, Retainer, long eye relief	1
-26	26 41580 0020	. . GUARD, Eyepiece, long eye relief	1
	84 41580 0102	. . SUPPORT, EYEPIECE, ASSEMBLY	1
-27	79 41580 0102	. . . SUPPORT, Eyepiece	1



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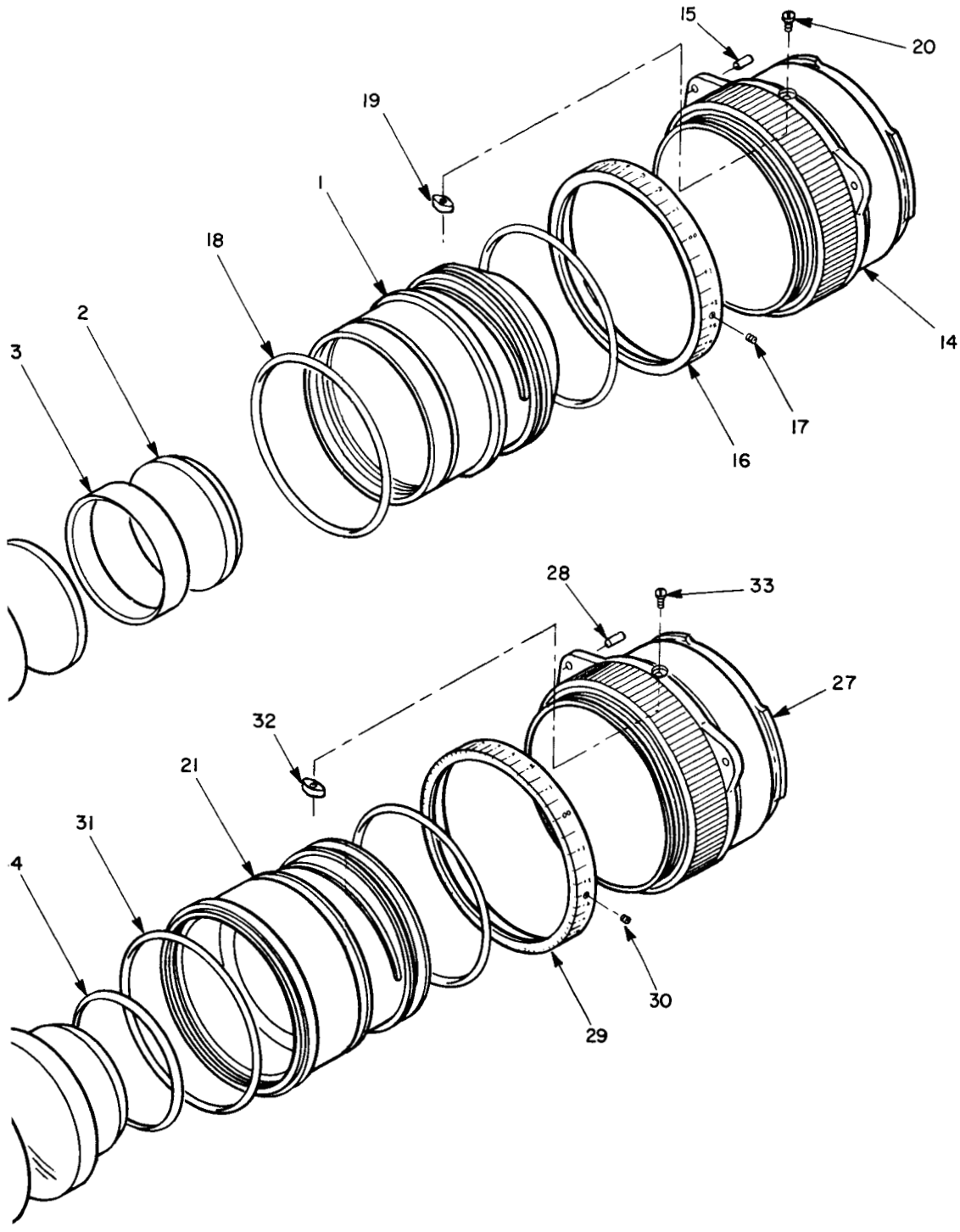

Figure 5.6 Eyepiece Assemblies, Normal and Long Eye Relief

FIGURE AND INDEX NO.	PART NUMBER	1 2 3 4 5 6 7	DESCRIPTION	UNITS PER ASSY
			EYEPIECE ASSEMBLIES, NORMAL AND LONG EYE RELIEF (Continued)	
5.6-				
-28	39 40990 0030	. . .	PIN, Dowel	3
-29	57 41580 0120	. .	RING, Engraved, long eye relief	1
-30	10 41580 0410	. .	SCREW, Set, hex socket, cup point	2
-31	74 45302 0131	. .	PACKING Preformed (Parker No. 131)	2
-32	1471B-78	. .	SHOE (Mat'l 1471B-78.1)	1
-33	61 40205 0108	. .	SCREW, Flat hd	1
-34	57 41580 0380	. .	SPACER, Long eye relief	As Req'd