D E P A R T M E N T O F T H E A R M Y T E C H N I C A L M A N U A L

OPERATOR, ORGANIZATIONAL, DIRECT AND GENERAL SUPPORT, AND DEPOT MAINTENANCE MANUAL

THEODOLITE: DIRECTIONAL 1/10 SECOND, 23 IN. LONG TELESCOPE ELECTRICAL ILLUMINATION, W/3 CARRYING CASES, FIXED LEG TRIPOD

(WILD HEERBRUGG MODEL T4A-68)

FSN 6675-089-8884

H E A D Q U A R T E R S , D E P A R T M E N T O F T H E A R M Y

A U G U S T 1 9 6 8

CHANGE
No. 2

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, *28 January 1977*

Operator, Organizational, Direct Support and General Support, and Depot Maintenance Manual
THEODOLITE, DIRECTIONAL; 1/10 SECOND; 23 in. LONG TELESCOPE; ELECTRICAL ILLUMINATION; w/3 CARRYING CASES; FIXED LEG TRIPOD
(WILD HEERBRUGG MODEL T4A-68)
NSN 6675-00-089-8884

TM 5-6675-297-15, 8 August 1968, is changed as follow

Page i. Content. The title for Appendix B and C is changed to read as follows.

B. COMPONENTS OF END ITEMS LIST.
C. ADDITIONAL AUTHORIZATION LIST.

Add the following below appendix C:

D. MAINTENANCE ALLOCATION CHART.
E. EXPENDABLE SUPPLIES AND MATERIALS LIST.

Page 1-1, paragraph 1-1. Subparagraph b is superseded as follows.

b. Appendix A contains a list of publications applicable to this manual. Appendix B list integral components of and basic issue items for the Directional Theodolite to help you inventory items required for safe and efficient operation. Appendix C list additional items authorized for the support of the Directional Theodolite. Appendix D contains the Maintenance Allocation Chart. Appendix E list expendable supplies and materials.

Page A-1. Appendix A is superseded as follows.

APPENDIX A
REFERENCES

A-1. Astronomical Publications

TM 5-236-67	The American Ephemeris and Nautical Almanac for the Year 1967
TM 5-238	60-Degree Star Graphs

A-2. Painting

AR 746-1	Color, Marking, and Preparation of Equipment for Shipment

A-3. Maintenance

TM 38-750	The Army Maintenance Management System (TAMMS)
TM 5-6675-297-35P	Direct Support, General Support, and Depot Maintenance Repair Parts and Special Tools List; Theodolite, directional; 1/10 second, 23 in. long telescope, electrical, illumination w/3 carrying cases, fixed leg tripod (Wild Herrbrugg Model T4A-68) FSN 6675-089-8884

A-4. Shipment and Storage

TM 740-97-2	Preservation of USAMECOM Equipment for Storage
TM 740-90-1	Administrative Storage of Equipment

***This change supersedes C1, 22 May 1973.**

Page B-1. Appendix B is superseded as follows.

APPENDIX B
COMPONENTS OF END ITEMS LIST

Section I. INTRODUCTION

B-1. Scope

This appendix lists integral components of and basic issue items for the *Directional Theodolite* to help you inventory items required for safe and efficient operation.

B-2. General

The Components of End Item List is divided into the following sections:

a. Section II. Integral Components of the End Item. These items, when assembled, comprise the *Directional Theodolite* and must accompany it whenever it is transferred or turned in. These illustrations will help you identify these items.

b. Section III. Basic Issue Items. These are minimum essential items required to place the *Directional Theodolite* in operation, to operate it, and to perform emergency repairs. Although shipped separately packed they must accompany the instrument during operation and whenever it is transferred between accountable officers. The illustrations will assist you with hard-to-identify item. This manual is your authority to requisition replacement BII, based on Table(s) of Organization and Equipment (TOE)/Modification Table of Organization and Equipment (MTOE) authorization of the end item.

B-3. Explanation of Columns

a. Illustration. This column is divided as follows:

(1) *Figure Number.* Indicates the figure number of the illustration on which the item is shown (if applicable).

(2) *Item number.* The number used to identify item called out in the illustration.

b. National Stock Number (NSN). Indicates the National stock number assigned to the item and which will be used for requisitioning.

c. Part Number (P/N). Indicates the primary number used by the manufacturer, which controls the design and characteristics of the item by means of its engineering drawings, specifications, standards, and inspection requirements to identify an item or range of items.

d. Description. Indicates the Federal item name and, if required, a minimum of description to identify the item.

e. Location. The physical location of each item listed is given in this column. The lists are designed to inventory all items in one area of the major item before moving on to an adjacent area

f. Usable On Code. "USABLE ON" codes are included to help you identify which component items are used on the different models. Identification of the codes used in these lists are:

Code	Used on
CML	All

g. Quantity Required (Qty Reqd). This column lists the quantity of each item required for a complete major item.

h. Quantity. This column is left blank for use during inventory. Under the Rcv'd column, list the quantity you actually receive on your major item, The Date columns are for use when you inventory the major item at a later date, such as for shipment to another site.

Section II. INTEGRAL COMPONENT OF END ITEM

(1) ILLUSTRATION (a) FIGURE NO.	(1) ILLUSTRATION (b) ITEM NO.	(2) NATIONAL STOCK NUMBER	(3) PART NO. & FSCM	(4) DESCRIPTION	(5) LOCATION	(6) USABLE ON CODE	(7) QTY REQD	(8) QUANTITY RCV'D	DATE	DATE	DATE
2-2			XT4-99-1968 (89905)	Base and U Frame Assembly			1				
2-3			XT4-119-1968 (89905)	Horizontal Axis and Telescope Assembly			1				
2-6			T4A707-1968 (89905)	Level Assembly Suspension			1				
2-6			T4A706A (89905)	Level Assembly, Horrebow - Talcott			1				
2-3			T4A1123 (89905)	Shade, Optical (Protective Tube)			1				
2-3			T401040(89905)	Cable Assembly Switch, Rheostat Assembly			1				
-			XT4-20 (89905)	Cable Assembly, Chronograph			1				
-			XT4-18 (89905)	Cable Assembly, Microscope Eyepiece			1				
-			XT4-17 (89905)	Cable Assembly, Vertical Circle			1				
3-6			T4A1020 (89905)	Case, Battery Box			1				
2-5			T1A29001 (89905)	Illumination Mirror Assembly			2				
2-5			GVP22 (89905)	Case, Transport, Base and U Frame			1				
2-5			GVP23 (89905)	Case, Transpire Horizontal Axis and Telescope			1				

(1) ILLUSTRATION (a) FIGURE NO.	(1) ILLUSTRATION (b) ITEM NO.	(2) NATIONAL STOCK NUMBER	(3) PART NO. & FSCM	(4) DESCRIPTION	(5) LOCATION	(6) USABLE ON CODE	(7) QTY REQD	(8) QUANTITY RCV'D	(8) QUANTITY DATE	(8) QUANTITY DATE	(8) QUANTITY DATE
2-5			T4A950A (89905)	Case, Transport Suspension Level			1				
2-5			T4A970A (89905)	Case Accessory			1				
2-5			EB75 (89905)	Light. Extension Emergency			1				
2-5			GEB12-00000 (89905)	Hand lamp Assembly			1				
2-14			T21-4 (89905)	Adapter, Electrical Lamp (Lamp Assembly) Tripod Assembly Consisting of the following:			2				
2-7			T4A930 (89905)	Tripod Assembly			1				
2-7			T4A1031 (89905)	Cover, Tripod Head			1				

Section III. BASIC ISSUE ITEMS

(1) ILLUSTRATION (a) FIGURE NO.	(1) ILLUSTRATION (b) ITEM NO.	(2) NATIONAL STOCK NUMBER	(3) PART NO. & FSCM	(4) DESCRIPTION	(5) LOCATION	(6) USABLE ON CODE	(7) QTY REQD	(8) QUANTITY RCV'D	(8) QUANTITY DATE	(8) QUANTITY DATE	(8) QUANTITY DATE
2-5			HDP1-1(89905)	Brush, Dusting			2				
2-5			T4A963 (89905)	Pin, Adjusting, Large			2				
2-5			3A55 (89905)	Pin, Adjusting, Small			4				
2-5			HDW1-2 (89905)	Screwdriver, Jewelers			1				
2-5			HDW1-4 (89905)	Screwdriver, Jewelers			1				
2-5			GGGS121 (81438)	Screwdriver, Jewelers			1				
2-5			T4A942A (89905)	Wrench, Spanner			1				
2-5			T4A247 (89905)	Wrench, Key			1				
2-5			GGT00870 (89905)	Tweezers			1				
2-5			12299-5A (89905)	Container, Oil			1				
2-5			13369-11 (89905)	Screwdriver, Flat Tip			1				
2-5			13369-10 (89905)	Screwdriver, Flat Tip			1				
2-5			13369-9 (89905)	Screwdriver, Flat Tip			1				
2-5			HEG3-2 (89905)	Lamp, Incandescent			8				
2-5			KKC00300 (81348)	Chamois			1				
2-5			HDF3-12-7403 (89905)	Container, Grease			1				
2-5			12299-5A (89905)	Container, Oil			1				

Page C-1. Appendix C is superseded as follows.

APPENDIX C
ADDITIONAL AUTHORIZATION LIST
Section I. INTRODUCTION

C-1. Scope
This appendix lists additional items you are authorized for the support of the *Directional Theodolite*.

C-2. General
This list identifies items that do not have to accompany the instrument and that do not have to be turned in with it. These items are authorized to you by CTA, MTOE, TDA or JTA.

3. Explanation of Listing
National stock number, descriptions, and quantities are provided to help you identify and request the additional items you require to support this equipment. "USABLE ON" codes are identified as follows:

Code	Used on
CML	All

Section II. ADDITIONAL AUTHORIZATION LIST

(1) NATIONAL STOCK NUMBER	(2) DESCRIPTION PART NUMBER & FSCM	USABLE ON CODE	(3) U/M	(4) QTY AUTH
	BA23 (80063) Battery, Dry Cell 1.5 Volts		EA	12

Page D-1. Appendix D is added as follows:

APPENDIX D
MAINTENANCE ALLOCATION CHART
Section I. INTRODUCTION

D-1. General

a. This section provides a general explanation of all maintenance and repair functions authorized at various maintenance levels.

b. Section II designates overall responsibility for the performance of maintenance operations on the identified end item or component. The implementation of the maintenance tasks upon the end item or component will be consistent with the assigned maintenance operations.

c. Section III lists the special tools and test equipment required for each maintenance operation as referenced from section II.

d. Section IV contains supplemental instructions, explanatory notes and/or illustrations required for a particular maintenance function.

D-2. Explanation of Columns in Section II

a. Functional Group Number. The functional group is a numerical group set up on a functional basis. The applicable functional grouping indexes (obtained from TB 750-93-1, Functional Grouping Codes) are listed on the MAC (Maintenance Allocation Chart) in the appropriate numerical sequence. These indexes are normally set up in accordance with their function and proximity to each other.

b. Component Assembly Nomenclature. This column contains a brief description of the components of each functional group.

c. Maintenance Functions and Maintenance Categories. This column lists the various maintenance functions (A through K) and indicates the lowest maintenance category authorized to perform these operations. The symbol designations for the various maintenance categories are as follows:

C - Operator or crew
O - Organizational maintenance
F- Direct support maintenance
H - General support maintenance
D - Depot maintenance

The maintenance functions are defined as follows:

A - Inspect: Verify serviceability and detect incipient electrical or mechanical failure by close visual examination.

B - Test: Verify serviceability and detect incipient electrical or mechanical failure by measuring the mechanical or electrical characteristics of the item and comparing those characteristics with authorized standards. Tests will be made commensurate with test procedures and with calibrated tools and/or test equipment referenced in the MAC,

C - Service: Operations required periodically to keep the item in proper operating condition, i.e., to clean, preserve, drain, paint, and replenish fuel lubricants, hydraulic, and deicing fluids, or compressed air supplies.

D - Adjust: Regulate periodically to prevent malfunction. Adjustments will be made commensurate with adjustment procedures and associated equipment adjustment specifications.

E - Aline: Adjust two or more components of an electrical or mechanical system so that their functions are properly synchronized or adjusted.

F - Calibrate: Determine, check, or rectify the graduation of an instrument, weapon, or weapons system or components of a weapons system.

G - Install: Remove and install the same item for service or when required for the performance of other maintenance operations.

H - Replace: Substitute serviceable components, assemblies and subassemblies for unserviceable counterparts.

I - Repair: Restore to a serviceable condition by replacing unserviceable parts or by any other action required using available tools, equipment and skills, including welding, grinding, riveting, straightening, adjusting, and facing.

J - Overhaul: Restore an item to a completely serviceable condition (as prescribed by serviceability standards developed and published by the commodity commands) by employing techniques of "Inspect and Repair Only As Necessary" (IROAN). Maximum use of diagnostic and test equipment is combined with minimum disassembly during overhaul "Overhaul" may be assigned to any level of maintenance except organizational, provided the time, tools, equipment, repair parts authorization, and technical skills are available at that level Normally, overhaul as applied to end items, is limited to depot maintenance level.

K - Rebuild: Restore to a condition comparable to new by disassembling to determine the condition of each component part and reassembling using serviceable, rebuilt, or new assemblies, subassemblies, and parts.

d. Reference Note. This column, subdivided into columns L and M, is provided for referencing the Special Tool and Test Equipment Requirements (sec. III) and Remarks (sec. IV) that may be associated with maintenance functions (sec. II).

D-3. Explanation of Columns in Section III

a. Reference Code. This column consists of a number and a letter separated by a dash. The number references the T&TE (Tool and Equipment) requirements column on the MAC. The letter represents the specific maintenance function the item is to be used with. The letter is representative of columns A through K on the MAC.

b. Maintenance Category. This column shows the lowest level of maintenance authorized to use the special tool or test equipment.

c. Nomenclature. This column lists the name or identification of the tool or test equipment.

d. Tool Number. This column lists the manufacturer's code and part number, or Federal stock number of tools and test equipment.

D4. Explanation of Columns in Section IV

a. Reference code. This column consists of two letters separated by a dash, both of which are references to section II. The first letter references column M and the second letter references a maintenance operation, columns A through K.

b. Remarks. This column lists information pertinent to the maintenance operation being performed, as indicated on the MAC section II.

Section II. MAINTENANCE ASSIGNMENT

FUNCTIONAL GROUP NUMBER	COMPONENT ASSEMBLY NOMENCLATURE	MAINTENANCE FUNCTIONS											NOTE REFERENCE	
		A	B	C	D	E	F	G	H	I	J	K	L	M
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	REBUILD	TOOLS AND EQUIPMENT	REMARKS
18	BODY, CAB, HOOD AND HULL													
1808	Carrying Cases:													
	Case, base and alidade assembly								O	O				
	Case, telescope assembly								O	O				
	Case, suspension level								O	O				
	Case, accessory								O	O				
67	PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL													
6700	Surveying Instrument:													
	Theodolite	C		O	C				O	F	D			A
6701	Telescope Assembly:													
	Telescope assembly			C						D				B
	Axis assembly, telescope									D				
6702	Optics:													
	Objective assembly, telescope			C						D				C
	Eyepiece assembly, telescope			C	C				O	D				D, E
	Eyepiece assembly, setting circle			C	C				O	D				F, G
	Eyepiece assembly, vertical circle			C	C				O	D				H, I
	Eyepiece assembly, horizontal circle			C	C				O	D				J, K
	Mirror illumination			C	C				O	F				
	Circle assembly, vertical								D	D				
	Circle assembly, setting								D	D				
6703	Structural and Precision Parts:													
	Base assembly, horizontal								D	D				
	U-standard assembly								D	D				
	Drive assembly, horizontal circle			C					D	D				
	Clamp, vertical, horizontal									D				
	Footscrew assembly				C				F	H				
	Screw assemblies, vertical and horizontal, collimation				C				F	H				
	Axis assembly, horizontal and vertical									D				
	Level assembly, collimation									D				
6704	Batteries								C					

FUNCTIONAL GROUP NUMBER	COMPONENT ASSEMBLY NOMENCLATURE	MAINTENANCE FUNCTIONS											NOTE REFERENCE	
		A	B	C	D	E	F	G	H	I	J	K	L	M
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	REBUILD	TOOLS AND EQUIPMENT	REMARKS
6705	Fuses and Lamps:													
	Housing lamp								O	F				
	Light, emergency			C					O	F				
6711	Controls and Special Components:													
	Rheostat assembly									F				
	Switch, lamp									F				
6712	Mounting Connecting Devices:													
	Contact rings									D				
	Receptacles									D				
	Housing, illumination									D				
6713	Miscellaneous Wiring and Fittings:													
	Leads, electrical, external								O	F				
	Wiring internal									D				
6717	Power Supply (self-contained)													
	Box, battery			C					O	F				
6718	Compass and Level:													
	Level assembly, circular			C	D					D				
	Level assembly, horrebow			C	C					D				1
	Level assembly, vertical circle			C	C					D				2
	Level suspension			C	C					D				
	Level assembly, setting circle			C	C					D				3
6719	Tripods:													
	Tripod assembly			C	C					O				4

Section III. SPECIAL TOOL AND SPECIAL TEST EQUIPMENT REQUIREMENTS

Reference Code	Maintenance Level	Nomenclature	Tool No.
1-D	C	Screwdriver, Jewelers	
2-D	C	Screwdriver, Jewelers	
3-D	C	Wrench: Fork Pin	
4-D	C	Wrench Key, 4mm Square.	

Section IV. REMARKS

Reference Code	Remarks
A-D	External
B-C	External
C-C	External
D-C	External
E-D	External
F-C	External
G-D	External
H-C	External
I-D	External
J-C	External
K-D	External

Page E-1. Appendix E is added as follows.

APPENDIX E
EXPENDABLE SUPPLIES AND MATERIALS LIST

Section I. INTRODUCTION

E-1. Scope

This appendix lists expendable supplies and materials you will need to operate and maintain the Directional Theodolite. These items are authorized

to you by CTA50-970, Expendable Items (except Medical, Class V, Repair Parts, and Heraldic Items).

E-2. Explanation of Columns

a. Column 1 - Item Number. This number is assigned to the entry in the listing and is referenced in the narrative instructions to identify the material (e.g., "Use cleaning compound, Item 5, App. D").

b. Column 2 - Level. This column identifies the lowest level of maintenance that requires the listed item (enter as applicable:)

C - Operator/Crew
O - Organizational Maintenance
F- Direct Support Maintenance
H - General Support Maintenance

c. Column 3 - National Stock Number. This is the National stock number assigned to the item; use it to request or requisition the item.

d. Column 4 - Description. Indicates the Federal item name and, if required, a description to identify the item. The last line for each item indicates the part number followed by the Federal Supply Code for Manufacturer (FSCM) in parenthesis, if applicable.

e. Column 5 -Unit of Measure (U/M). Indicates the measure used in performing the actual maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., ea, in., pr). If the unit of measure differs from the unit of issue, requisition the lowest unit of issue that will satisfy your requirements.

Section II. EXPENDABLE SUPPLIES AND MATERIALS LIST

(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) U/M
1	C	6850-00-680-2233	Desiccant Activatedty 1.5 lb.	LB
2	C	7920-00-401-8034	Y - equivalent to 6850-00-264-6565 Cloth, Lint-free, Non-abrasive, General Purpose Part No. 1001	BX
3	C	9150-00-985-7244	Grease, Instrument and Aircraft (G1A) MIL-23827	TU
4	C	9150-00-252-6382	Oil, Clock and Watch (OCW) 5CC	BT
5	C	6810-00-223-2739	Acetone, Technical, 1 pt. Can, Fed Spec MMM-A-185	PT
6	C	6850-00-664-5685	Cleaning Solvent, Fed Spec PD-680	QT
7	C		Lens Tissue, NNNP40TYPE I CLASS I (81349)	PK
8	C		Orange Sticks, 13218E3063 (97403)	PK

By Order of the Secretary of the Army:

BERNARD W. ROGERS
General, United States Army
Chief of Staff

Official:

PAUL T. SMITH
Major General, United States Army
The Adjutant General

Distribution:

To be shipped in accordance with DA Form 12-25A, Operator maintenance requirements for Surveying Equipment.

GPO 887-883

TECHNICAL MANUAL
No. 5-6675-297-15

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *8 August 1968*

OPERATOR, ORGANIZATIONAL, DIRECT AND GENERAL SUPPORT, AND DEPOT MAINTENANCE MANUAL

THEODOLITE: DIRECTIONAL 1/10 SECOND, 23 in. LONG TELESCOPE ELECTRICAL ILLUMINATION, W/3 CARRYING CASES, FIXED LEG TRIPOD (WILD HEERBRUGG MODEL T4A-68)

FSN 6675-089-8884

CHAPTER 1
INTRODUCTION

Section I. GENERAL

1-1. Scope

a. These instructions are published for use by personnel to whom the Wild Heerbrugg Model T4A-68 directional theodolite is issued. Chapters 1 through 3 provide information on operation, preventive maintenance services, and organizational maintenance of equipment, accessories, components, and attachments. Chapters 4 and 5 provide information for direct and general support and depot maintenance. Also included are descriptions of main units and their functions in relationship to other components.

b. Appendix A contains a list of publications applicable to this manual. Appendix B contains the list of basic issue items authorized for the operator of this equipment and the list of maintenance and operating supplies required for initial operation. Appendix C contains the maintenance allocation chart. Organizational, direct and general support and depot - maintenance repair parts and special tools will be listed in TM 5-6675-297-25P when printed.

c. Numbers in parentheses following nonmenclature callouts on illustrations indicate quantity; numbers preceding nonmenclature callouts indicate preferred sequence.

d. Report of errors, omissions, and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to DA Publications) and forwarded direct to Commanding General, U.S. Army Mobility Equipment Command, ATTN: AMSME-MPP, 4300 Goodfellow Boulevard, St. Louis, Mo. 63120.

1-2. Record and Report Forms

DA Form 2258 (Depreservation Guide for Vehicles and Equipment).

Section II. DESCRIPTION AND TABULATED DATA

1-3. Description

a. The theodolite is a surveying instrument for high precision measurements of horizontal and vertical angles. It is used primarily for performing first order triangulations and astronomic-geodetic observations for such geographical determinations as latitude and longitude.

b. The theodolite (figs. 1-1 through 1-4) comprises and alidade mounted on a base assembly so as to be free to rotate about a vertical axis. The cone shaped base assembly is provided with three adjustable footscrew assemblies for accurate leveling. It contains the vertical axis system together with the graduated horizontal circle and optical system for reading horizontal angles. The alidade comprises a U-frame together with the telescope and its horizontal axis system. The graduated vertical circle and the optical system for reading vertical angles is mounted on one end of the horizontal axis. The telescope eyepiece and associated setting circle assembly, fixed and movable reticles, and a self-recording micrometer for positioning the movable reticle are mounted on the opposite end of the horizontal axis. Provision is also made for mounting a collimation level assembly, a suspension level assembly, a Horrebow-Talcott level assembly, and a setting circle level assembly. The instrument is wired for illuminating the horizontal circle, the vertical circle, the setting circle, and the reticle field, using an external battery.

c. The upper end of the fixed vertical axis is secured to the top of the cone shaped base and extends downward. The vertical axis of the alidade

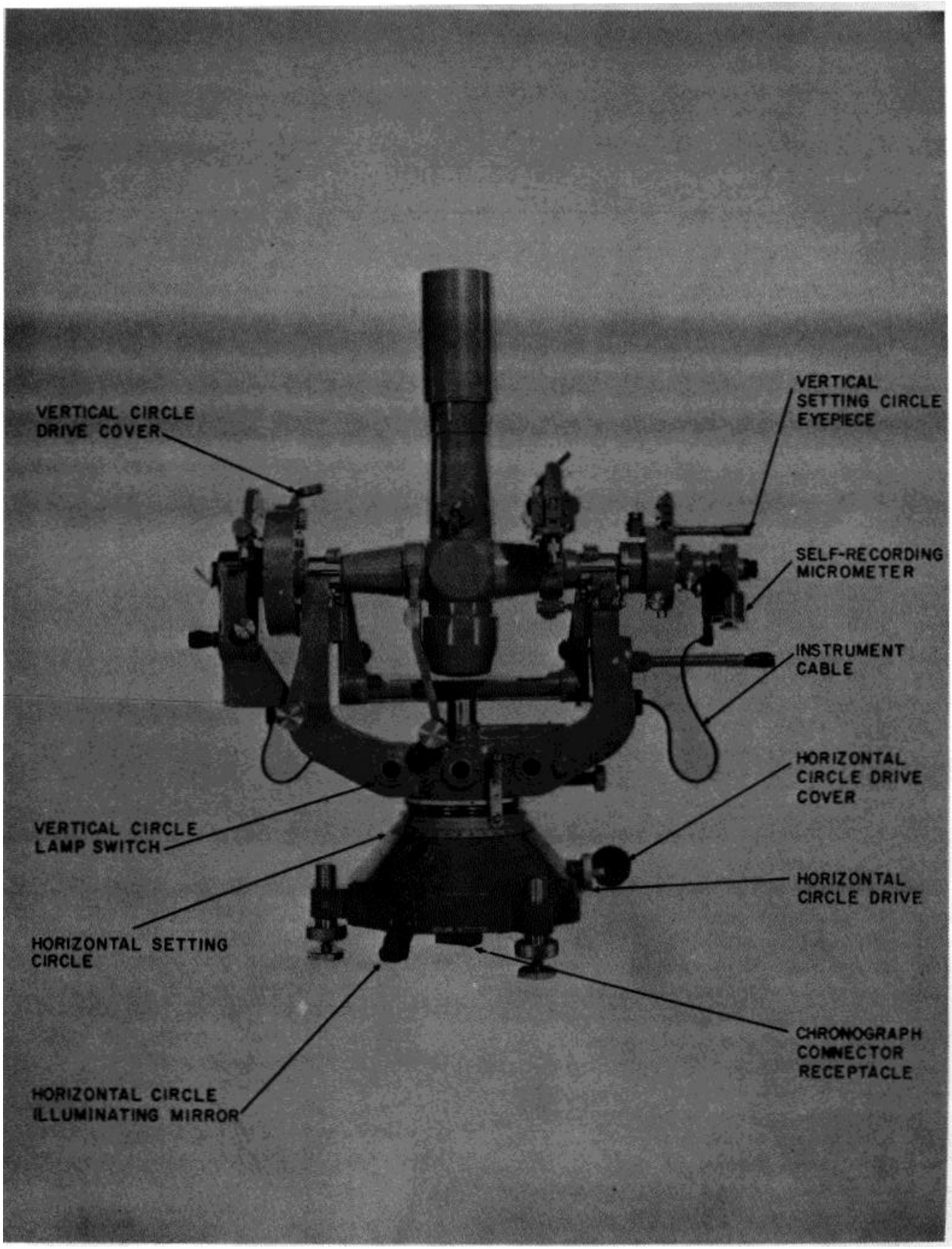


Figure 1-1. Theodolite, front view.

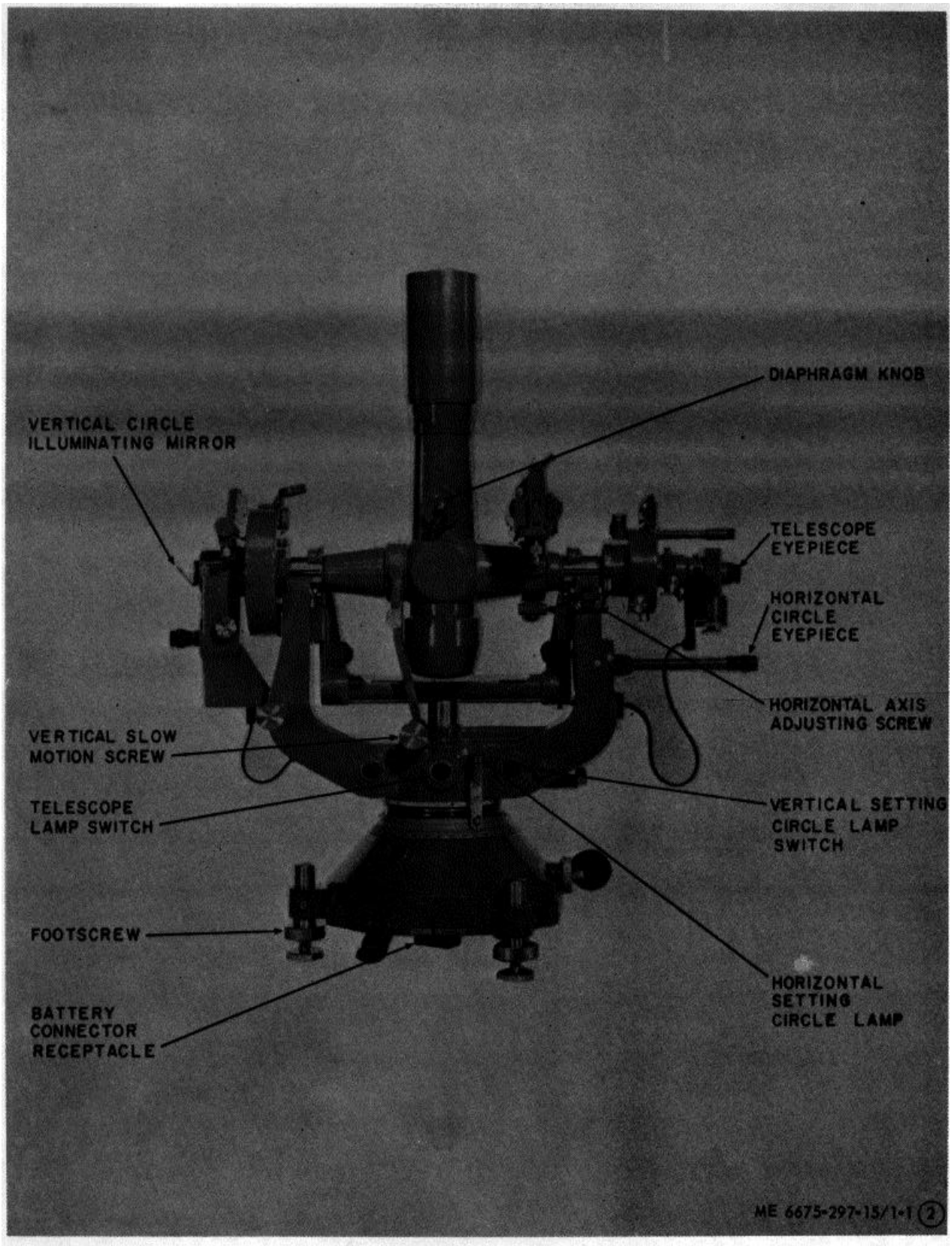


Figure 1-1. - Continued

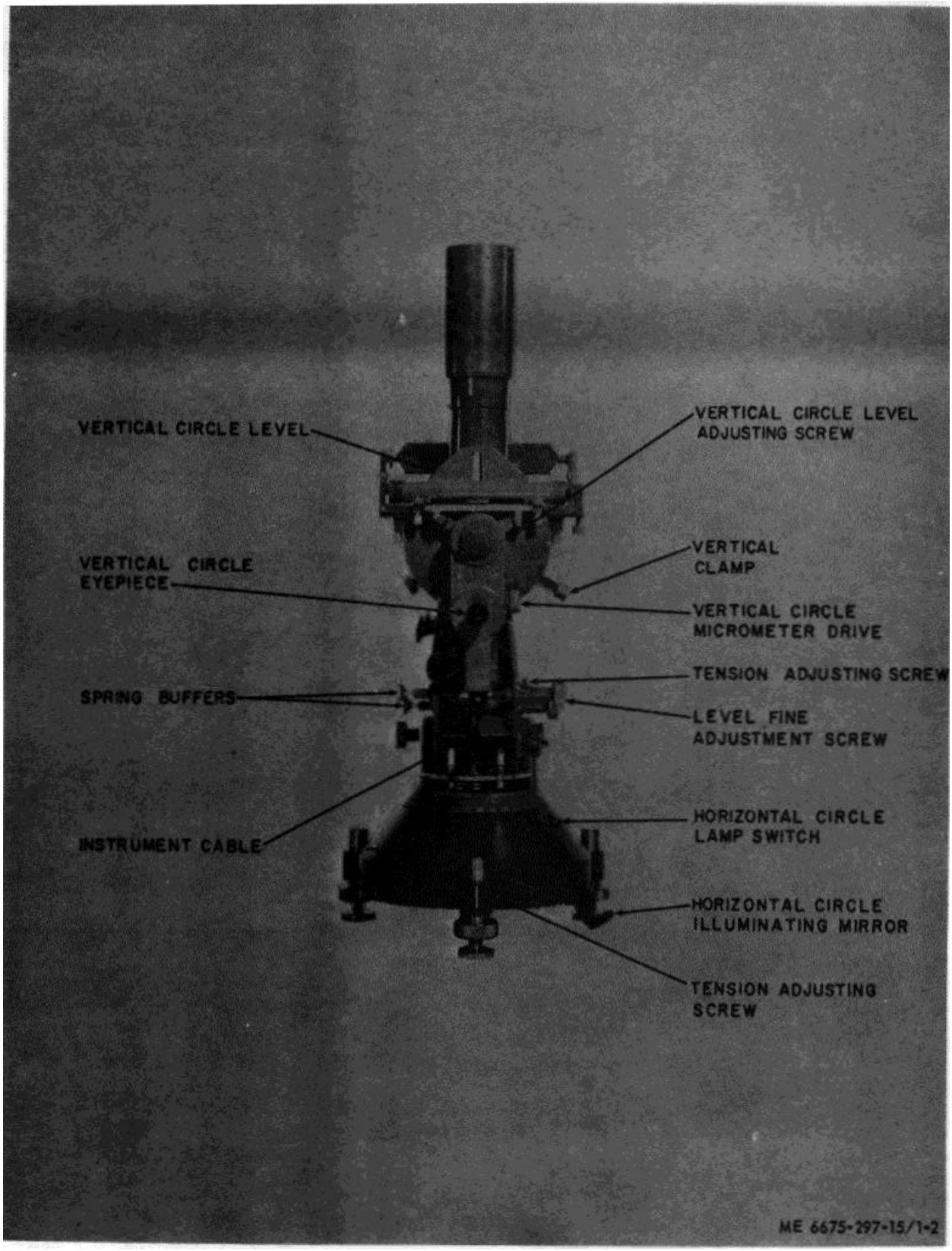


Figure 1-2. Theodolite, left side view.

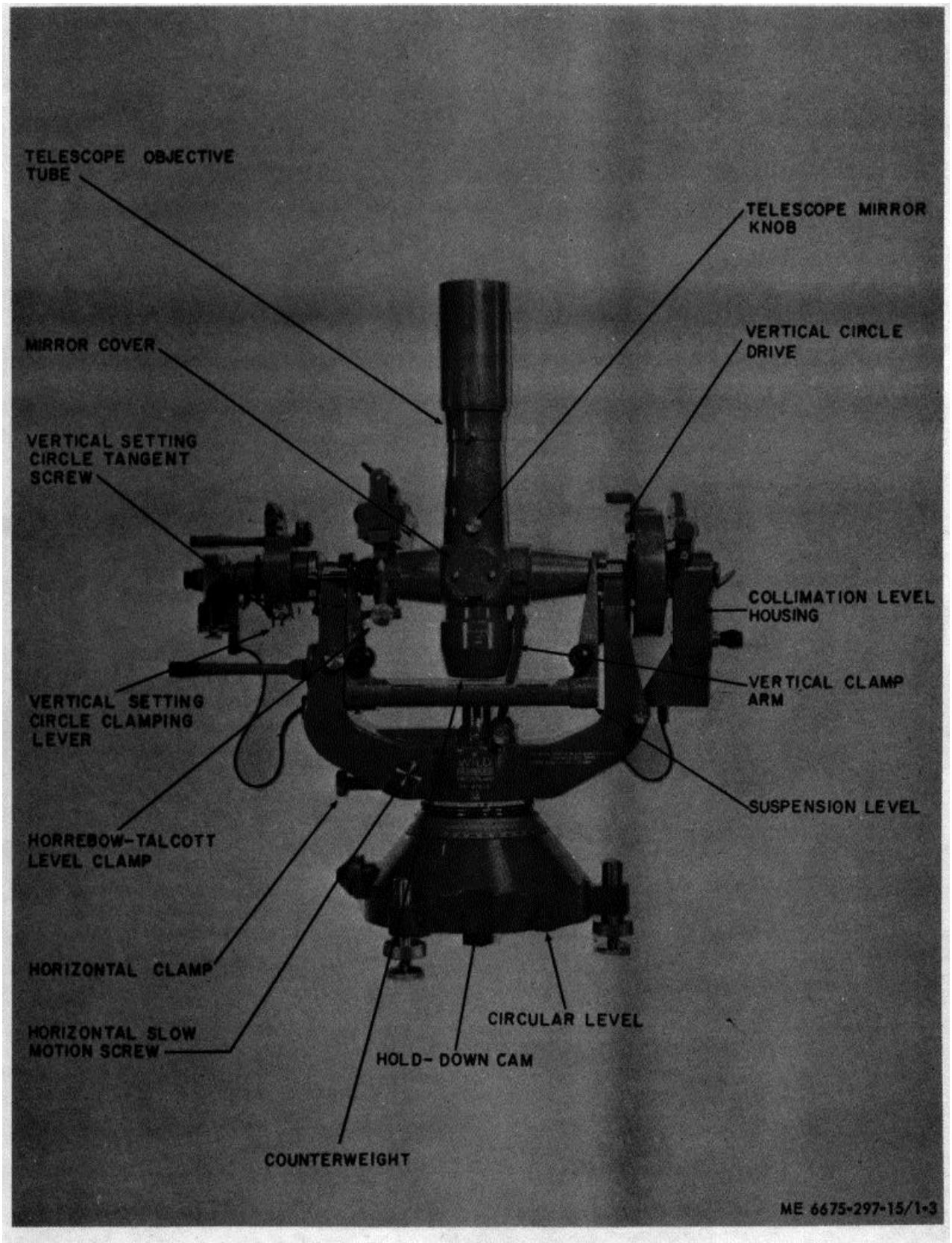


Figure 1-3. Theodolite, rear view.

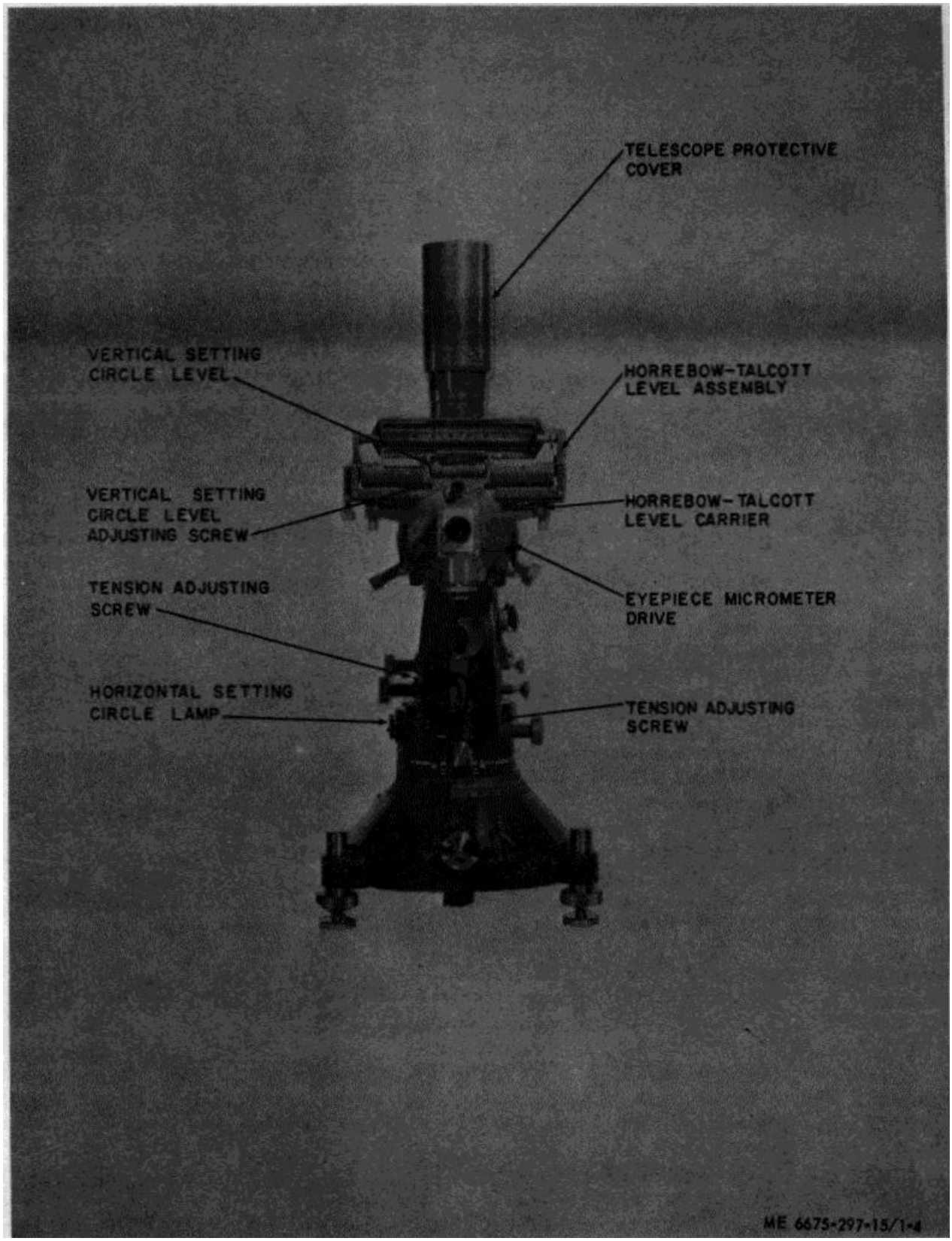


Figure 1-4. Theodolite, right side view.

is secured to the base of the U-frame and is precisely fitted to the bore of the fixed vertical axis. The bearing surfaces of both axes are conical. A ball bearing carries the weight of the alidade and ensures automatic centering of the vertical axis system. The length of the vertical axis virtually eliminates eccentricity so that the alidade runs smoothly and maintains precise alinement at all temperatures and requires no adjustment. The carrier of the graduated horizontal circle rotates about the outside of the fixed vertical axis, supported by a split retaining ring secured to the top of the cone shaped base. The axis of the alidade is hollow and contains part of the optics for the horizontal circle reading microscope.

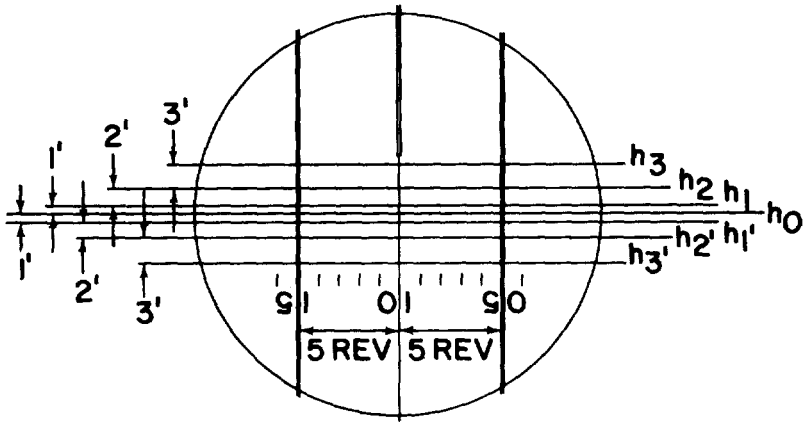
d. The U-frame assembly of the alidade supports the horizontal axis system and maintains it in precise alinement. It also contains part of the optics for the horizontal circle reading microscope which is mounted on one arm of the U-frame. The horizontal axis system is supported on precision ball bearing assemblies, one of which is adjustable in height to provide for accurate alignment.

e. The horizontal axis is hollow, one side forming part of the telescope optical system and the other providing for mounting the vertical circle system. Precisely ground bearing journals at either end rest on paired ball bearings to ensure precise alinement. Most of the weight of the horizontal axis system is supported by spring loaded ball bearings at the inner ends of the bearing journals. This ensures that the paired ball bearings function primarily to precisely aline the axis.

f. The optical axis of the telescope forms a right angle, light from the objective being reflected to the eyepiece by a mirror at the center of the horizontal axis. The weight of the objective is balanced by a weight secured to the horizontal axis immediately behind the reflecting mirror.

g. A fixed and a movable reticle are provided at the focal plane. Crosslines (often called crosshairs) are etched on the fixed reticle as shown in figure 1-5. A single crossline, parallel to line V10 on the fixed reticle, is etched on the movable reticle. The movable reticle is fixed in relation to the eyepiece, the two being positioned with respect to the fixed reticle by a micrometer screw having an indexed drum for direct reading of reticle position and a contact drum for electrically recording reticle position with respect to time. The movable crossline is therefore always at the center of the eyepiece field but can be traversed across the whole field of view.

h. The entire eyepiece assembly can be rotated between two stops 90 degrees apart. The movable reticle can therefore be used for measuring small angles in either azimuth or elevation. The axis of the micrometer screw is placed parallel to the telescope objective for measuring angles in elevation it is placed at right angles to the telescope objective for measuring angles in azimuth.



ME 6675-297-15/1-5

Figure 1-5. Fixed reticle crossline pattern.

i. The suspension level is used for measuring he inclination of the horizontal axis. It is suspended free of strain from extensions of the bearing journals at the ends of the horizontal axis. A special connection rod positions the suspension level automatically.

j. Provision is made for mounting two Horrebow-Talcott levels on the horizontal axis. One level is permanently mounted on the level support and the other can be removed for adjusting the bubble length. The levels are used for measuring small changes in tilt of the telescope. A rotatable mirror facilitates reading the bubble positions.

k. Horizontal and vertical setting circles are provided for orienting the telescope to previously calculated horizontal and vertical angles for observations of a star. The graduated ring of the horizontal setting circle may be turned to obtain a reading of zero when the telescope is in the meridian. The zero point of the vertical setting circle is the zenith.

1-4. Identification and Tabulated Data

a. Identification. The model T4A-68 directional theodolite has the following identification markings:

(1) U-*frame assembly.*

(*a*) The manufacturer's name, model number, and serial number are engraved oil the U-frame.

(*b*) All identification plate secured to the U-frame carries the Federal stock number and contract number.

(2) *Horizontal axis and telescope assembly.* The model number and serial number are stenciled on the upper side of the counterweight.

(3) *Suspension level*. The model number and serial number are stenciled on the left-hand bracket.

b. Tabulated Data.

(1) *Weights*. The T4A-68 directional theodolite (fig. 1-6) consists of the following:

	Pound	Kilogram
Base and U-frame assembled	72	32.5
Transport box	44	20.0
Horizontal axis and telescope assembled	40	18.0
Transport box	4	21.0
Suspension level and carrying case	10	4.5
Accessories and carrying case	8	3.6
Battery box (less batteries)	7	3.0
	227	102.6

(2) *Extra accessories.* The following accessory instruments are used with the directional theodolite. They are synchronized with the directional theodolite to ensure compatibility between the equipment.

	Pound	Kilogram
1 Naval chronometer "Nardin"	4	1.8
1 Field chronograph "Favag"	27	12.2
1 Short-wave receiving set with battery	24	10.7
1 Barometer with thermometer (approx.)	3	1.4
1 Tripod	38	17.4
	96	43.5

Note.

Wooden tripod with metal tripod plate for use at field stations where no pillar is available.

(3) *Telescope.*

Diagonal type for horizontal viewing:
- Lens aperture ..... 60 mm (2 3/8 in).

Eyepiece with recording micrometer:
- Magnification 70X
- Focal length ..... 540 mm (21 in.)

(4) *Vertical axis system*. Conical ball bearing, no side play, free running at any temperature without adjustment.

(5) H*orizontal circle*.

Material ..... Glass
Scale length ..... 360°
Diameter of division ..... 250 mm (10 in.)
Division interval ..... 2 minutes
Reading by optical coincidence micrometer with automatic formation of mean value.
Division interval of micrometer ..... 0.1 second

(6) *Vertical circle*.

Material ..... Glass
Scale length ..... 360°
Diameter of division ..... 145 mm (5 3/4 in.)
Division interval ..... 4 minutes
Reading by optical coincidence micrometer with automatic formation of mean value.
Division interval of micrometer ..... 0.28 seconds

(7) *Setting circle for telescope tilt.*

With leveling scale:
- Division interval ..... 1°
- Interval of microscope scale ..... 10 minutes
- Estimation to ..... 1 minute

(8) *Suspension level*.

Sensitivity per 2 mm (approx) ..... 1 second

(9) *Vertical circle level.* Level deviation set or read by mean of coincidence prisms.

(10) *Horrebow-Talcott levels.*

Sensitivity per 2 mm ..... 1 Second to 2 seconds

(11) *Electrical connections.* Plug socket in foot of instrument base for connection of eyepiece micrometer to field chronograph. Plug

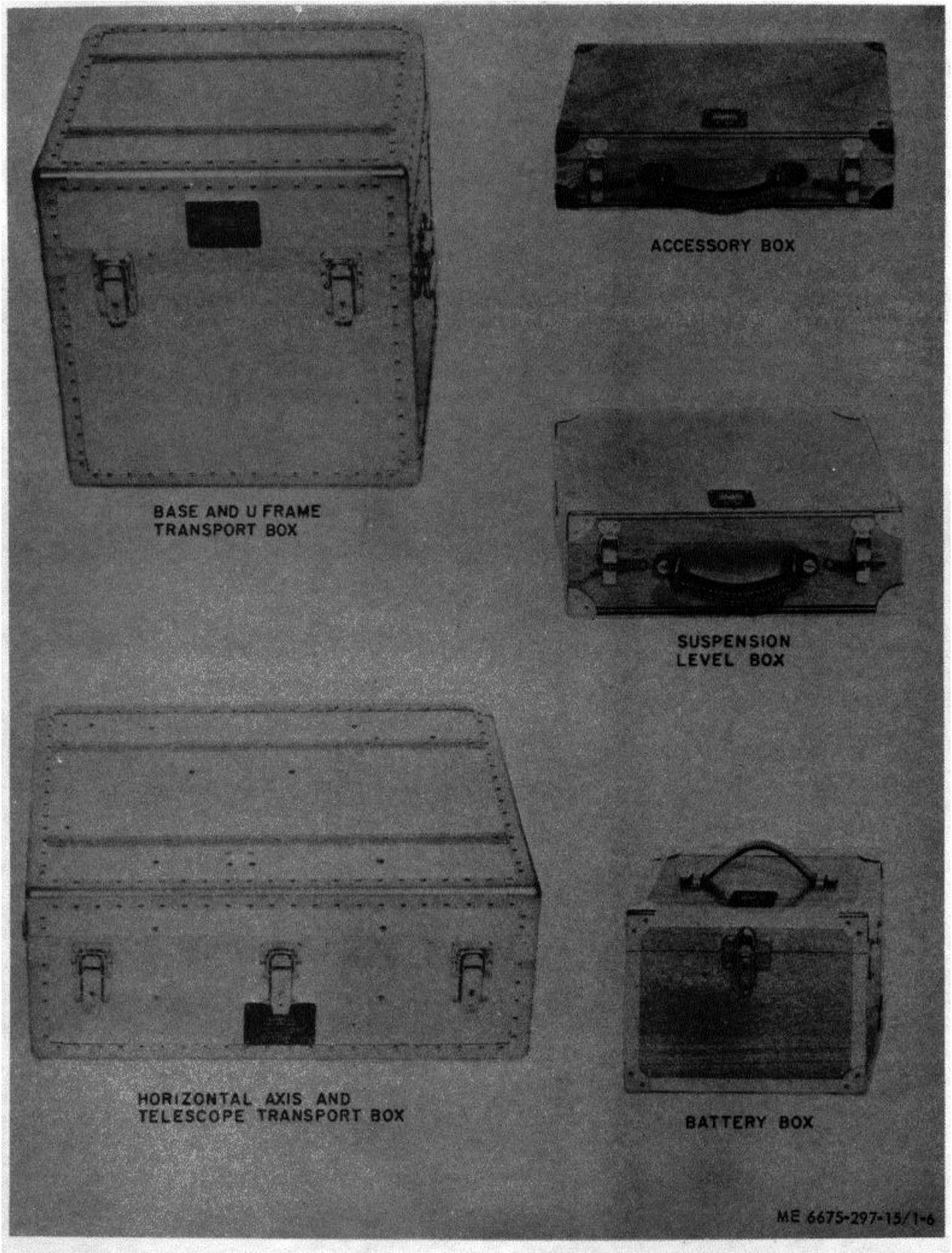


Figure 1-6. T4A-68 Directional Theodolite packed for transport.

socket in foot of instrument base for connection of battery for illuminating scales. Two connecting cables from alidade to telescope.

(12) *Instrument switches*. Horizontal circle lamp, vertical circle lamp, setting circle lamp and telescope lamp.

(13) *Accessories.* Accessories carried in the accessory case include the following:

2 Cleaning brushes
3 Cleaning sticks
1 Chamois
3 Jewelers screwdrivers
2 Large adjusting pins
1 Fork-and-pin wrench
1 Allen wrench
1 Pair tweezers
3 Common screwdrivers
1 Illumination cable with switch and rheostat
1 Chronograph connecting cable
2 Instrument connecting cables
1 Emergency lamp with cable
1 Handlamp with cable
1 Grease can
1 Oil container
4 Small adjusting pins
2 Illuminating mirrors
8 Spare lamps

(14) *Battery box*. Six dry cells are carried in the battery box. Three dry cells are connected for powering the illuminating lamps. Three dry cells are carried as spares.

1-5. Difference in Models

This manual covers only the Wild Heerbrugg model T4A-68 directional theodolite. No known unit differences exist for the model covered by this manual.

CHAPTER 2

INSTALLATION AND OPERATION INSTRUCTIONS

Section I. SERVICE UPON RECEIPT OF EQUIPMENT

2-1. Unloading Equipment

a. Directional Theodolite. The directional theodolite is shipped in two shipping cases (fig. 2-1). The base and U-frame assembly are packed in a packing case and crated as shown. The loaded weight of the shipping case is 210 pounds. The horizontal axis and telescope assembly are packed in a separate packing case and crated as shown. The loaded weight of this shipping case is 180 pounds. A handtruck or manpower may be used to unload the crates.

Caution

Handle the cased equipment carefully to avoid damage.

b. Accessories. The suspension level and Horrebow-Talcott levels are packed in a packing case. Accessories, such as tools, interconnecting cables, and spare lamps, are packed in an accessory box and a separate battery box is provided. These three boxes are packed in a shipping case as shown in figure 2-1. The loaded weight of the shipping case is 70 pounds. A handtruck or manpower may be used for unloading the equipment.

Caution

Handle the cased equipment carefully to avoid damage.

c. Tripod. The tripod is shipped in a separate shipping crate (fig. 2-1). The loaded weight of the shipping crate is 150 pounds. A handtruck or manpower may be used to unload the crate.

2-2. Unpacking Equipment

a. General. Select a location protected from the weather for unpacking the directional theodolite and accessories. Set the shipping cases up off the ground on suitable supports. Save the shipping cases and packing materials for future use.

b. Directional Theodolite.

(1) Remove nails securing tops of two shipping cases and remove tops in one piece.

(2) Remove packing materials from top and sides of each transport box.

(3) Remove packing cases from shipping cases.

(4) Replace wrapping and packing in shipping cases and replace tops. Store shipping cases in a safe place.

(5) Refer to figure 2-2 and remove base and U-frame assembly from packing case. Place base and U-frame on a firm, clean, level surface.

(6) Inspect base and U-frame assembly (para 2-3).

(7) Refer to figure 2-3 and remove horizontal axis and telescope assembly from packing case.

(8) Inspect horizontal axis and telescope assembly (para 2-3).

(9) Install horizontal axis and telescope assembly on base and U-frame assembly (para 2-4).

c. Accessories.

(1) Remove nails securing top of shipping case and remove top as one piece.

(2) Remove packaging from top of shipping case and remove upper case.

(3) Remove packing protecting second box and remove second case.

(4) Remove packing protecting third box and remove third case.

(5) Replace wrapping and packing in shipping case and replace top. Store shipping case in a safe place.

(6) Inspect contents of accessory case, suspension level packing case, and battery case (para 2-3).

d. Tripod.

(1) Remove nails securing top of shipping crate and remove top as one piece.

(2) Remove the wrapped tripod from the crate and carefully remove all wrapping material.

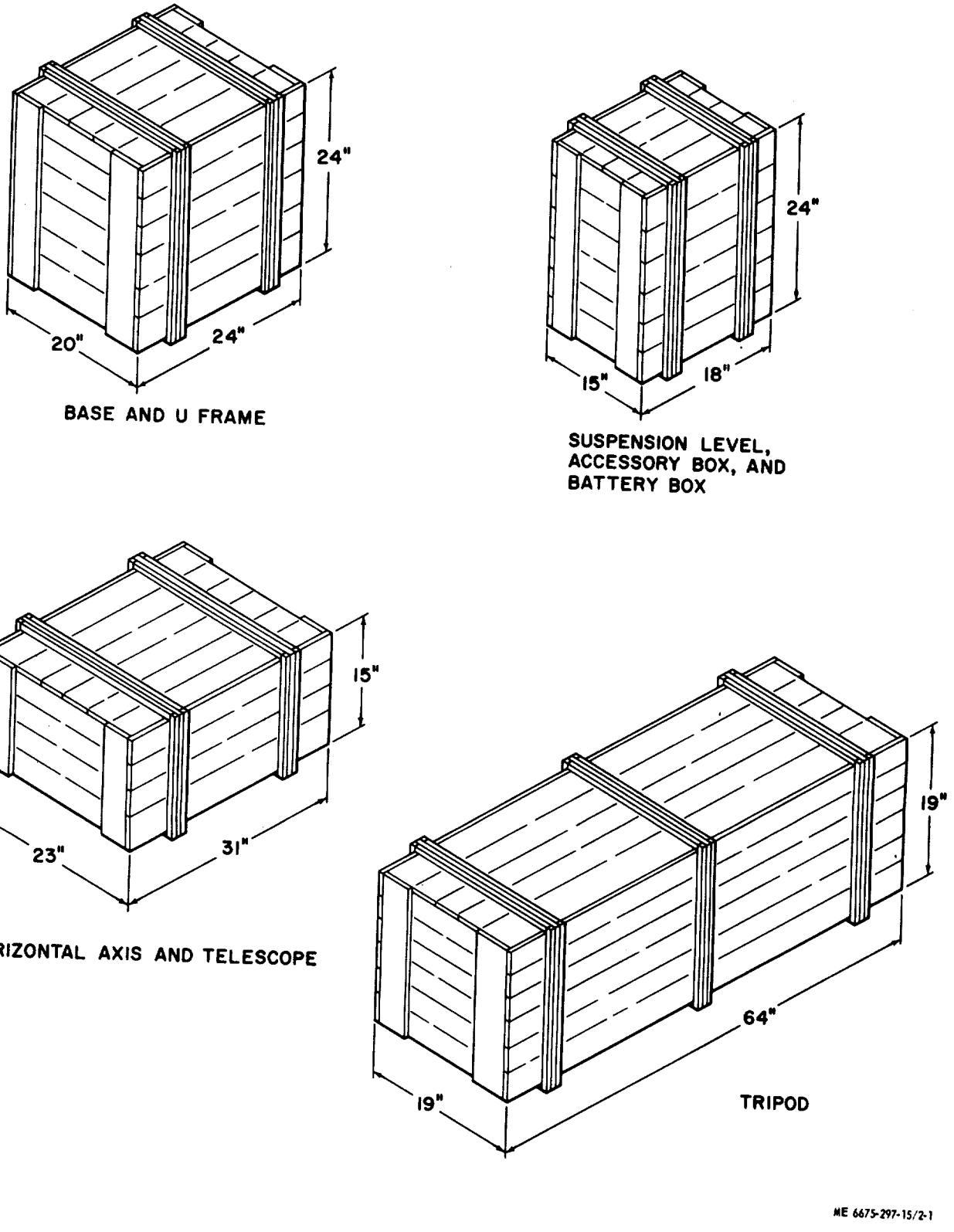


Figure 2-1. Shipping cases with dimensions.

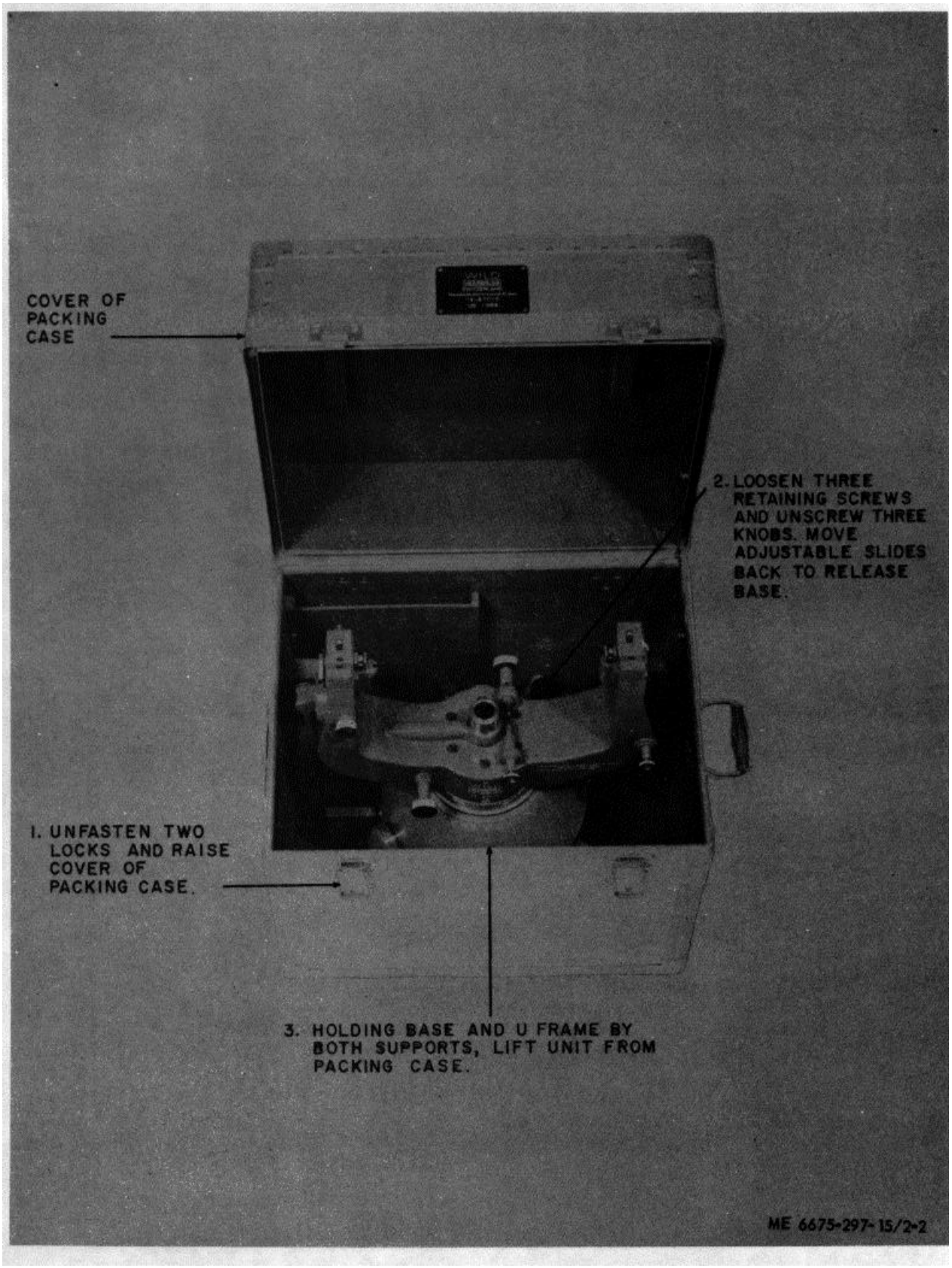


Figure 2-2. Base and U-frame assembly, removal from packing case.

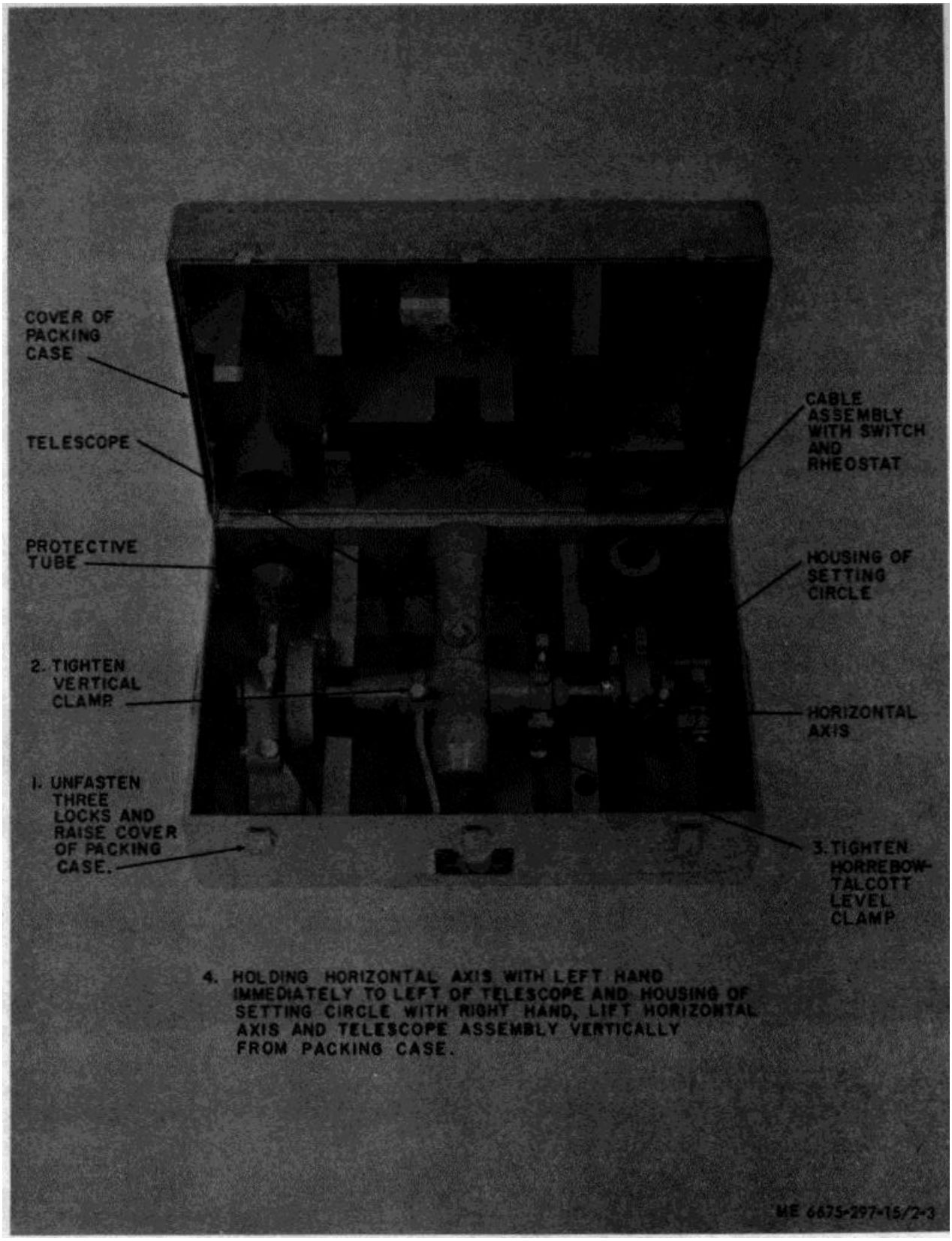


Figure 2-3. Horizontal axis and telescope assembly, removal from packing case.

(3) Replace wrapping material and packing in shipping crate and replace top. Store shipping crate in a safe place.

2-3. Inspecting and Servicing Equipment

a. Base and U-Frame Assembly.

(1) Inspect packing case (fig. 2-2) for dents, cracks, corrosion, or other damage.

(2) Refer to paragraph 2-2 and remove base and U-frame assembly front packing ease.

(3) Inspect base and U-frame assembly visually for broken or missing parts; cracked or scratched lenses, mirrors, or level vials; loose or missing mounting hardware; or other signs of damage. Report all damage and deficiencies to field maintenance.

(4) Test three footscrews (fig. 1-1) for rough travel. They should turn freely with thumb and finger pressure but should be tight enough to hold the instrument in any position. Adjust tension as necessary by means of tension adjusting screw (fig. 1-2).

(5) Loosen horizontal clamp (fig. 1-3) and white arresting ring (fig. 2-10) and check to be certain that U-frame rotates freely about vertical axis.

(6) Tighten horizontal clamp and check that U-frame is not free to rotate.

(7) With horizontal clamp tightened, turn horizontal slow motion screw (fig. 1-3) throughout its full travel in both directions. Rotation should be free with thumb and finger pressure but should be tight enough to hold in any position. Adjust tension as necessary by means of tension adjusting screw (fig. 1-2).

(8) Lift cover from horizontal circle drive (fig. 1-1) and turn horizontal circle drive (fig. 1-1) throughout its full travel in both directions. Rotation should be free and smooth throughout its full travel.

b. Horizontal Axis and Telescope Assembly.

(1) Inspect packing case (fig. 2-3) for dents, cracks, corrosion, or other damage.

(2) Refer to paragraph 2-2 and remove horizontal taxis and telescope assembly from packing case.

(3) Inspect two bearing journals for scratches, nicks, burrs, corrosion, or other damage.

(4) Inspect telescope objective for finger marks, dust, scratches, or etching. Remove any dust with a camel's hair brush. If breathing on lens and willing with chamois does not clean lens, use lens tissue and grain alcohol or acetone.

Caution

Do not use acetone on plastic material.

(5) Refer to paragraph 2-4 and install horizontal axis and telescope assembly on U-frame.

(6) Lift cover from vertical circle drive (fig. 1-1) and turn vertical circle drive (fig. 1-3), checking to be certain that rotation is smooth and free throughout full travel of vertical circle drive.

(7) Check vertical clamp (fig. 1-2) for proper operation.

(8) With vertical clamp tightened, turn vertical slow motion screw (fig. 1-1) throughout its full travel in both directions. Rotation should be free with thumb and finger pressure but should be tight enough to hold in any position. Adjust tension, as necessary, by means of tension adjusting screw (fig. 1-4).

(9) With vertical setting circle clamping lever (fig. 1-3) engaged, turn vertical setting circle tangent screw (fig. 1-3) throughout its full travel. Rotation should be free and smooth.

(10) Turn eyepiece micrometer drive (fig. 1-4) throughout its full travel. Rotation should be free and smooth and eyepiece should travel through its full range.

(11) Turn level fine adjustment screw (fig. 1-2) throughout its full travel. Rotation should be free and smooth with thumb and finger pressure, but should be tight enough to hold in any position. Adjust tension, as necessary, by means of tension adjusting screw (fig. 1-2).

c. Battery Case and Illuminating Lamps.

(1) Unfasten lock on battery case and raise cover.

(2) Inspect battery case for dents, cracks, missing or broken latch, or other damage.

(3) Inspect all electrical connectors for corrosion or other damage.

(4) Inspect all wiring and leads for frayed or otherwise damaged insulation, loose or broken connections, and evidence of broken leads.

(5) Refer to figure 2-4 and install six 1.5-volt dry cells in battery box.

(6) Using vertical circle illumination cable assembly, provided in accessory box, connect plug on collimation level housing to plug on U-frame.

(7) Using cable assembly with switch and rheostat, provided in accessory box, connect plug

on base of instrument of left-hand plug on battery box.

(8) Place horizontal circle lamp switch (fig. 1-2) in up (ON) position and check to be certain that horizontal circle lamp is lit.

(9) Place vertical circle lamp switch (fig. 1-1) in up (ON) position and check to be certain that vertical circle lamp is lit.

(10) Place vertical setting circle lamp switch (fig. 1-1) in up (ON) position and check to be certain that vertical setting circle lamp is lit.

(11) Place telescope lamp switch (fig. 1-1) in up (ON) position and check to be certain that telescope lamp it lit.

(12) Turn rheostat control on cable assembly and check that brightness of all lamps increases and decreases as control position is varied. Leave control at maximum brightness position.

(13) Turn diaphragm knob (fig. 1-1) throughout its full travel in both directions and check that brightness of telescope field illumination increases and decreases as knob is turned.

(14) Turn telescope mirror knob (fig. 1-3) from one extreme position to the other and check that turning knob cuts off or restores telescope field illumination at each position.

d. Accessory Case With Accessories.

(1) Unfasten two locks and raise cover of accessory case (fig. 2-5).

(2) Inspect accessory box for dents, cracks, corrosion or other damage.

(3) Inspect all interconnecting cables for damaged connectors, defective insulation, and indications of broken leads.

(4) Inspect emergency lamp and handlamp with associated cables for defective connectors,

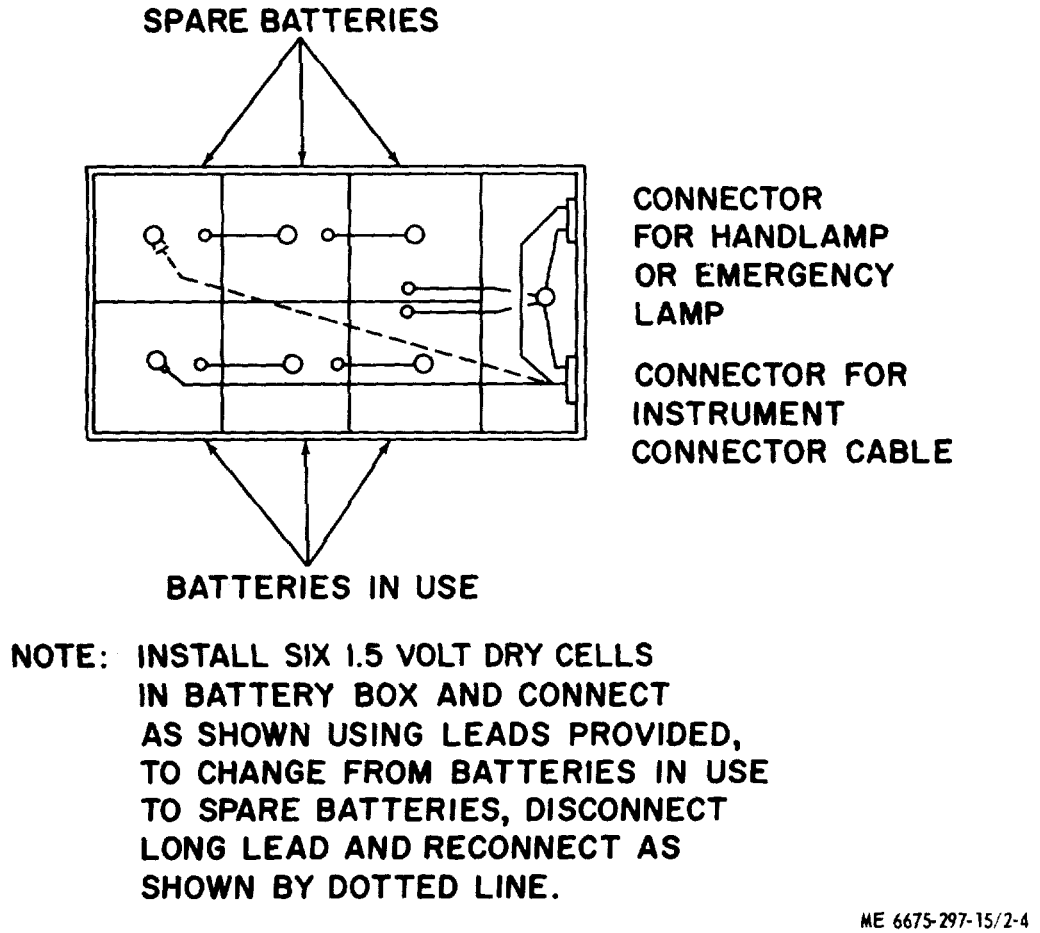


Figure 2-4. Installation of batteries.

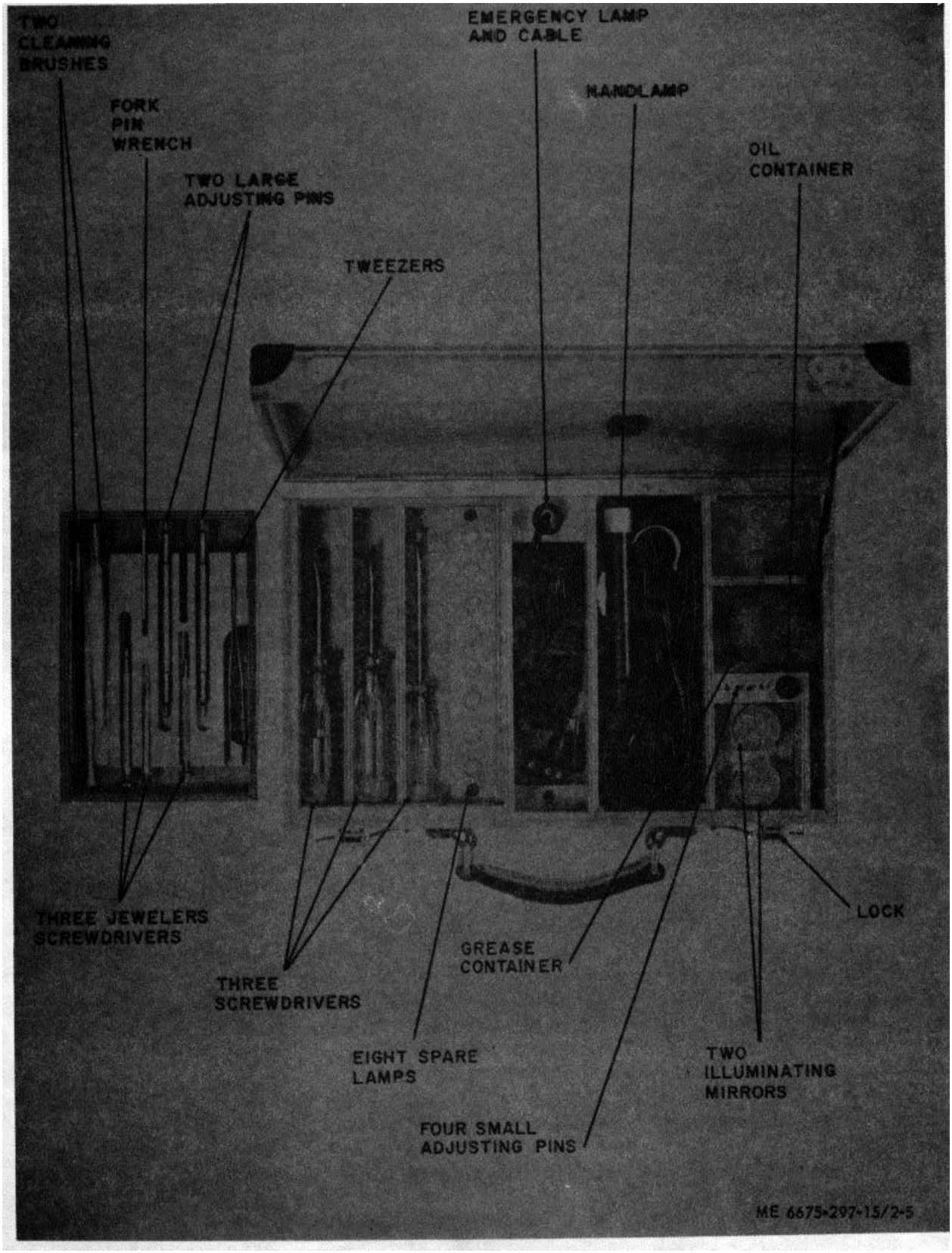


Figure 2-5. Accessory case with accessories.

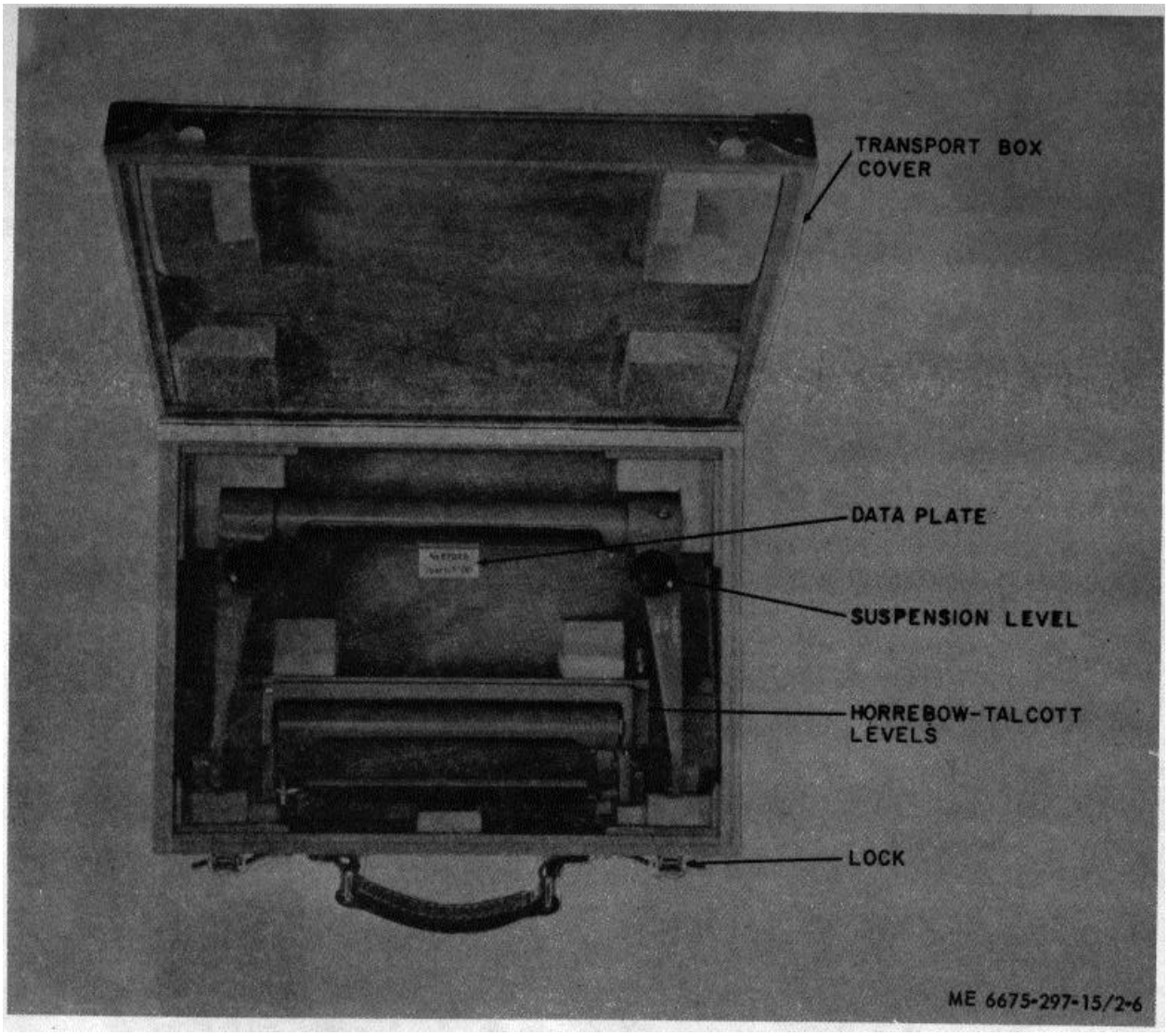


Figure 2-6. Transport box, suspension level, and Horrebow-Talcott level.

damaged insulation, defective lamps, damaged sockets, or damaged switches.

(5) Check that eight spare lamp)s are in good condition and securely mounted.

(6) Inspect illuminating mirrors for finger marks, dust, scratches, or etching. Remove any dust with a camel's hair brush. If breathing on mirror and wiping with chamois does not clean mirror, use lens tissue and grain alcohol or acetone.

(7) Inspect all tools for serviceability.

(8) Replace a defective accessory case and all defective accessories.

e. Suspension and Horrebow-Talcott Levels.

(1) Unfasten two locks and raise transport box cover (fig. 2-6).

(2) Inspect transport box for dents, cracks, corrosion, or other damage.

(3) Inspect suspension level for cracked or broken level vial, cracked or otherwise damaged mount, loose or damaged adjusting screws, or other damage.

(4) Inspect mounting surfaces of suspension level for nicks, burrs, or other damage.

(5) Inspect two levels of Horrebow-Talcott level for cracked or broken level vials, cracked or otherwise damaged mounts, loose or damaged hardware, or other damage.

(6) Inspect mounting surface of Horrebow-Talcott level for nicks, burrs, or other damage.

f. Tripod Assembly.

(1) Inspect the tripod assembly (fig. 2-7) for damaged or missing cover, damaged legs, damaged or missing leather belt, or damaged shoes.

(2) Unfasten leather straps of cover and remove cover.

(3) Inspect top plate and hinges of tripod for cracks or other damage.

(4) Unbuckle the leather belt and open the tripod legs.

(5) Inspect tripod for loose or missing hardware.

(6) Correct or report all deficiencies to field maintenance.

2-4. Installation or Setting-up Instructions

a. General. To obtain satisfactory results in astronomical field work, it is essential that the theodolite be as stable as possible when set up. A pillar built of bricks or concrete is the most satisfactory support. A pillar, however, must be built several months prior to use since it must harden and set to ensure stability. When a pillar is not available, the tripod, provided with the theodolite should be used.

b. Pillar Dimensions.

(1) The height of a pillar should be approximately 18 inches below the eye level of the average observer. This brings the telescope eyepiece to the average observers eye level.

(2) The top surface of the pillar should be approximately 18 inches square. This provides sufficient s)pace for setting up the instrument safely and does not interfere with performing observations.

(3) The positions of the three footscrews should be marked on the pillar. The tips of the three footscrews form an equilateral triangle 11 inches on the side. One side should be oriented east to west.

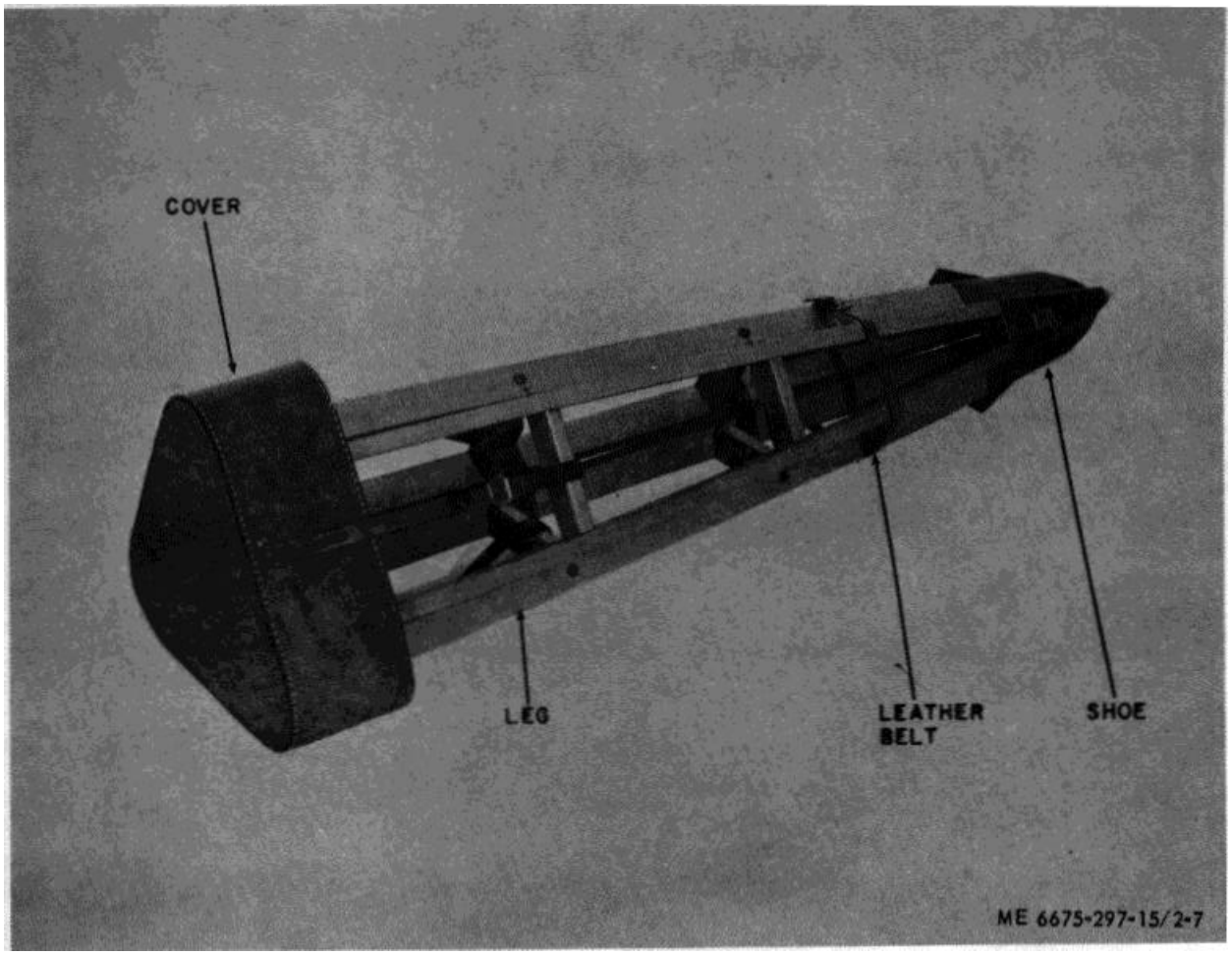


Figure 2-7. Tripod assembly.

The horizontal circle lamp switch may be on either the north or south side.

c. Use of a Tent. Since the theodolite must remain on the pillar or tripod during the entire period of observations, a tent or other suitable structure should be erected to protect the equipment from sunshine and bad weather. The enclosure should be sufficiently spacious so that a table, two chairs, and all accessories for the observations can be set up under cover. Openings must be provided ill the walls of the structure to permit making all required observations. After all equipment has been set up, the interior of the structure must be thoroughly cleaned.

d. Tripod. If the tripod is to be used to support the theodolite, refer to figure 2-8 and erect the tripod over the station point. Set up the tripod so that one side of the triangle formed by the three legs points north and south. The third leg will therefore extend to either the east or west. Since many observations must be made with the horizontal axis pointing east and vest, positioning the tripod ill this manner permits the observer to straddle one leg or stand between two legs while making these observations.

e. Theodolite.

(1) Remove base and U-frame assembly front lacking case (para 2-2).

(2) Refer to figure 2-9 and mount base and U-frame assembly on tripod.

NOTE

If base and U-frame assembly are to be mounted on a pillar, position three footscrew pads within three traced circles on pillar, making certain that pads lay flat.

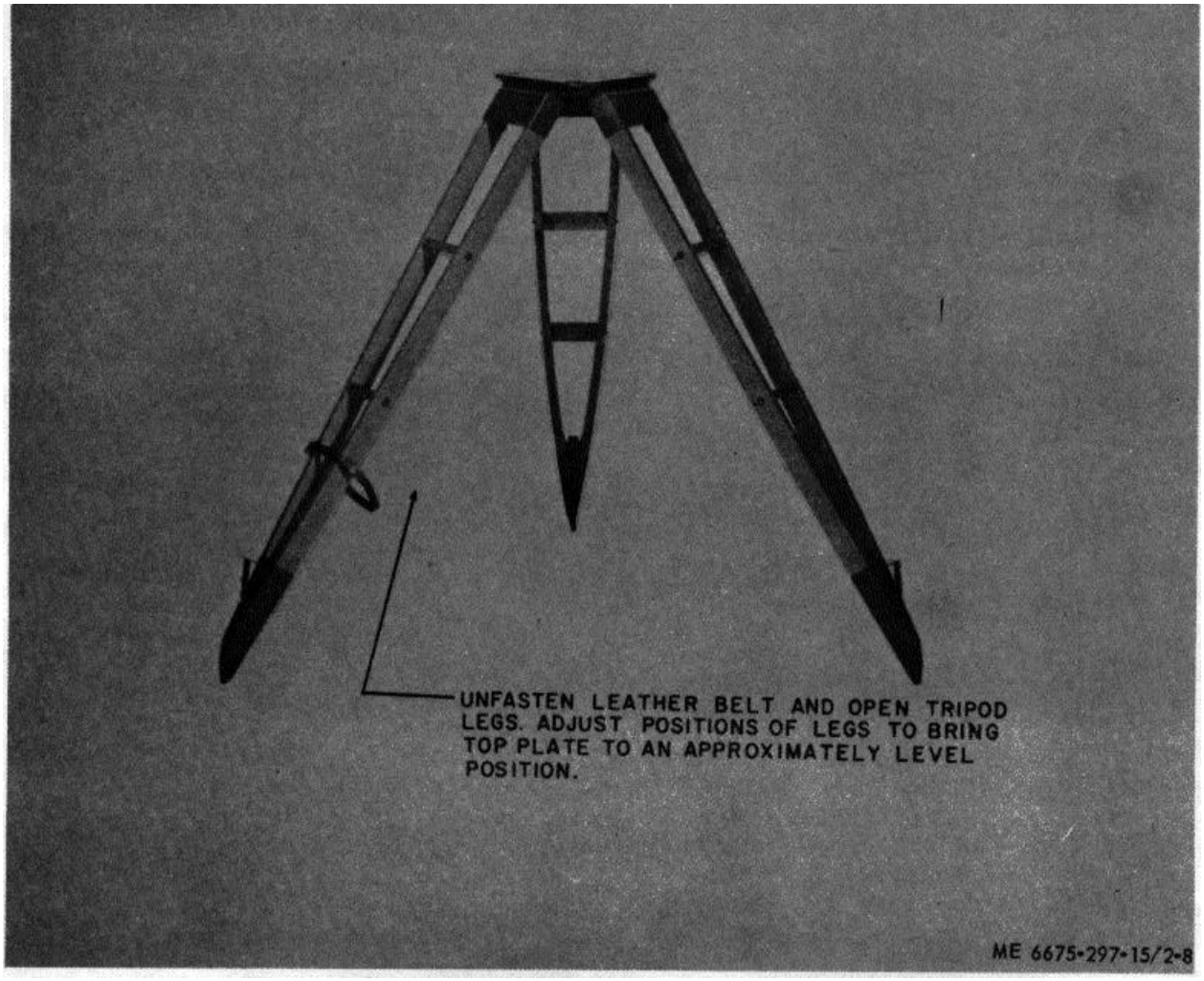


Figure 2-8. Tripod assembly, removal and installation.

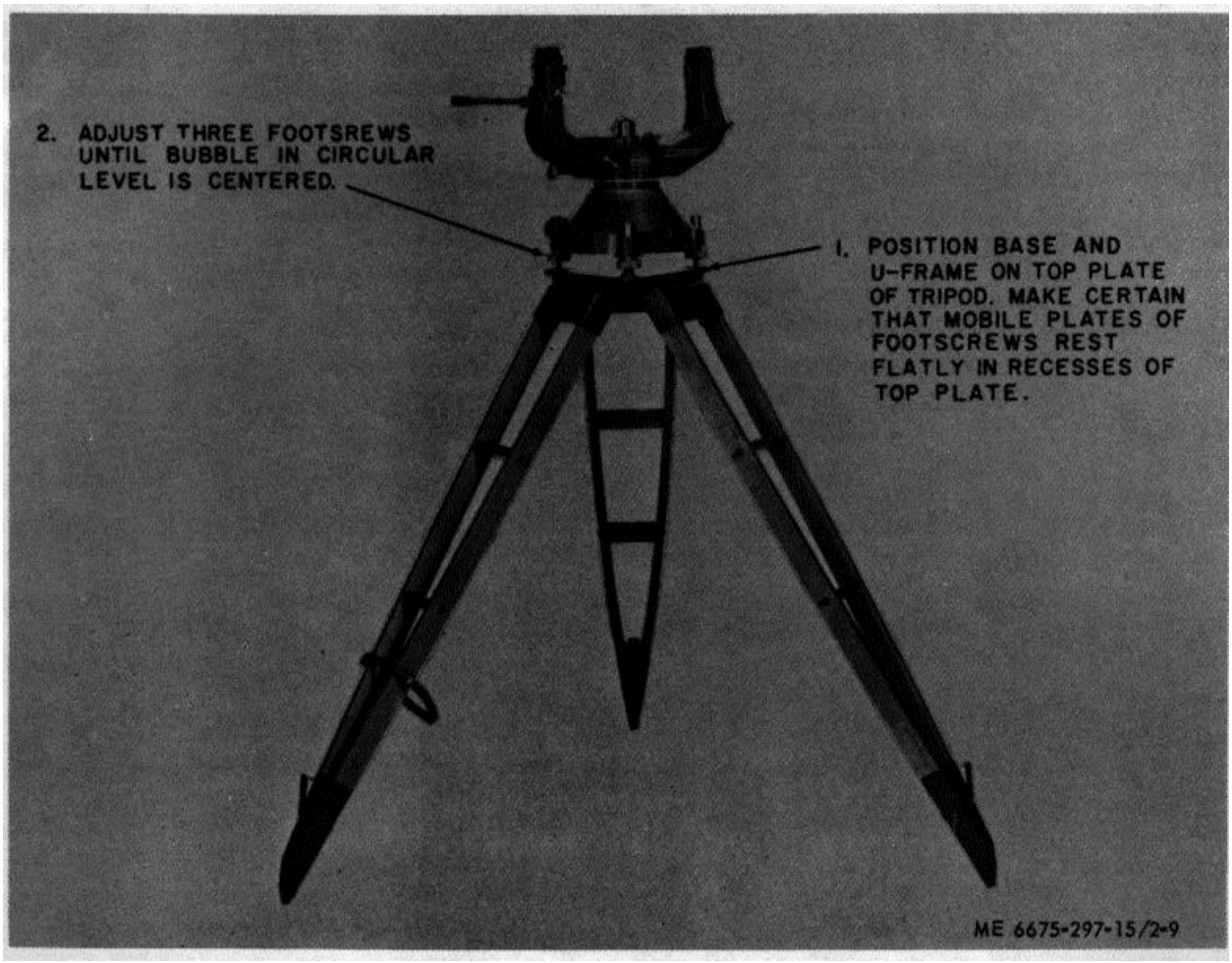


Figure 2-9. Base and U-frame installed on tripod.

(3) Using an adjusting pill, provided in accessory case (fig. 2-5), turn white arresting ring (fig. 2-10) clockwise until red MEASURING mark on arresting ring is alined with red mark on base.

NOTE

This releases U-frame, lowering it onto ball bearing. With horizontal clamp (fig. 1-3) released, U-frame can now be turned freely.

(4) Using three footscrews, adjust position of base assembly until bubble in circular level (fig. 1-3) is centered.

(5) Withdraw two spring buffers (fig. 1-2), turning associated knobs approximately 90 degrees to lock in open position.

(6) Rotate U-frame until three switches are in front and eyepiece of horizontal circle eyepiece (fig. 1-1) is at the right side.

(7) Remove horizontal axis and telescope assembly front packing case (para 2-2).

(8) Tilt telescope vertically upward so that tongues of vertical clamp arm and collimation level housing (fig. 1-3) extend vertically downward.

(9) Introducing tongues of vertical clamp arm and collimation level housing between spring buffers withdrawn in step (5), above, and associated slow motion screw, install horizontal axis and telescope on U-frame.

(10) Release spring buffers withdrawn in step (5), above.

(11) Holding Horrebow-Talcott level carrier (fig. 1-4) in one hand and vertical clamp arm in the other, rotate level carrier until spring loaded lock pin of level carrier engages groove in U-frame.

(12) Tighten vertical clamp.

NOTE

To prevent condensation on objective lens, install protective tube (fig. 2-3) on telescope tube.

(13) Using instrument cable, provided in accessory case, connect plug on U-frame to plug on collimation level housing.

(14) Using instrument cable, provided in accessory case, connect plug on U-frame to plug on self-recording micrometer.

(15) Using illuminating cable, provided in accessory case, connect battery case to plug on base of instrument.

f. 7ime Recording Equipment. Refer to figure 2-11 and connect the radio receiver, chronograph, chronometer, and theodolite as shown, using the cables provided in the accessory box.

2-5. Installation of Separately Packed Components

a. Suspension Level. The suspension level is carried in a separate packing case. It should not

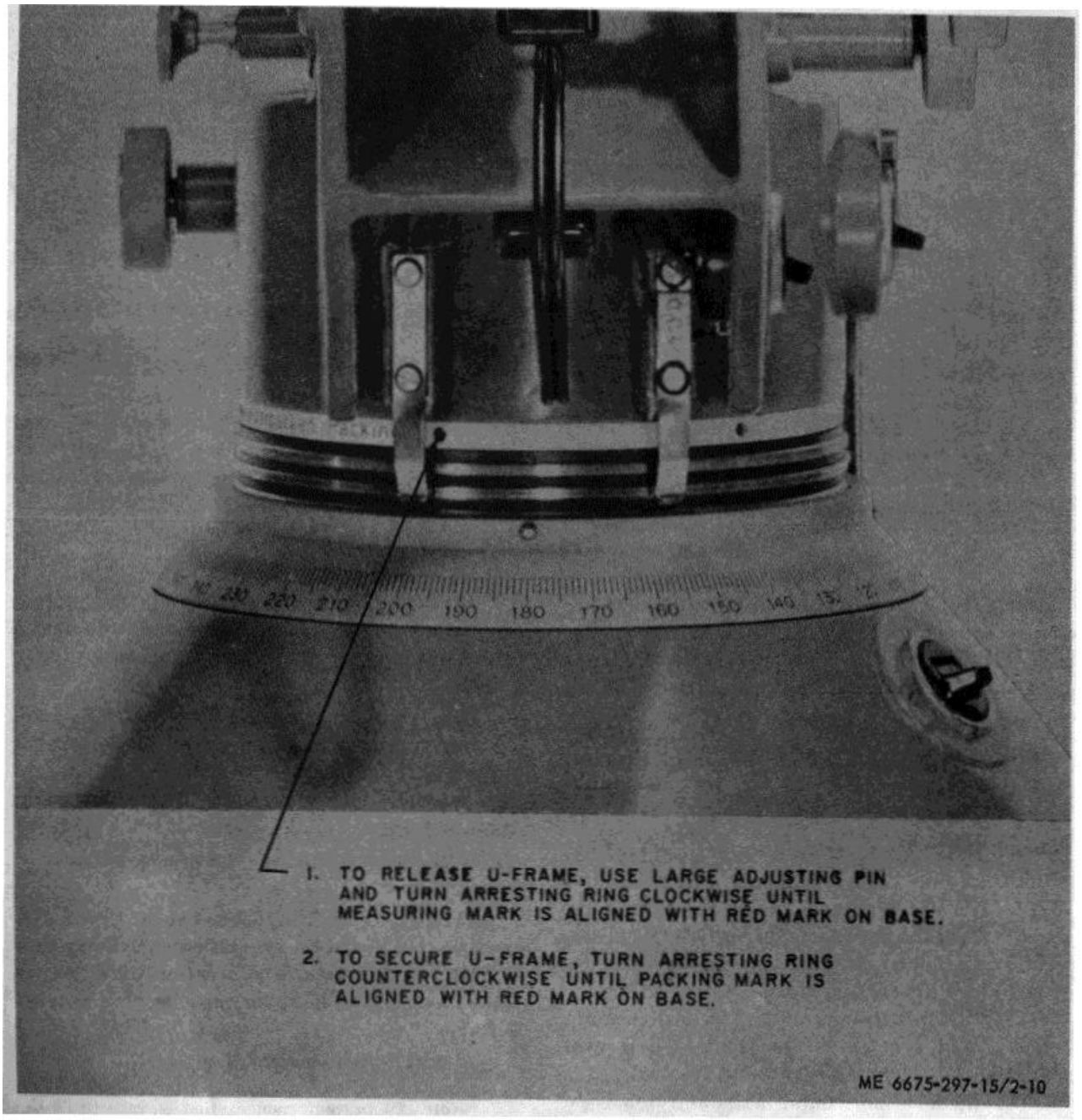


Figure 2-10. Unlocking and locking U-frame.

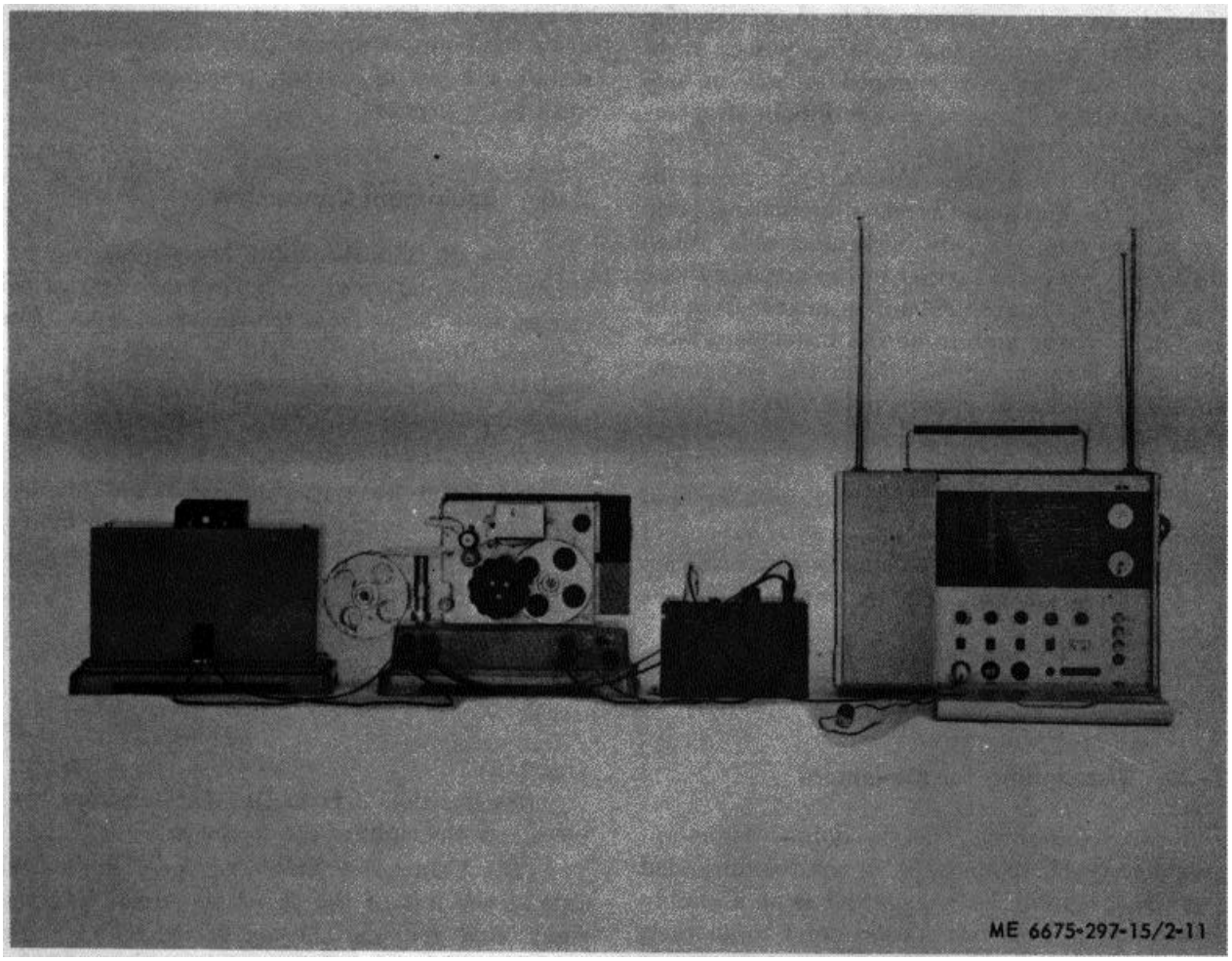


Figure 2-11. Time recording equipment installation.

be installed on the theodolite until after all accessory equipment to be used in the planned observations has been installed, the work area thoroughly cleaned, and the theodolite thoroughly cleaned and lubricated (para 3-5). To install the suspension level, proceed as follows:

(1) Remove suspension level from packing case and clean it carefully, making certain that all dust is removed.

(2) Using lens tissue and grain alcohol or acetone, thoroughly clean the surfaces which will rest oil the horizontal axis. Then apply a very thins film of grease to these surfaces.

(3) Hang the level oil the horizontal axis, orienting it as shown in figure 1-3. The sleeve of the level will then rest against the nickled cylinder at the center of the U-frame, ensuring correct positioning of the level.

Note

The sensitivity of the suspension level is indicated on, a plate on the accessory box.

(4) Check length of level bubble. Bubble should be approximately 40 graduations in length.

(5) If level bubble is not approximately 40 graduations in length, remove level from horizontal axis and tilt zero end of scale up to shorten bubble or down to lengthen bubble.

(6) Repeat steps (3) through (5), above, as necessary to obtain a level bubble approximately 40 graduations in length.

NOTE

Suspension level should not be removed from horizontal axis during an observation.

b. Horreobow-Talcott Level Assembly. The Horrebow-Talcott level assembly (fig. 1-4) is carried in the suspension level packing case (fig. 2-6). To install the assembly, mount base plate of level assembly in

groove of level carrier (fig. 1-4), making certain that locating pin on right side of level carrier is engaged in hole in base plate. Secure with two captive screws in level carrier.

c. Horizontal Circle Illuminating Lamp or Mirror. The horizontal circle illuminating lamp and mirror (fig. 1-2) are interchangeable. When not in use, they are carried in the accessory case (fig. 2-5). To remove the lamp or mirror from the receptacle at the bottom of the instrument base, draw the lamp or mirror from the receptacle. To install a lamp or mirror, press into receptacle until fully engaged.

d. Vertical Circle Illuminating Lamp or Mirror. The vertical circle illuminating lamp and mirror (fig. 1-1) are interchangeable. When not in use, they are carried in the accessory case (fig. 2-5). To remove the lamp or mirror from the receptacle at the side of the collimation housing, draw the lamp or mirror from the receptacle. To install a lamp or mirror, press into receptacle until fully engaged.

2-6. Equipment Conversion

a. General. The theodolite is equipped for artificial illumination of the horizontal and vertical circles as it comes from the transport boxes. For daylight illumination it will be necessary to install the horizontal and vertical circle illumination mirrors.

b. Daylight Illumination.

(1) Refer to paragraph 2-5 and remove horizontal and vertical circle illumination lamps.

(2) Install horizontal and vertical circle illumination mirrors (para 2-5).

Section II. MOVEMENT TO A NEW WORKSITE

2-7. Dismantling for Movement

a. Short Distances. The theodolite weighs approximately 112 pounds. It is not recommended that the theodolite be transported as an assembly when moving from one station point to another.

b. Dismantling. To dismantle theodolite for movement, proceed as follows:

(1) Disconnect illuminating cable and two instrument cables from theodolite and battery box and store in accessory box.

(2) If horizontal and vertical circle illuminating mirrors have been installed, remove mirrors and install illuminating lamps by performing the procedures of paragraph 2-5 *a* and *b* in reverse.

(3) Lift suspension level from horizontal axis and secure in packing case.

(4) Remove Horrebow-Talcott level assembly from carrier and secure in suspension level packing case.

(5) Tighten vertical clamp.

(6) Remove protective tube from telescope tube. Place protective tube in horizontal axis and telescope assembly packing case.

(7) Tighten clamp on Horrebow-Talcott level carrier (fig. 1-3).

(8) Withdraw and secure two spring buffers (fig. 1-2).

(9) Position U-frame so that telescope eyepiece is to the right of the observer.

(10) Using the left hand, grip horizontal axis at the left of the objective tube. Using the right hand grip the housing of the zenith angle setting circle and left horizontal axis and telescope assembly from U-frame.

(11) Replace horizontal axis and telescope assembly in packing case.

(12) To ensure proper fit in packing case, loosen vertical clamp and clamp on Horrebow-Talcott level carrier. When assembly is properly fitted, retighten clamps.

(13) Close and secure cover on packing case.

(14) Release two spring buffers withdrawn in step (8), above.

(15) Turn the horizontal circle eyepiece down against the U-frame.

(16) Turn the U-frame so that the left arm is directly over one of the three hold-down cams (fig. 1-3) which will later rest on the base star in the packing case.

(17) Using an adjusting pin, turn white arresting ring counterclockwise until red PACKING mark on arresting ring is alined with red mark on base.

(18) Loosen three retaining screws and three milled knobs in packing case and draw back three adjustable slides.

(19) Grasp the U-frame on both sides, from below, and raise the base and U-frame, placing it in the transport box so that the three hold-down cams rest on the base star.

(20) Check to be certain that U-frame is parallel to front of packing case. If not, cover cannot be closed.

(21) Press three adjustable slides into base of theodolite and secure by tightening associated milled knobs. Secure knobs by tightening three retaining screws.

(22) Close and secure cover on packing case.

(23) Check to be certain all accessories have been packed in accessory case. Then, close and secure cover on accessory case.

2-8. Reinstallation After Movement

After movement to a new worksite, install theodolite as outlined in paragraph 2-4.

Section III. CONTROLS AND INSTRUMENTS

2-9. General

This section describes, locates, illustrates, and furnishes operator, crew, or organizational maintenance personnel sufficient information about various controls and instruments for proper operation of the theodolite.

2-10. Controls and Instruments

The purpose of controls and instruments are illustrated in figure 2-12.

Section IV. OPERATION OF EQUIPMENT

2-11. General

a. Instructions in this section are published for information and guidance of personnel responsible for operation of the theodolite.

b. The operator must know how to perform every operation of which the theodolite is capable. This section gives instructions on handling and setting up the theodolite, basic motions and adjustments of the theodolite, and coordinating basic motions to perform specific tasks for which the equipment is designed. Since nearly every job presents a different problem, the operator may have to vary given procedures to fit the individual job.

2-12. Adjustments

a. General. There are two types of adjustments made on the theodolite: instrument and operational adjustments. Instrument adjustments bring the theodolite into proper operating condition with respect to the interrelationship of its parts and are not normally made in the field. Operating adjustments bring the theodolite into proper relationship with the terrain and are required each time the theodolite is set up for making observations. This paragraph covers instrument adjustments. Operating adjustments are covered in paragraph 2-13.

b. Circular Level Adjustment. To adjust the circular level, proceed as follows:

(1) Level the theodolite (para 2-13).

(2) Center bubble of circular level by tightening or loosening one or more of three adjusting screws located beneath circular level.

NOTE

Do not tighten adjusting screws all the way. Circular level must float on adjusting springs.

c. Horizontal Axis Alinement. The bearing on the telescope eyepiece side of the U-frame is adjustable in height to permit alinement of the horizontal axis. Perform the alinement as follows:

(1) Level the theodolite (para 2-13).

(2) Note readings of suspension level bubble ends.

(3) Remove suspension level and reinstall in reversed position.

(4) Note readings of suspension level bubble ends.

(5) Adjust horizontal axis adjusting screw (fig. 1-1) so as to halve the difference between the readings obtained in steps (2) and (4) above. Note final readings of bubble ends.

NOTE

Turn adjusting screw clockwise to raise bearing; counterclockwise to lower -bearing. Turn adjusting screw in small increments always making final turn in a clockwise direction.

(6) Repeat steps (3) through this step until

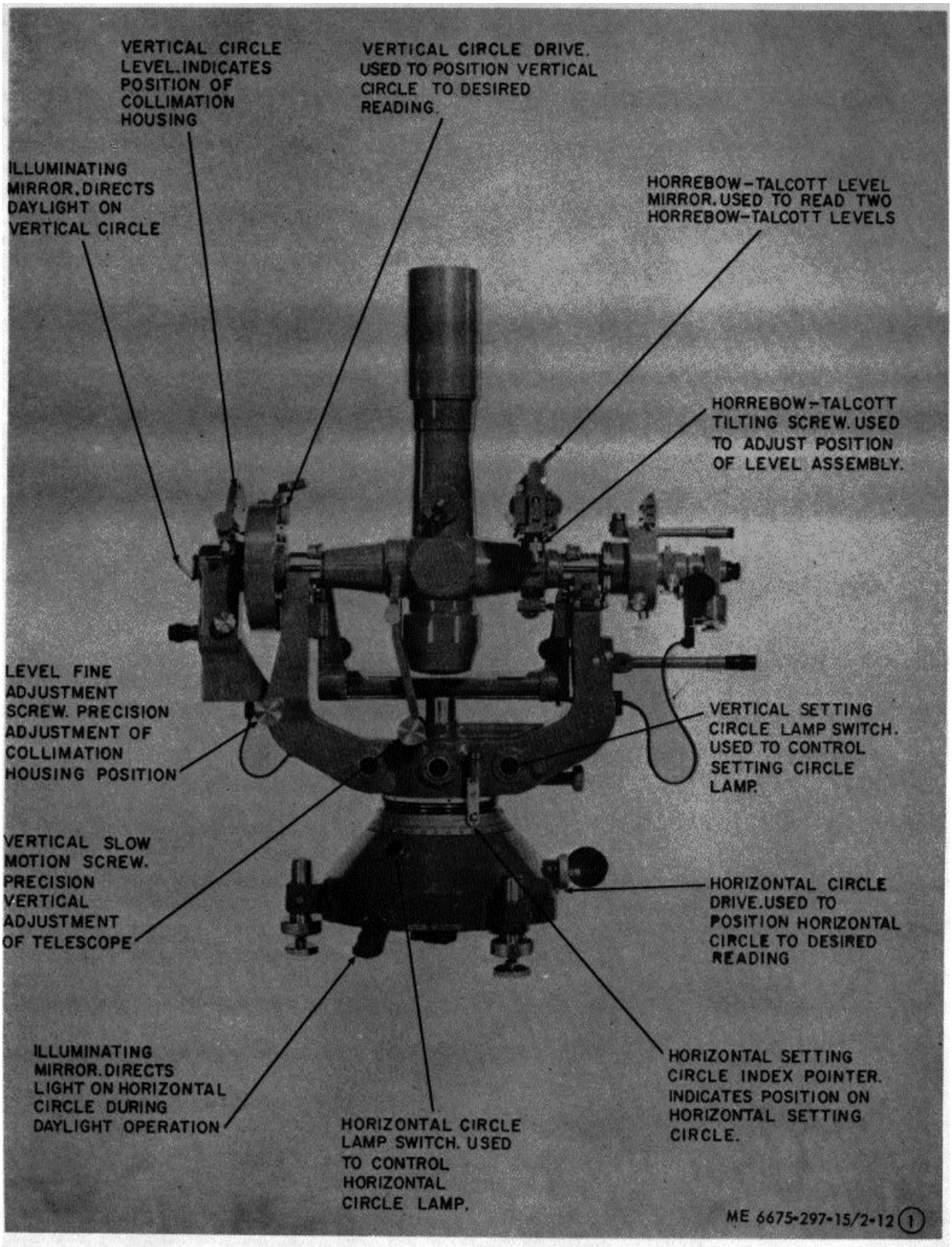


Figure 2-12. Controls and instruments.

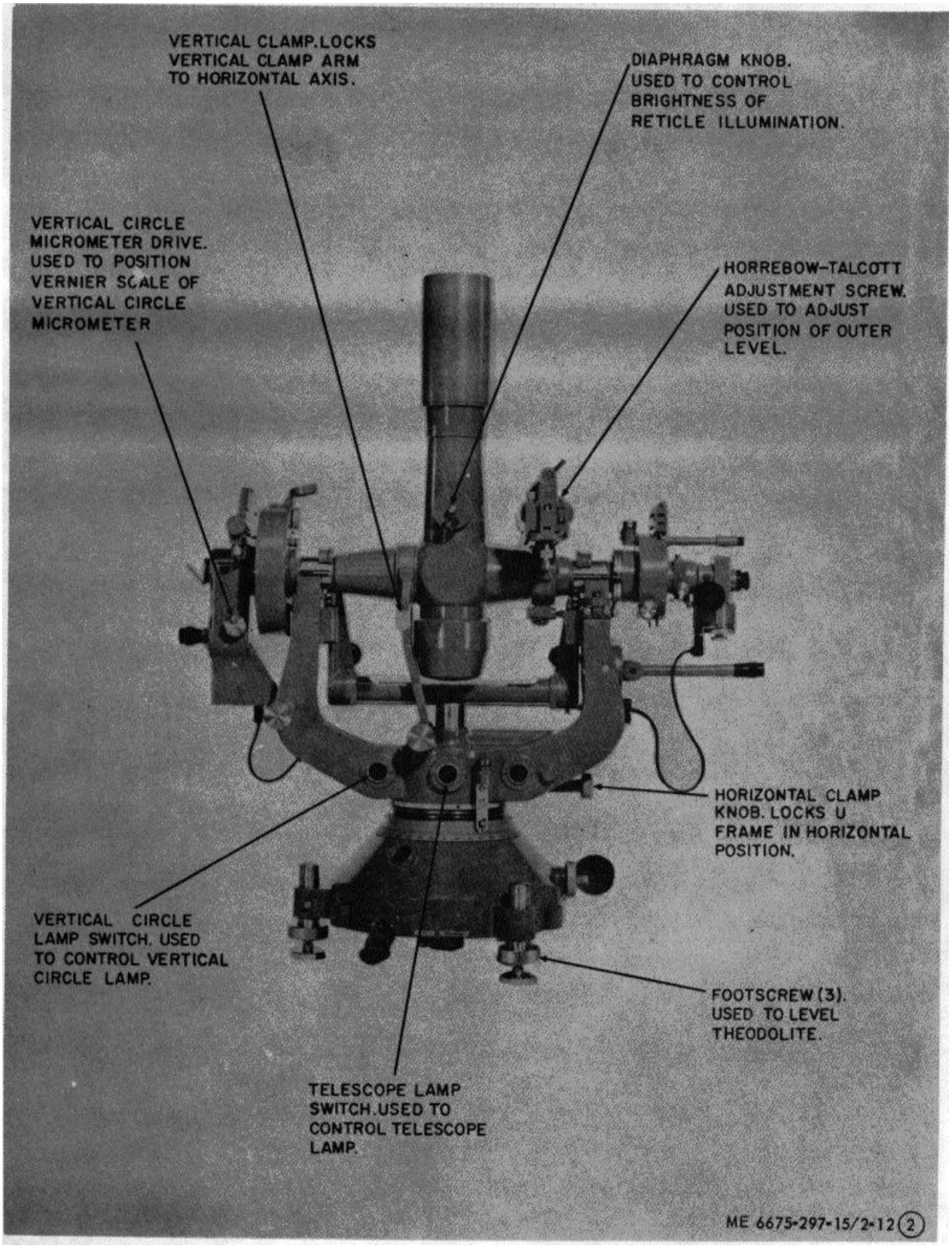


Figure 2-12.--Continued.

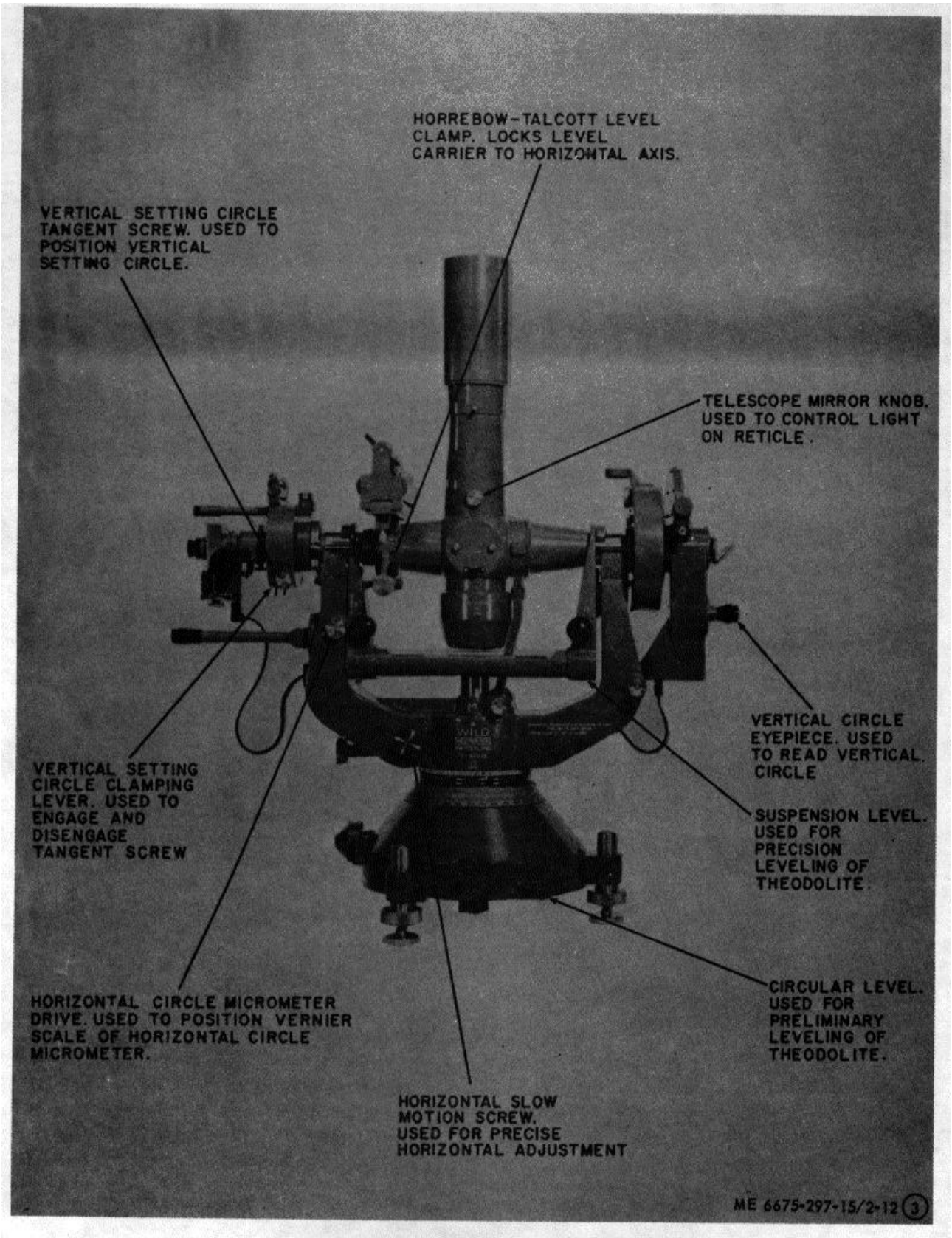


Figure 2-12.--Continued.

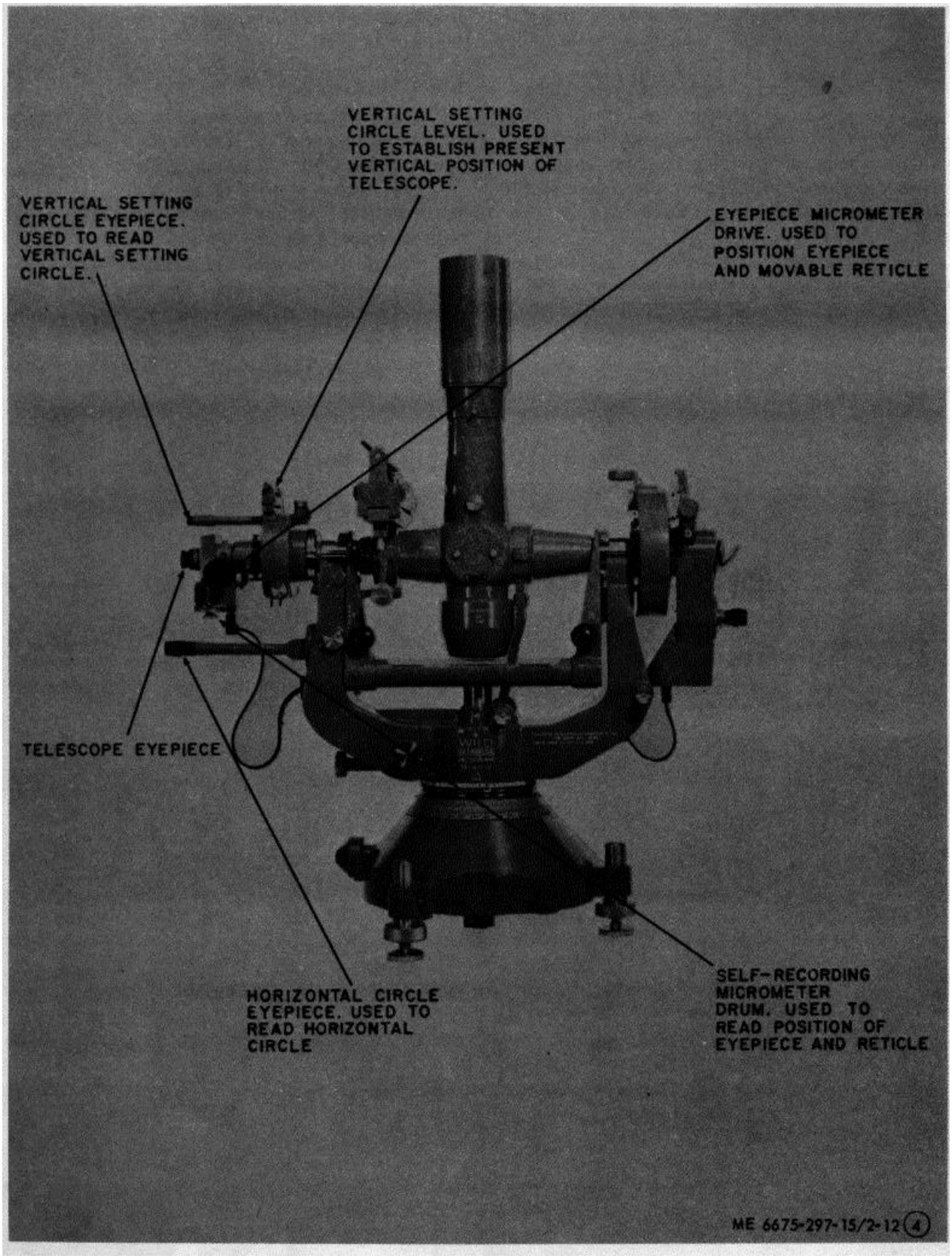


Figure 2-12.--Continued.

the bubble deflection after reversal of the suspension level is not more than three scale intervals.

(7) Return suspension level to normal position.

d. Suspension Level Adjustment. The center point of the suspension level bubble should be within three scale intervals of the center of the scale, when the theodolite is leveled. If not, proceed as follows:

NOTE

To determine center point of bubble, add scale readings of both ends of bubble and divide by 2.

(1) With horizontal axis alined as described in paragraph *c*, above, note position of center point of bubble.

(2) Rotate alidade 180 degrees and again note position of center point of bubble.

(3) Refer to figure 2-13 and adjust suspension level vial in small increments so as to move center of bubble toward center of scale.

(4) Repeat steps (1) through (3), above, until center of bubble is within three scale intervals of center of scale.

e. Reticle Adjustment. If parallax is observed between the reticle crosslines and the image of an infinitely distant object (a star), the reticle is

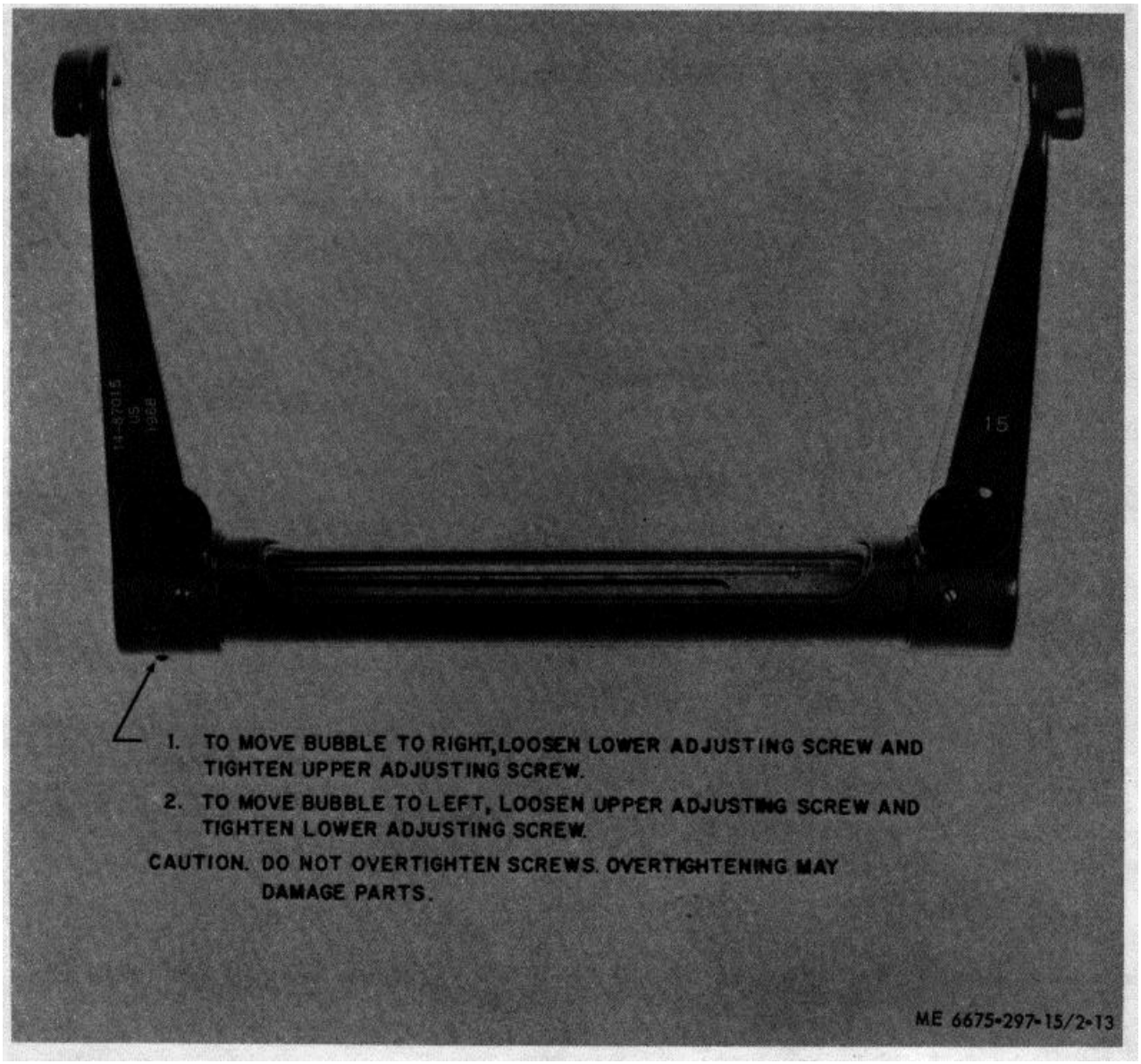


Figure 2-13. Adjusting suspension level vial.

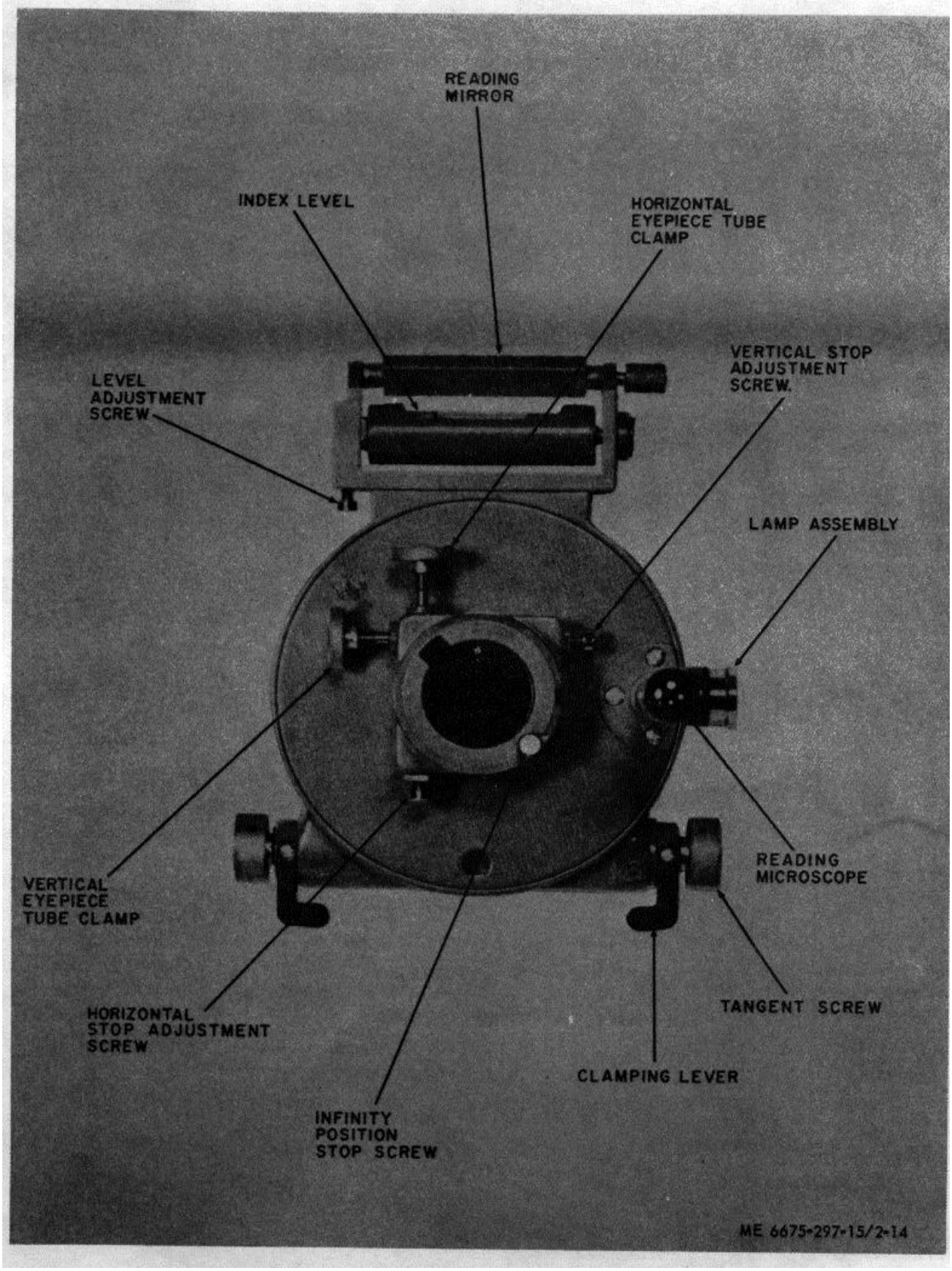


Figure 2-14. Eyepiece end of telescope, eyepiece removed.

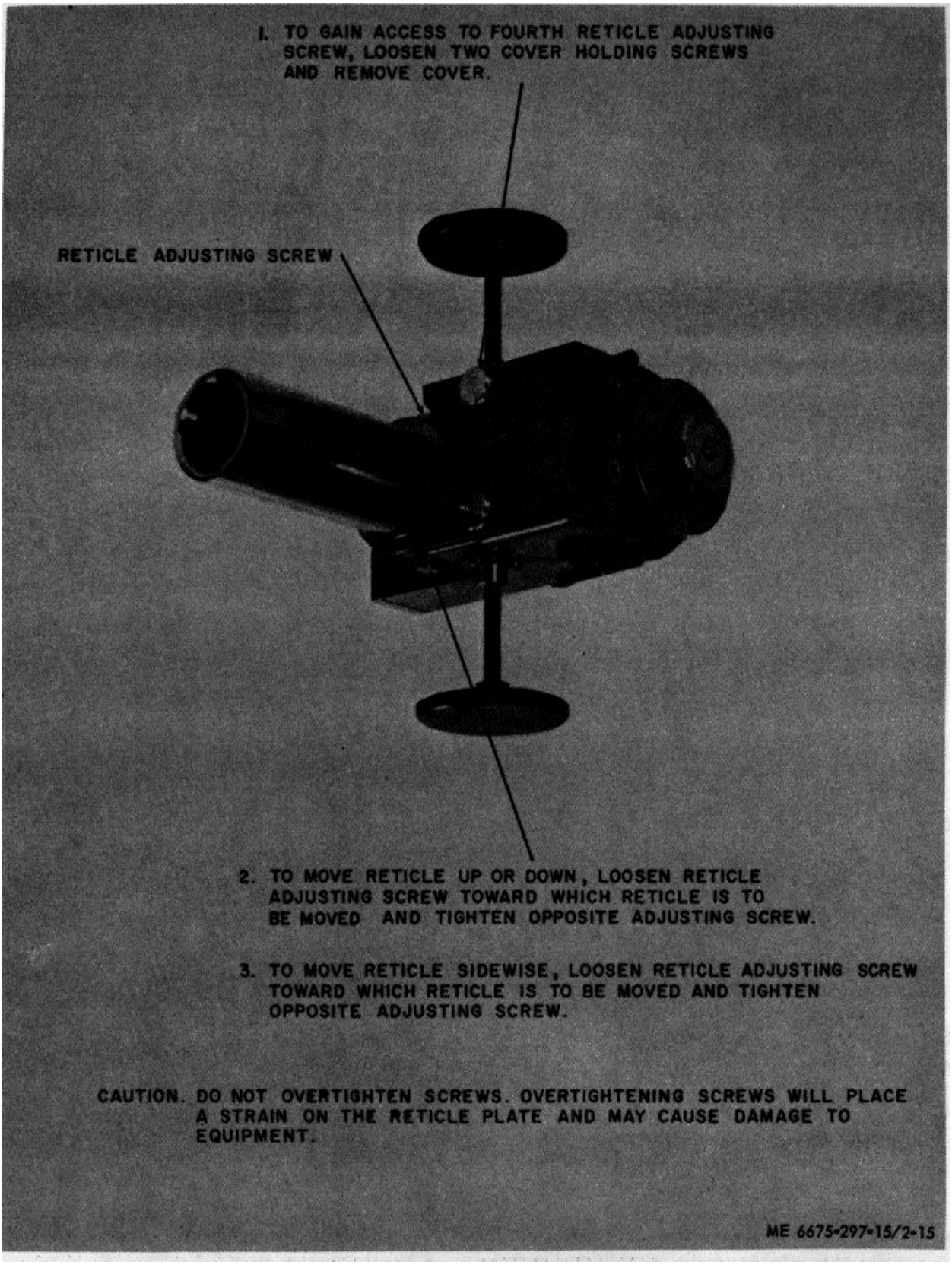


Figure 2-15. Adjusting reticle position.

not in the focal plane of the II telescope objective. To correct this condition, proceed as follows:

(1) Focus telescope eyepiece on reticle cross-lines (para 2-13).

(2) Observe a star or other very distant object and center it on crosslines with eye at approximate center of eyepiece and eyepiece pressed into contact with infinite position stop screw (fig. 2-14).

(3) Move eye to right and note movement of image with respect to vertical crosslines.

(4) If in step (3), above, image moves to right, turn infinity position stop screw in slightly using an adjusting pin. If image moves to left, turn stop screw out slightly.

(5) Repeat step (2) through this step until no parallax is observed as eye is moved from center of eyepiece to one side.

f. Reticle Crossline Centering. To center the reticle crossline in the field of view, proceed as follows:

(1) Level the theodolite and focus eyepiece on reticle crosslines (para 2-13).

(2) Aline center of crosslines on a sharply defined target.

(3) Loosen horizontal and vertical eyepiece clamps (fig. 2-14).

(4) Rotate eyepiece 90 degrees, observing relation of target to center of crosslines. If center of crosslines moves from target, note direction of movement.

(5) Remove eyepiece from telescope.

(6) Refer to figure 2-15 and adjust position of reticle in a direction opposite to movement observed in step (4), above.

(7) Install eyepiece in telescope and repeat steps (2) through this step until center of crosslines does not move off target during performance of step (4).

g. 90-Degree Stop Adjustment. The 90-degree stops provide for alinement of the limiting positions of the eyepiece so that the reticle crosslines will be horizontal and vertical at these positions.

To adjust the 90-degree stops, proceed as follows:

(1) Level the theodolite and focus eyepiece on reticle crosslines (para 2-13).

(2) With eyepiece in the counterclockwise position, sight the theodolite on a well defined target at instrument level.

(3) Turn theodolite back and forth about the vertical axis. Target should move along horizontal crossline.

(4) If target deviates from horizontal crossline, loosen locknut on horizontal stop adjusting screw (fig. 2-14), using forked spanner provided in accessory box. Using horizontal stop adjusting screw and horizontal clamp screw, adjust position of eyepiece until end of crossline bisects target. To rotate eyepiece, turn one screw outward and follow up by turning opposite screw in.

CAUTION

Do not overtlghten screws.

(5) Repeat steps (3) and (4), above, until target moves along crossline when performing step (3), above.

(6) Tighten locknut loosened in step (4). Then repeat step (3) to be certain that adjustment has not altered.

(7) Loosen horizontal clamp screw and rotate eyepiece to the clockwise position. Secure by tightening 90-degree'clamp screw (fig. 2-14).

(8) Repeat the procedures of steps (3) through (6), above, to adjust position of eyepiece, except use 90-degree stop adjusting screw and 90degree clamp screw instead of their horizontal counterparts.

h. Horizontal Collimation Adjustment. When sighting a well defined target with the telescope first in the normal position and then in the reverse position, the difference in readings of the horizontal circle should be within 3 seconds of 180 degrees. If not, proceed as follows:

(1) Level the theodolite and focus eyepiece on reticle crosslines (para 2-13).

(2) With mirror cover (fig. 1-3) beneath horizontal axis, aline center of crosslines on a distant, well defined target at instrument level.

(3) Read horizontal circle.

(4) Reverse telescope and aline center of crosslines on the same target.

(5) Read horizontal circle.

(6) Subtract reading obtained in step (3) from reading obtained in step (5), above. Difference should be between 179° 59 minutes 57 seconds and 180° 0 minutes 3 seconds. If difference is not within the limits specified, proceed with the following steps.

Note. Customary methods of observation eliminate small collimation errors from the results. It Is not necessary to reduce the collimation error to zero. However, the error should not exceed 3 seconds.

(7) Remove two screws securing mirror cover and remove mirror cover.

(8) Using horizontal slow motion screw (fig. 2-12), turn telescope off target by an angle equal to one half the difference obtained in step (6),

above, turning telescope in that direction which approaches a horizontal circle reading equal to 180° plus the reading obtained in step (3), above.

(9) If difference obtained in step (6), above, is greater than 180°, rotate telescope mirror clockwise by loosening screw S1 (fig. 2-16) and tightening screw S2. Rotate mirror ill small increments until target is again alined with center of crosslines.

CAUTION

Do not overtighten adjusting screws.

(10) If difference obtained in step (6), above, is less than 180°, rotate telescope mirror as described in step (9), above, except loosen screw S2 and tighten screw S1. This rotates the mirror counterclockwise.

(11) Repeat, the procedures of steps (2) through this step until the difference obtained in step (6), above, is within the limits specified.

Note. If a second theodolite is available, it can be used as a target for performing the above procedures. With the two theodolites pointed precisely at each other and the crosslines on the second illuminated, the crosslines are equivalent to a target at infinity.

i. Contact Drum Adjustment. With movable crossline (fig. 2-17) centered between double vertical crossline, the zero mark of the measuring drum (fig. 2-18) should be tat the index mark and the reference contact of the contact drum should be centered oil the current pick-off. If either of these conditionals do not exist, reset the contact drum and the measuring drum as follows:

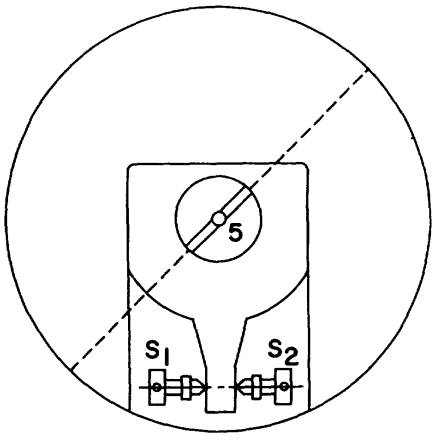


Figure 2-16. Telescope mirror adjustment.

NOTE

To observe position of reference contact, lift contact drum protective cover. Reference contact is centered between two short insulating segments.

(1) Draw eyepiece tube from telescope, closing openings in horizontal axis and eyepiece tube with dustproof plugs or thin, dustproof, nonshredding, tissue paper.

(2) Remove round nut (fig. 2-18) from micrometer shaft, using pin spanner provided in accessory box.

(3) Open protective cover and center movable crossline between double vertical crossline 10 by turning either micrometer knob.

(4) Holding micrometer knob from turning, turn contact drum by hand until the reference contact is centered under the current pick-off.

(5) Set zero mark of measuring drum at index mark and secure with round nut removed in step) (2), above. Check to be certain that movable crossline, reference contact, and zero mark are still correctly positioned.

(6) (Close protective cover and remove dustproof plugs from openings in horizontal axis and eyepiece tube.

(7) Install eyepiece tube ill horizontal axis.

j. Vertical Circle Level Adjustment. When readings of the vertical circle are taken with the telescope sighted on a fixed target with the alidade in both the normal and reversed positions, the readings should differ by 180° $\pm$3 seconds. If the difference in readings is greater than 3 seconds, adjust vertical circle level as follows:

(1) Aline telescope on a fixed target.

(2) Using level fine adjustment screw (fig. 2-12), position collimation so as to center bubble of vertical circle level.

(3) Read vertical circle.

(4) Reverse position of alidade and repeat steps (1) through (3), above.

(5) If A is the smaller of the two readings obtained in steps (3) and (4), above, and B is the larger, the true vertical angle V is given by the formula

$$V = \frac{A + (360 - B)}{2}$$

Calculate the true vertical angle by means of this formula.

(6) With the telescope pointed at the target,

adjust position of collimation housing by means of level fine adjustment screw until vertical circle reads the true vertical angle.

(7) Using level fine adjustment screw (fig. 1-2), adjust position of level until bubble is centered.

k. Vertical Setting ('circle Level Adjustment.

When readings are taken of the vertical setting circle with the telescope sighted on a fixed target with the alidade in both the normal and reversed positions, the readings should differ by 180° ±3 seconds. If the difference is greater than 3 seconds, adjust vertical setting circle level as follows:

(1) Aline telescope on a fixed target.

(2) Using the tangent screw (fig. 2-12), position housing of vertical setting circle so that level bubble is centered.

(3) Read zenith angle on vertical setting circle.

(4) Reverse alidade and repeat steps (1) through (3), above.

(5) If A is the smaller of the two readings obtained in steps (3) and (4), above, and B is the larger, the correct, zenith angle Z is given by the formula

$$Z = \frac{A + (360 - B)}{2}$$

Calculate the correct zenith angle by means of this formula.

(6) With the telescope pointed at the target, adjust the vertical setting circle to read the correct zenith angle by means of tangent screw (fig. 2-12).

(7) Using level adjusting screw (fig. 1-4), adjust position of level until bubble is centered.

2-13. Theodolite Operation

a. Preliminary operation.

(1) Set up the theodolite over the station point (para. 2-4).

(2) If vertical and horizontal circles are to be illuminated by daylight, install mirrors (para. 2-4).

(3) Perform operator's daily maintenance (para. 3-7).

b. Theodolite Leveling. After preliminary leveling by means of the circular level, proceed as follows:

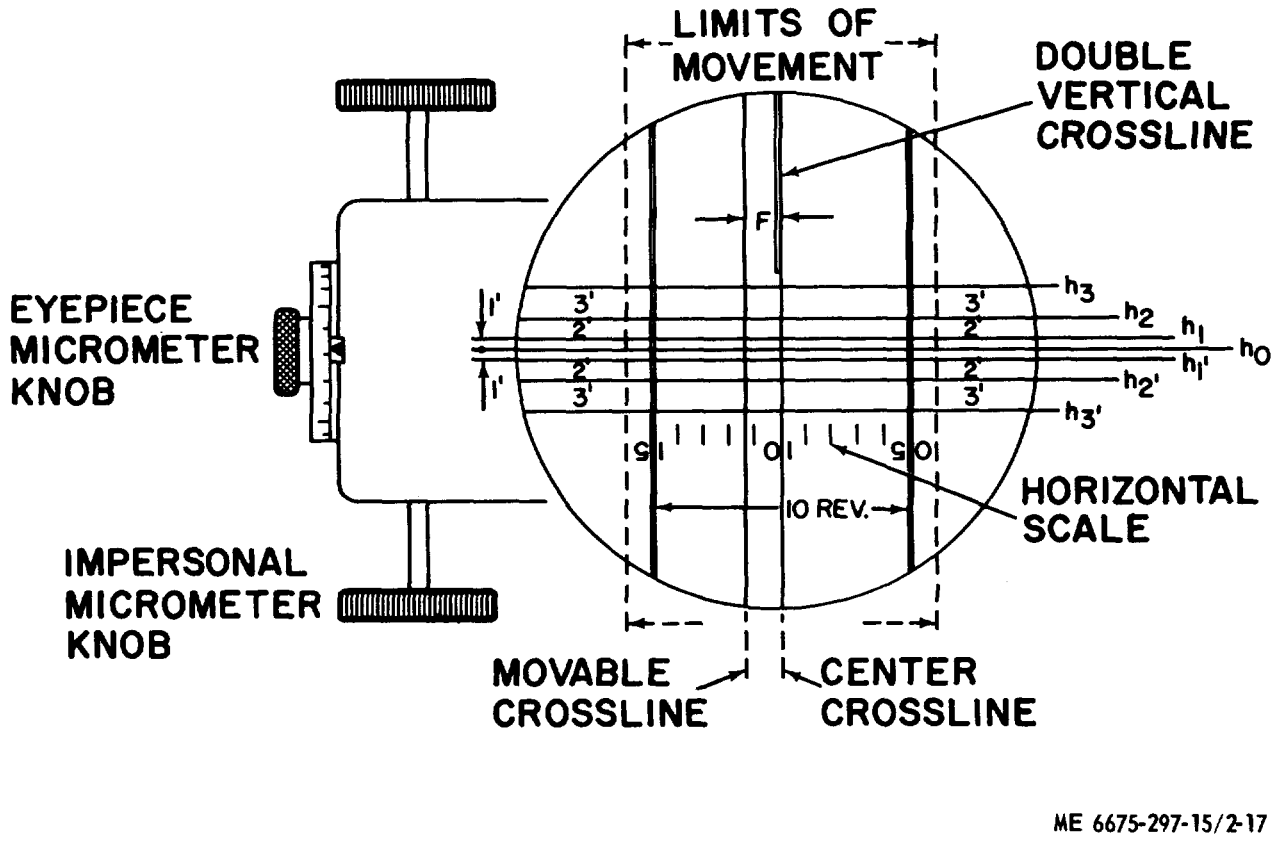


Figure 2-17. Crossline pattern of fixed and movable reticles.

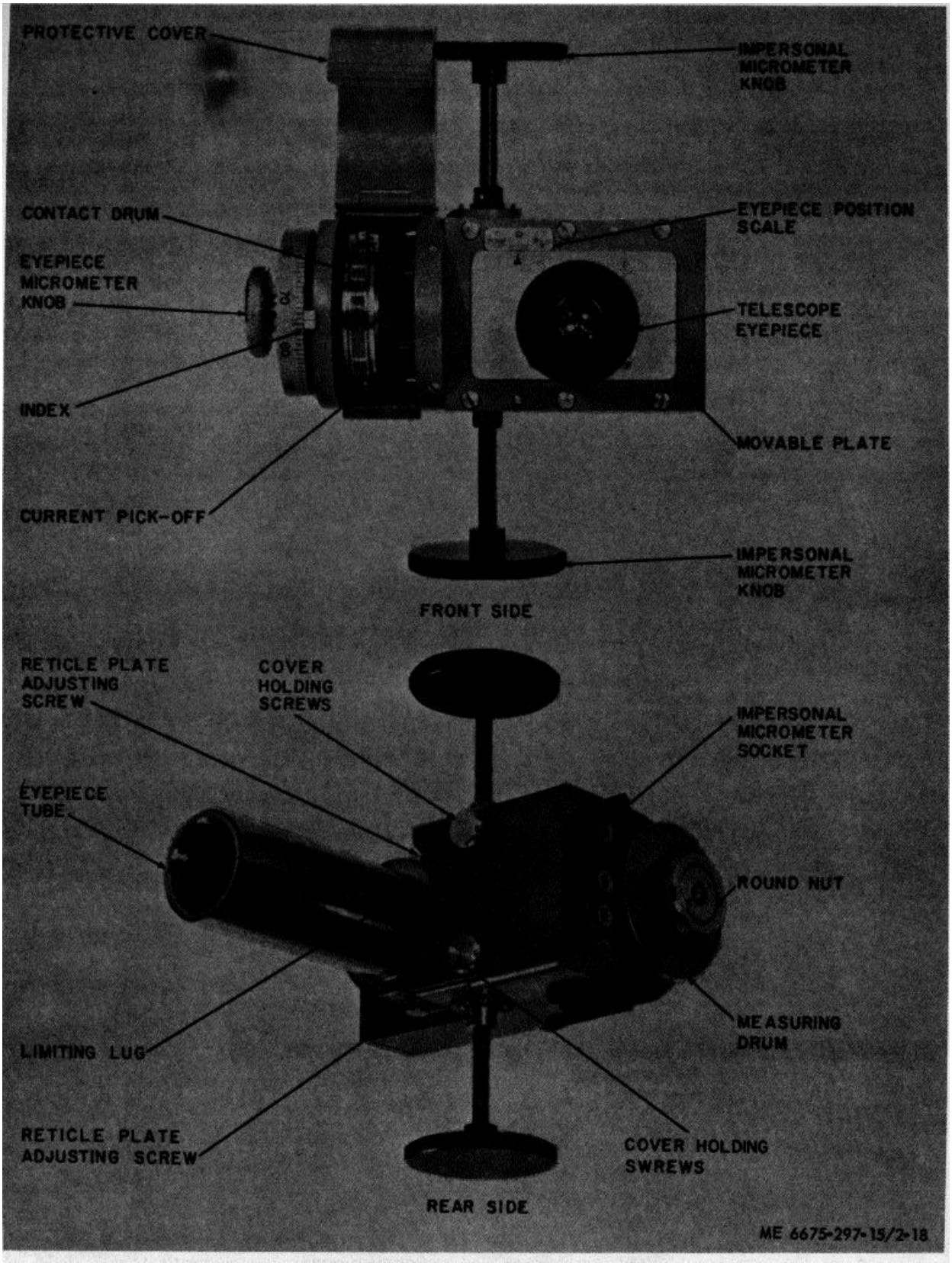


Figure 2-18. Eyepiece tube.

(1) With horizontal axis parallel to a straight line between two footscrews F1 and F2 (fig. 2-19.), adjust these two footscrews until suspension level bubble is approximately centered.

(2) Read positions of ends of bubble L1 and R1 and compute position of bubble center B1 from the formula B1 = (L1 + R1)/2.

(3) Rotate the alidade through 180 degrees (fig. 2-20) and read positions of ends of bubble 1,2 and R2. Then compute new position of bubble center 132 from the formula B2 = (L2 + R2)/2.

(4) Substitute the values of B1 and 132 in the formula M1 = (B1 + B2)/2 to obtain correct position of bubble center.

(5) Adjust footscrews F1 and F2 until position of bubble center B2 is equal to M1 when calculated ill a(ccorda1ce with the formula given in step (3), above.

(6) Rotate alidade through 90 degrees to position suspension level over footscrew F3 as shown in figure 2-21.

(7) Adjust footscrew F3 until suspension level bubble is approximately centered.

(8) Repeat steps (2) through (4), above, to determine correct position of bubble center.

Note. If bubble center positions obtained in steps (4) and (8), above, deviate from the center of the suspension level scale by more than two scale intervals, suspension level requires adjustment (para 2-12).

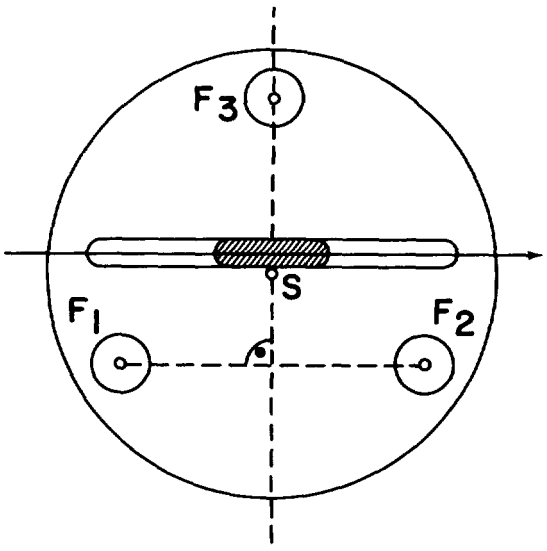


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Figure 2-19. Suspension level parallel to footscrews F1 and F2, bubble approximately centered.

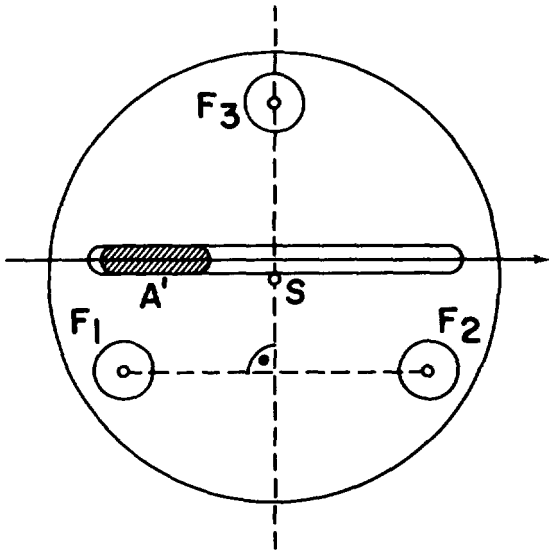

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Figure 2-20. Alidade rotated 180 degrees.

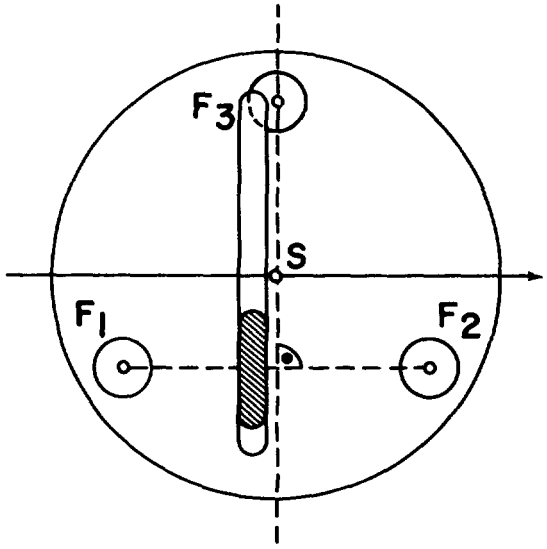

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Figure 2-21. Alidade rotated 90 degrees.

(9) Adjust footscrew F3 until position of bubble center is equal to value obtained for M1 in step (8), above.

(10) Rotate alidade about vertical axis and note that bubble remains stationary with respect to level graduations.

NOTE

Accuracy in leveling the theodolite is of the utmost importance since it greatly facilitates the computations of results.

c. Telescope Focusing. To focus the telescope, proceed as follows.

(1) Refer to figure 2-22 and focus telescope eyepiece sharply on reticle crosslines.

Note. Observe setting on indexed ring of eyepiece. This setting will remain constant for each observer but varies from one observer to another.

(2) If target is distant, focus telescope by loosening horizontal or vertical eyepiece tube clamp (fig. 2-14) and pressing eyepiece tube in against infinity adjusting screw. Secure by tightening clamp screw.

(3) If target is not distant, focus telescope b)y loosening horizontal or vertical clamp screw and drawing eyepiece tube out until target app)ears sharp. Secure by tightening clamp screw.

d. Alining Theodolite on a Fixed Object.

(1) Turn impersonal micrometer knob (fig. 2-18) to center movable crossline between vertical crossline 10 of fixed reticle.

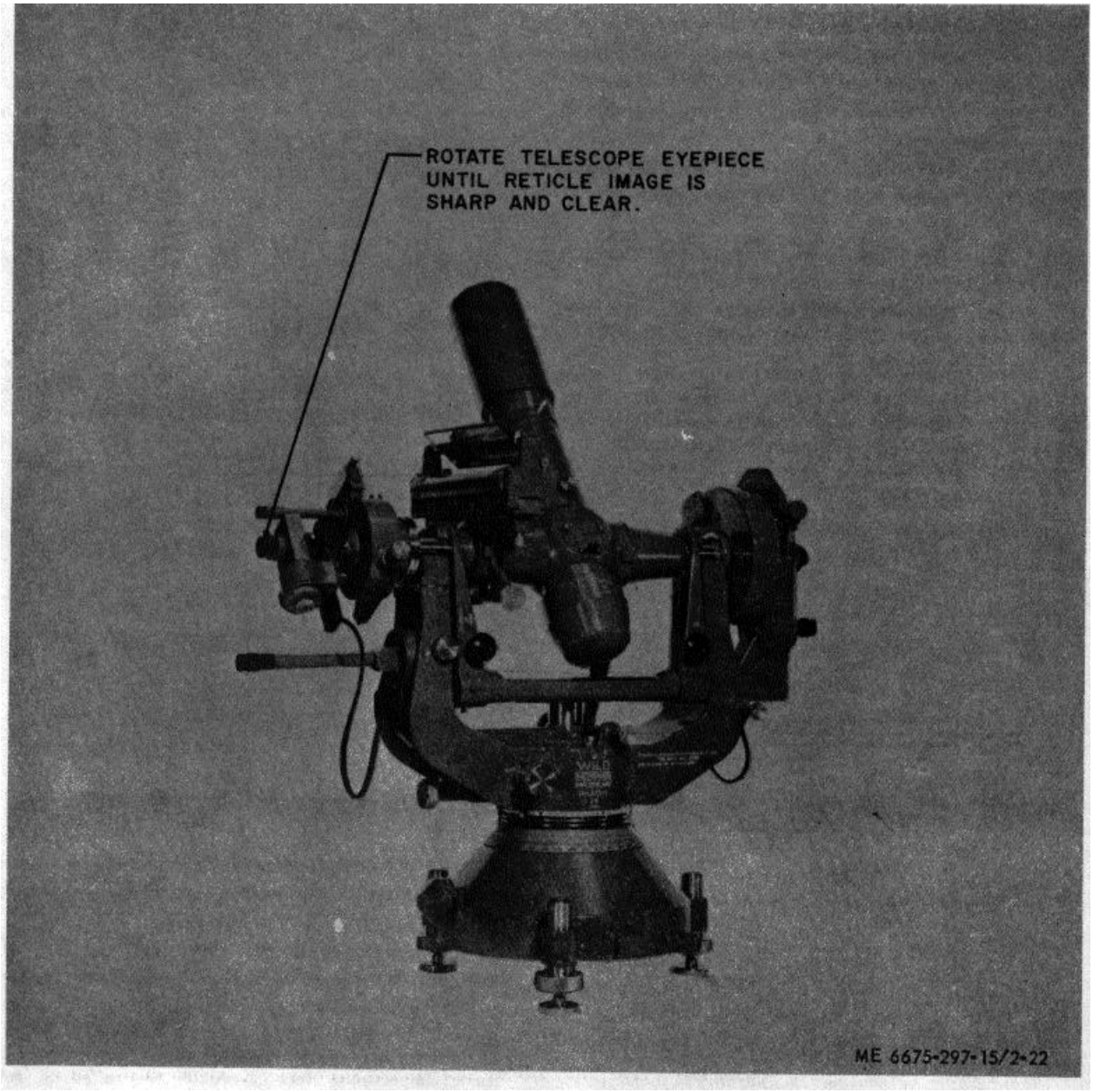

Figure 2-22. Focusing telescope eyepiece.

(2) With telescope pointing approximately on target, aline center crosslines of fixed reticle accurately on target, using horizontal and vertical slow motion screws (fig. 2-12) for final positioning.

(3) Read horizontal and vertical circles (para. *e* and *f*, below).

(4) Rotate the theodolite about the vertical axis approximately 180 degrees.

(5) Transit telescope to opposite side of vertical and repeat steps (2) and (3), above.

(6) For each position of the telescope, record the following data: reading of horizontal circle, reading of vertical circle, and readings of suspension level bubble ends.

e. Reading the Horizontal Circle. To read the horizontal circle, raise the articulated tube of the horizontal circle eyepiece (fig. 2-12) to a horizontal position. With horizontal circle lamp switch in the up (ON) position, the scales will appear as shown in figure 2-23. Two windows appear in the field of view. In the upper window, images of the graduations from diametrically opposite points of the horizontal circle appear opposite each other with the lower image inverted. A vertical line centered in the lower half of the window serves as an index mark. The horizontal circle is graduated in 2 minute intervals. Each degree mark is identified by number and the 20 minute and 40 minute graduations are also identified by number. To read the horizontal circle, proceed as follows:

(1) Turn milled focusing ring on horizontal circle eyepiece until images of scale are black and sharp.

(2) Turn horizontal circle micrometer drive (fig. 2-12) until opposing graduations of upper and lower images coincide.

Note. Turning horizontal circle micrometer drive does not move horizontal circle. By means of prisms the lower image is offset in such a manner as to accurately measure the seconds and tenths of a second which must be added to the base reading to obtain maximum accuracy.

(3) Obtain the base reading as follows. Starting with the upright numbered degree mark at the left of the index mark, count the ten-minute intervals to the left of the index mark. In figure 2-23 this gives 146° 20 minutes. From this ten-minute mark, count 2 minute graduations to corresponding ten-minute mark at right of index mark on lower image of scale. Each 2 minute interval counted now represents 1 minute since we are counting the intervals on both sides of the index mark. In the example, 7 minutes must be added to 146° 20 minute to obtain a base reading of 146° 27 minutes.

(4) On the circular scale in the lower part of the field of view, read seconds and tenths of a second at the index mark, centered within the window. On this scale, each whole second is numbered and each one-second interval is divided into tenths. In figure 2-23 the reading is 19.2 seconds.

(5) Add the value obtained in step (4), above, to the value obtained in step (3). In the example this gives a complete reading of 146° 27 minutes 29.2 seconds.

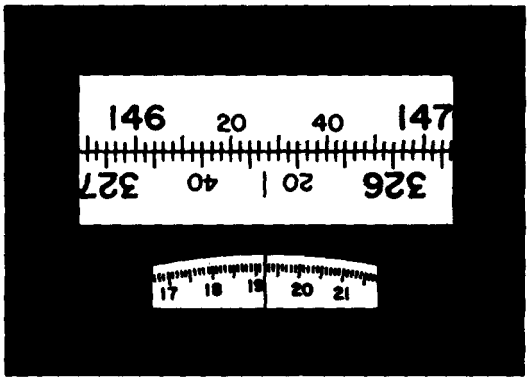

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Figure 2-23. Horizontal circle micrometer, field of view.

f. Reading the Vertical Circle. With vertical circle lamp switch (fig. 2-12) in the up (ON) position, the scale will appear as shown in figure 2-24. Two windows appear in the field of view of the vertical circle micrometer. In the lower window, images of the graduations from diametrically opposite points of the vertical circle appear opposite each other with the upper image inverted. A vertical line, centered in the upper part of the window, serves as an index mark. The vertical circle is graduated in 4 minute intervals. Each degree mark is identified by number and the 20 minute and 40 minute graduations are identified by longer graduation marks. To read the vertical circle, proceed as follows:

NOTE

It is necessary to establish a correction factor for converting bubble deflection of the vertical circle level to seconds of arc. Establish this factor as described in paragraph *g*, below.

(1) Turn level fine adjustment screw (fig. 2-12) to bring ends of bubble of vertical circle level to approximate coincidence. If coincidence does not occur with bubble ends between graduations 6 and 9 on the scale, loosen two milled screws securing level to mount and remove level. Then, adjust length of bubble so that coincidence occurs with bubble ends between graduations 6 and 9 on the scale. To lengthen level bubble, hold level with numbered side raised. To shorten level bubble, hold level with numbered side lowered and shake lightly.

(2) Turn milled focusing ring on vertical circle eyepiece (fig. 2-12) until in-ages of scale are black and sharp.

(3) Turn vertical circle micrometer drive (fig. 2-12) so that graduations of lower image coincide with the opposing graduations of the upper image.

NOTE

Turning vertical circle micrometer drive does not move vertical circle. It offsets the lower image in a manner similar to the horizontal circle micrometer drive (para *c*, above).

(4) Obtain the base reading as follows. Starting with the upright numbered degree line at the left of the index mark, count the 20 minute intervals at the left of the index mark. In figure 2-24 this gives 88° 20 minutes. From this 20 minute mark, count 4 minute graduations to corresponding 20 minute mark on upper image. Each 4 minute mark counted now represents 2 minutes. In the example there are 8 marks, there 16 minutes (8 X 2 minute) must be added to 88° 20 minutes to obtain the base reading of 88° 36 minutes.

(5) On the circular scale in the upper part of the field of view, read remaining minute (either 0 or 1), seconds, and tenths of a second at the index mark centered ill the window. Each even numbered second on this scale is numbered with the remaining minute indicated by the number 0 or 1 above it. Each second interval is divided into 0.2 second intervals. In figure 2-24 the reading is 1 minute 26.9 seconds.

(6) To obtain the complete reading, add the value obtained in step (5), above, to the value obtained in step (4). In the example, the complete reading is 88° 37 minutes 26.9 seconds.

(7) The complete reading obtained in step (6), above, must be corrected for level bubble deflection by adding or subtracting the corresponding value in seconds. If the level bubble deflection is as shown in figure 2-25 and the correction factor is 2.06 seconds per scale interval, the corresponding correction is obtained as follows. Scale reading of left end of bubble minus scale reading of right end of bubble equals bubble deflection. Bubble deflection times correction factor equals correction. Using the scale readings as shown in figure 2-25, we obtain a bubble deflection of 6.6-8.2 or -1.6. Using a correction factor of 2.06 the correction is -1.6 X 2.06 seconds or -3.3 seconds. This gives us a corrected reading of 88° 37 minutes 23.6 seconds.

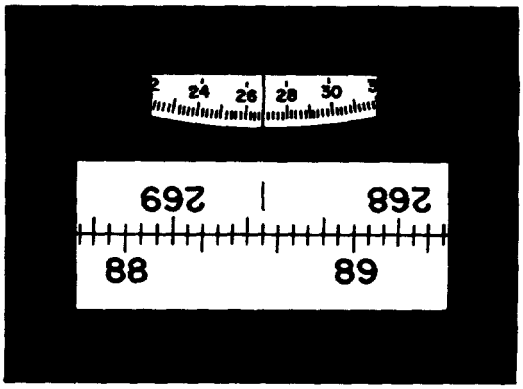

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Figure 2-24. Vertical circle micrometer, field of view.

g. Determination of Bubble Deflection Factor.

(1) Using level fine adjusting screw (fig. 2-12) bring left end of bubble of vertical circle level to a position between the first and second scale intervals.

(2) Read positions of left and right ends of bubble and record these values in a chart similar to that shown in figure 2-26, using columns 3 and 4, respectively.

(3) Read vertical circle as described in steps (3) through (6) of paragraph *f*, above. Record this reading in column 1.

(4) Repeat steps (1) through (3), above, moving left end of bubble approximately two scale intervals each time until a total of six sets of readings have been obtained.

(5) Repeat steps (1) through (4), above, starting with left end of bubble between scale intervals 13 and 14 and reversing the direction of tilt.

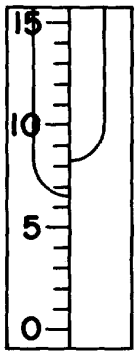

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Figure 2-25. Vertical circle level bubble ends and scale.

(6) Perform the calculations called for by the legend of figure 2-26 to determine the correction factor.

h. Positioning Horizontal Circle. The horizontal circle can be positioned to any desired initial reading by means of the horizontal circle drive (fig. 2-12). This permits taking readings of azimuth angles in sets, covering the complete range of circle graduations. The horizontal circle drive is protected by a hinged cover (fig. 1-1) to prevent accidental rotation of the horizontal circle while a set of observations is in progress. The cover Should be kept closed at all times except during circle rotation.

i. Positioning Vertical Circle. The vertical circle can be positioned to any desired initial reading in the same manner as the horizontal circle. The vertical circle drive (fig. 2-12) is also protected by at hinged cover (fig. 1-1) which should be kept closed at all times except when changing the setting.

j. Approximate Orientation of Telescope. The horizontal and vertical setting circles (fig. 1-1)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
β''	$\Delta\beta''$	1	r	d_1	Δd_1	p″/2	β''	$\Delta\beta''$	1	r	d_1	Δd_1	p″/2	pm″/2	Δ''
22,5		1.7	14,5	−12,8			21,1		2,2	14,2	−12,0				
	−3,7				+3,2	1,16		+2,6				−2,6	1,00	1,08	+0,05
18,8		3.3	12,9	− 9,6			18,5		3,5	12,9	− 9,4				
	−4,3				+3,6	1,19		+3,7				−3,5	1,06	1,12	+0,09
14,5		5.1	11,1	− 6,0			14,8		5,2	11,1	− 5,9				
	−3,3				+3,3	1,00		+4,8				−4,8	1,00	1,00	−0,03
11,2		6.8	9,5	− 2,7			10,0		7,7	8,8	− 1,1				
	−5,2				+4,5	1,15		+4,1				−4,4	0,93	1,04	+0,01
6,0		9.0	7,2	+ 1,8			5,9		9,8	6,5	+ 3,3				
	−3,7				+4,4	0,84		+3,2				−3,6	0,89	0,86	−0,17
2,3		11.2	5,0	+ 6,2			2,7		11,7	4,8	+ 6,9				
	−3,9				+3,5	1,11		+4,5				−4.1	1,10	1,10	+0,07
58,4		13.0	3,3	+ 9,7			58,2		13,7	2,7	+11,0				

from column 15: mean value p/2=1.03″, Correction Factor p=2.06″

Legend

Column	Description
1	Vertical circle reading β''
2	Change of inclination $\Delta\beta''$
3	Index level bubble reading left end
4	Index level bubble reading right end
5	Columns 3-4=d_i
6	$d_i+1 - d_i = \Delta d$
7	$\Delta\beta''/\Delta d$ (column 2/column 6) = ½ "Pars" value (absolute)
8-14	as for columns 1 to 7, but in reverse, i.e. readings, etc., made from bottom to top
15	Mean value of columns 7 and 14 (pm)
16	Column minus mean value of column 15

Figure 2-26. Calculation of correction factor for level bubble deflection.

provide for rapid orientation of the telescope at approximately the desired position. When observing stars, for instance, the telescope may be preoriented to pick up the specific star to be observed. This is accomplished by calculating the horizontal and vertical angles of the stars position at the time of observation. These angles are then set on the horizontal and vertical setting circles and the telescope oriented by means of the vertical setting circle level (fig. 2-12).

(1) *Pre-Orientation in Azimuth.* The horizontal setting circle is a graduated ring at the top of the cone-shaped base. It can be rotated by hand to any desired position. An index pointer (fig. 2-12) on the alidade indicates the alidade's position with respect to the horizontal circle. The circle is graduated iii tenths of a degree with each degree mark numbered. For astronomical work it is particularly useful if the horizontal setting circle is positioned so that a reading of zero is obtained when the telescope is alined on the meridian. When the telescope must be brought from the direct to the reverse position, it is advantageous to set the horizontal setting circle to zero at the direct position. Since the horizontal setting circle lamp (fig. 1-1) is automatically turned off at the 0° and 180° positions, this facilitates locating the direct and reverse positions of the alidade.

(2) *Pre-Orientation in Elevation.* The vertical setting circle comprises a graduated glass scale mounted in a housing which is free to turn about the horizontal axis. An index level (fig. 2-14) mounted on the housing establishes the reference for positioning the telescope. The vertical setting circle is read by means of a microscope (fig. 1-1) mounted above the telescope eyepiece. The vertical setting circle housing may be positioned by means of a tangent screw (fig. 2-12) having a knurled knob at each end. The tangent screw may be disengaged to permit rotating the housing by hand. When engaged it locks the housing is the preset position but permits refinement of the setting by turning the screw. The scale is graduated in degrees with each degree mark numbered. The 0° mark is toward the zenith and the numbering increases clockwise as seen through the microscope eyepiece. Vernier index lines spaced at ten minute intervals (fig. 2-27) provide for reading the setting circle to 1 minute by estimation. That portion of the scale seen in the field of view is normally illuminated electrically. Removing the lamp housing allows daylight to illuminate the scale.

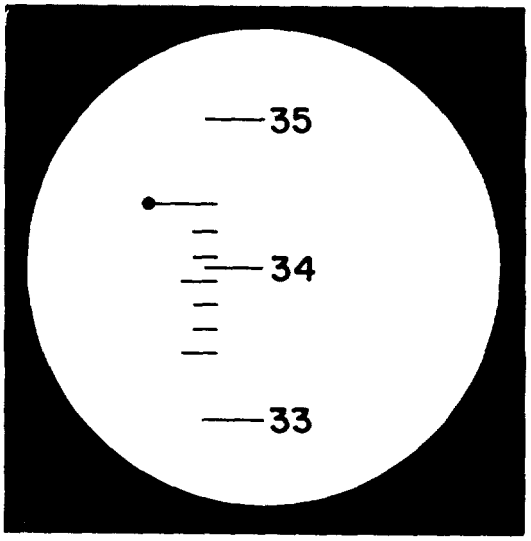

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Figure 2-27. Vertical Setting Circle Vernier Scale.

k. Use of Meteorological Instruments. In order to compute the refractive index of the atmosphere it is necessary to know the atmospheric pressure, temperature, and humidity. This data is also necessary for the determination of barometric altitude. The Thommen aneroid barometer (fig. 2-28) may be used for determining atmospheric pressure. The inner scale of the barometer is graduated in 100 millibar intervals for the range between 500 and 1100 millibars. The outer scale is graduated in 1 millibar intervals for the range between zero and 100 millibars. Temperature and humidity determinations should be made with a whirling psychrometer.

2-14. Use of Eccentric Instrument Stations.

a. When the instrument cannot be set up for observations over the center of the station, observations must be made from an eccentric station. In such cases, the observed latitude Q_e and longitude L_e of the eccentric station must be reduced to tile latitude Q_s and longitude L_s, of the geodetic station.

b. To reduce the observed latitude and longitude of the eccentric station to corresponding data for the geodetic station, proceed as follows:

(1) Using a good compass, determine the meridian through the eccentric station.

(2) Using a tape, measure the distances d, dg, and de as shown in figure 2-29.

Figure 2-28. Thommen aneroid barometer.

(3) Calculate the latitude of the geodetic station from the formula:

$Q_s = Q_e + \Delta q \times Q''/R$ where:

Q_s = latitude of geodetic station
Q_e = latitude of eccentric station
Q" = 206,265 seconds of arc
R = radius of earth

(4) (Calculate the longitude of the geodetic station front the formula:

$L_s = L_e + \Delta 1 \times Q''/15 \cos Q'' \times R$ where:

L_s = longitude of geodetic station
L_e = longitude of eccentric station
Q" = 206,265 seconds of are
R = Radius of earth

position with the levels horizontal by means of a spring loaded detent.

b. The two Horrebow-Talcott levels are graduated identically. Every tenth graduation on the outer level is numbered from 10 to 70 starting at the right. The corresponding graduations on the inner level are numbered from 110 to 170. The outer level is not detachable from the frame but its inclination to the frame is adjustable by means of a tilting screw (fig. 2-30). The inner level is detachable and secures to the frame by means of two milled-head screws. The tilt of the frame with respect to the base plate is also adjustable by means of a tilting screw. A rotatable mirror facilitates reading level bubble positions. The sensitivity of the assembly is between 1 and 2 seconds

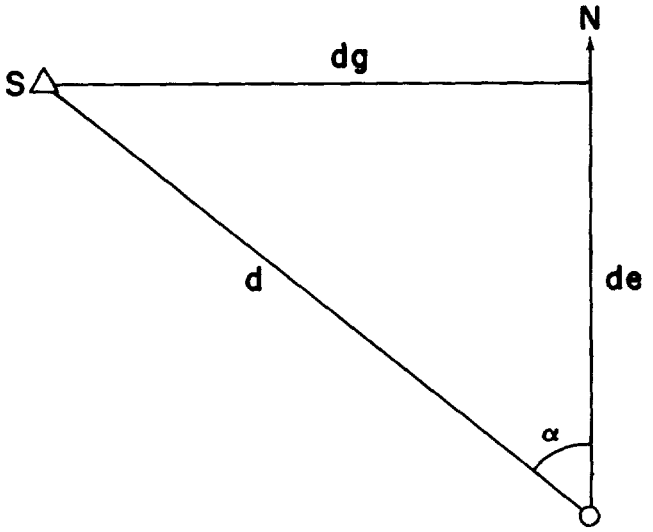

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Figure 2-29. Relationship of eccentric to geodetic station locations.

2-15. Use of Horrebow-Talcott Level Assembly.

a. Small changes in the elevation of the telescope can be measured with the Horrebow-Talcott level assembly (fig. 1-4). The assembly comprises two levels arranged parallel to each other in a frame which secures to a clamp (fig. 1-3) on the horizontal axis. The levels are mounted perpendicular to the horizontal axis and can be clamped at any angular relationship to the telescope. When the clamp is loosened, the level carrier may be rotated about the horizontal axis or held in fixed

of arc per 2 mm run.

c. Prior to use, the lengths of the two level bubbles must be adjusted to approximately 25 scale intervals and the levels alined parallel to each other. To adjust bubble length and aline the levels, proceed as follows:

(1) Clamp level carrier to horizontal axis by tightening clamping screw.

(2) loosen vertical clamp (fig. 2-12) and turn telescope to one side or the other until length of bubble in outer level is approximately 25 scale intervals.

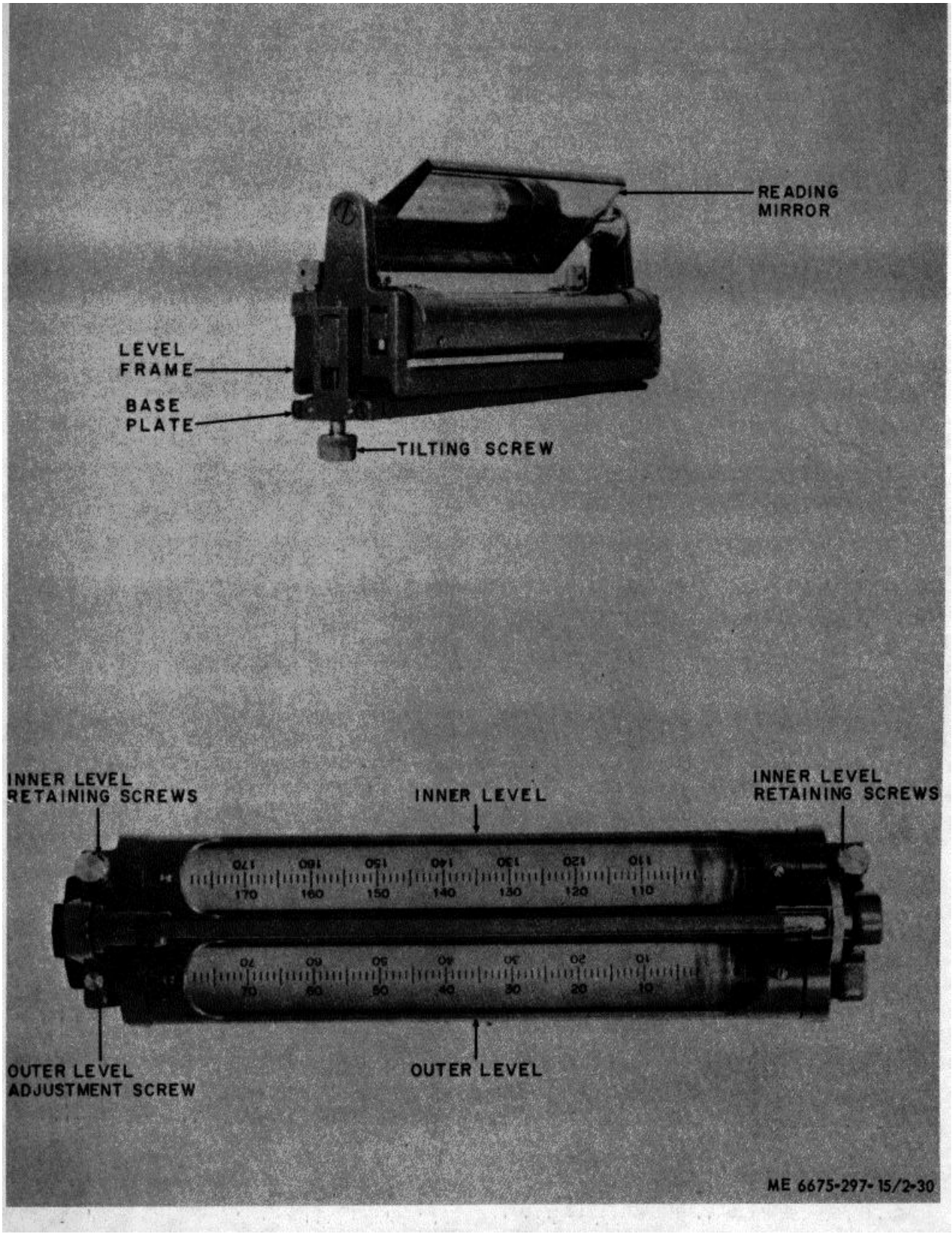


Figure 2-30. Horrebow-Talcott level assembly.

NOTE

Tilting level In one direction lengthens bubble. Tilting in the opposite direction shortens bubble.

(3) Remove inner level by removing two milled-head screws. Tilt level by hand until bubble length is approximately 25 scale intervals. Then, remount level on frame and secure with milled-head screws.

(4) With telescope tilted so that inner level is approximately level, adjust tilting screw (fig. 2-40) until bubble is accurately centered. Then, turn outer level adjustment screw until bubble in outer level is accurately centered.

d. Measuring Small Telescope Inclinations by Means of Horrebow-Talcott Level Assembly. To use the Horrebow-Talcott level assembly for measuring small angles in elevation, proceed as follows:

(1) With clamping screw of level carrier loosened and detent engaged, sight telescope on first target position.

(2) Tighten clamping screw.

Note. This action automatically disengages level carrier detent.

(3) Using tilting screw (fig. 2-30), center level bubbles. Record readings of both ends of each level bubble.

(4) With level carrier clamping screw tightened (step (2), above), sight telescope on second target position. Record readings of both ends of each level bubble.

(5) The average of the displacements of the centers of the two level bubbles between steps (3) and (4), above, when multiplied by the scale factor as determined by the procedure of step e, below, is equal to the angular displacement of the telescope sightings.

e. Determination of Horrebow-Talcott Level Assembly Scale Factor. To determine the scale factor for the Horrebow-Talcott level assembly, proceed as follows:

(1) With clamping screw of level carrier tightened, adjust inclination of telescope until right ends of level bubbles read approximately 15 and 115, respectively.

(2) Read and average the p1ositions of the left and right ends of the level bubbles and record the averages in columns 3 and 4, respectively, of a table similar to that shown in figure 2-26.

(3) Read vertical circle and record this reading in column 1.

(4) Repeat steps (1) through (3), above, moving right ends of bubbles approximately three scale intervals each time until left ends of bubbles reach positions 65 and 165, respectively.

(5) Repeat steps (1) through (4), above, starting with left ends of bubbles at positions 65 and 165, respectively, and reversing direction of tilt.

(6) Determine scale factor and standard deviation by performing the calculations called for by the legend of figure 2-26.

2-16. Use of Eyepiece Micrometer

a. The fixed reticle plate in the eyepiece has three vertical and seven horizontal crosslines (fig. 1-5). As shown in the figure, the horizontal crosslines are arranged symmetrically and spaced at specific intervals to facilitate star observations where the high order of accuracy obtainable with the eyepiece micrometer is not required. The center vertical crossline indicates the middle of the reticle. Two additional vertical crosslines and a horizontal scale function with a movable crossline controlled by the eyepiece micrometer to permit accurate measurement of a target with respect to the center vertical crossline.

b. The eyepiece micrometer consists of a movable reticle plate with a single, central, vertical crossline controlled by a micrometer screw to which a calibrated drum is secured. The drum is graduated in 100 equal intervals with every tenth interval numbered. One complete revolution of the drum is equivalent to shifting the position of the movable crossline through an interval of the horizontal scale on the fixed reticle. It corresponds to a change in direction of 150 seconds (2 minutes 30 seconds). The horizontal scale provides a measuring range of 12 drum revolutions, which corresponds to approximately 30 minutes of arc.

c. The eyepiece micrometer is controlled by a milled knob at the center of the measuring drum (fig. 2-18) or by either of two impersonal micrometer knobs. The impersonal micrometer knobs permit alternate movement with the left and right hand to facilitate following a star continuously with the movable line. The movable reticle is mounted on the telescope eyepiece which in turn is mounted on a rectangular movable plate. The micrometer screw moves this plate so that the movable crossline is always at the center of the field of view. As a result, the telescope image and fixed reticle appear to move rather than the movable crossline. The position of the eyepiece with respect to center is indicated on a position scale

mounted above the upper left corner of the movable plate.

d. The eyepiece tube can be rotated between two adjustable stops 90 degrees apart. This permits use of the movable crossline for measuring small angles ill elevation as well as in azimuth. The drive shaft between the impersonal micrometer knobs is oriented at right angles to the telescope tube for measuring angles in azimuth and parallel to the telescope tube for measuring angles in elevation.

e. To minimize personal error when following a star and particularly when making a determination of a stars transit time, an electrical contact drum is also mounted on the shaft of the micrometer screw. This contact drum and associated parts is termed the impersonal micrometer. The contact drum has 12 electrical contacts, 10 of which are of equal length. A narrower contact is positioned on each side of one of the 10 to identify it as the reference contact. The center of this reference contact is alined under the current pick-off when the zero mark of the calibrated measuring drum is alined with the index pointer. In following the transit of a star, the contact drum and current pick-off are connected to an electrical recording device together with an external device radio or chronometer for generating time signals. In this manner, the exact time of transit of a star through the central vertical crossline of the fixed retical can be determined.

f. To use the eyepiece micrometer for measuring small angles, it is necessary to know the angular equivalent of one revolution of the calibrated measuring drum. Perform this calibration as follows:

(1) Center movable crossline between double lines of fixed vertical crossline at 10 on horizontal scale.

(2) Check to be certain that zero on measuring drum is at index pointer. If not, readjust measuring drum (para. 2-12).

(3) Aline telescope on a sharply defined target at instrument level.

(4) Read horizontal circle. Record reading.

(5) Turn eyepiece micrometer knob exactly five turns. Movable crossline shall be centered between double lines at fixed crossline at either 05 or 15 on horizontal scale.

(6) Realine telescope on target.

(7) Read horizontal circle. Record reading.

(8) Center movable crossline between double lines of fixed vertical crossline at 10 on horizontal scale.

(9) Aline telescope on target.

(10) Read horizontal circle. Record reading.

(11) Repeat steps (5) through (10), above, moving movable crossline to opposite end of horizontal scale from that used in step (5).

(12) Determine differences in horizontal circle readings to obtain horizontal angles equivalent to each five rotations of eyepiece micrometer knob.

(13) Average four angles determined in step (12), above.

(14) Divide average angle obtained in step (13), above, by 5 to determine angular equivalent of one revolution of eyepiece micrometer knob.

g. To use impersonal micrometer for determining a star's transit, it is necessary to know the rate at which the movable line is moved in order to hold it centered on star. This rate can be determined from the recording by taking the time difference between the initial closing of the reference contact and the closing of the reference contact after four or more complete revolutions of the contact drum. The time difference between the closing and reopening of the reference contact and that between the closing of the reference contact and the closing or reopening of each of the other contacts may also be determined from the recording by averaging the time differences obtained during four or more complete cycles. When reducing data to the time of transit at the central vertical crossline, the declination D of the observed star must be taken into account. If F is the contact spacing from the center crossline, in seconds of time, and f is the required reduction value which must be applied to contact time, the f=F • sec D.

Note. Certain methods of determining time do not require a numerical reduction to the center crossline.

h. The impersonal micrometer may also be used for measuring small angles if the opening and closing of the contacts has been calibrated in terms of measuring drum readings. To perform this calibration, proceed as follows:

(1) (Connect an ohmmeter or bell test between the two outer poles of the impersonal micrometer socket (fig. 2-18) to determine when the contacts close or open.

NOTE

The current through the contacts should not exceed 50 milliamperes.

(2) Adjust movable crossline approximately half way between graduations 10 and 11 on horizontal scale.

(3) Turn micrometer drive so as to move movable crossline slowly toward graduation 10 and note reading of measuring drum when first (reference) contact closes.

(4) Continue turning micrometer drive in same direction as specified in step (3), above, and note the readings of the measuring drum as each contact opens and closes.

(5) Repeat steps (2) through (4), above, except start with movable crossline between graduations 9 and 10.

2-17. Time Recording

a. For astronomical field observations, time is determined by means of a chronometer pr from radio signals and may be in terms of sidereal time or mean time. For greatest accuracy a chronometer equipped with an electrical contact for recording seconds or a radio signal should be used in conjunction with the impersonal micrometer (para. 2-16) and the time signals and star positions should be recorded simultaneously on a chronograph.

b: The Chronometer and its Rate. Perfect regulation of a chronometer is not possible. The chronometer's rate of gain or loss must therefore be known. This is generally determined for a 24 hour period known as the "daily rate" by comparison with astronomical time determinations or suitable time signals available from certain radio stations. For greatest accuracy, such comparisons should be made with the aid of a chronograph. As a rule, the daily rate is not constant and should be redetermined at frequent intervals. In addition, a record of the accumulated errors should be maintained.

CAUTION

If the chronometer must be reset, the hands must be turned forwards, after releasing the hand locking device. Care must also be taken to aline the minute hand with the minute graduation when the second hand passes through the zero graduation.

c. The Radio Receiver. The radio receiver for receiving and recording time signals should have a frequency range covering most of the shortwave stations which broadcast time signals at frequent intervals. An approximate range from 4.9 to 22 megacycles (14 to 61 meters) is required. It should be battery operated and should be equipped with a sensitive relay activated by the time signals. Provision should be made for connecting the relay contacts to the chronograph. The relay contacts should be capable of handling a 500 milliampere load. A beat tone oscillator is required for use with unmodulated signals.

d. The Chronograph. The chronograph should have two stylus drives for separately recording the opening and closing of the chronometer contacts and the contacts of the radio receiver or the impersonal micrometer. The equipment should be connected as shown in figure 2-31. To record time, one stylus point is connected to the chronometer contacts and the other to the relay contacts of the

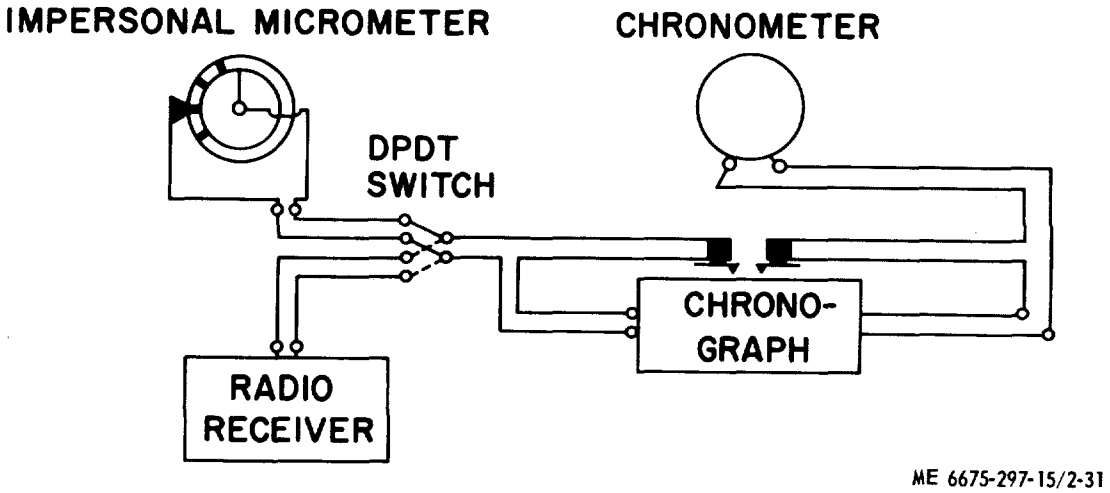


Figure 2-31. Chronograph Electrical Connections.

radio receiver. To record the time of transit of a star, one stylus is connected to the chronometer contacts and the other to the impersonal micrometer. A glass or plastic scale to facilitate reading the recording should also be available. The paper drive may be either spring driven from a hand wound spring motor or driven from a battery operated motor.

2-18. Operation in Extreme Cold (Below 0° F)

With proper precautions and servicing, the theodolite can be used in extreme cold. Its use is limited only by the endurance of operating personnel and by conditions affecting visibility. The instrument should be kept out-of-doors or in unheated shelters for short periods of non-use to prevent fogging of optical parts and dimensional changes which might affect the instruments accuracy. Extreme changes in temperature will cause internal stresses affecting accuracy. The theodolite should be cleaned and all possible lubricants removed before being put to use under conditions of extreme cold. Snowfall, winds, and refraction of light are some of the adverse conditions encountered at low temperatures.

CAUTION

Avoid subjecting the theodolite to sudden changes in temperature.

2-19. Operation in Extreme Heat

Both the theodolite and the operator should be protected by a surveyor's umbrella when sightings have to be taken in strong sunlight. Direct rays of the sun can cause internal stresses and distortion in the instrument. Heat ripples in the air near ground level create poor sighting conditions. When such conditions prevail, taking shorter sightings will reduce sighting errors. Taking sightings during the early morning and late evening will also lessen the magnitude of errors. Operator error due to eyestrain and fatigue can be kept down if the operator wears suitable dark glasses. If the theodolite has been stored in a cool place, it should be brought out of storage long enough before use to let the instrument temperature approach that of the outside air.

2-20. Operation in Dusty or Sandy Areas

Special care must be taken of an instrument that is being used in areas where dust and sand occur, since both dust and sand are highly abrasive. Moving parts of the theodolite will soon bind if they are allowed to remain on threaded or sliding surfaces and the instrument will become inaccurate or inoperable. Brush the theodolite off frequently and carefully wipe it clean. Take extreme care not to scratch lens and prism surfaces during cleaning operations. Always protect the instrument from dust or sand that is blowing. When not in use, place a protective cover over the entire instrument.

2-21. Operation Under Rainy or Humid Conditions

In humid areas, a slight drop in ambient temperature may cause condensation of moisture and fogging of lenses and prisms. Try to keep the theodolite warmer than the surrounding air. Internal fogging can usually be removed by taking the theodolite into a warm, dry area or by the use of desiccants. Dry the instrument thoroughly after use and wipe all metal parts with a soft cloth lightly impregnated with watch oil. Do not get any of the oil on the lens, prism, or level vial surfaces.

2-22. Operation in Salt Water Areas

Salt air is highly corrosive to metals, and especially to brass, from which many theodolite parts are made. Salt reacts with brass to produce a green deposit (verdigris) which must be guarded against and removed as soon as it is noticed. Wipe the instrument frequently with a soft cloth and dry thoroughly. Clean the instrument daily, immediately after use, and apply a thin film of watch oil to all metal parts. If the theodolite is exposed to direct salt spray, it should be cleaned thoroughly and returned to an instrument shop for overhauling as soon as possible.

2-23. Operation at High Altitudes

No special operating procedures are required for operation at high altitudes.

CHAPTER 3

OPERATOR AND ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section I. OPERATOR AND ORGANIZATIONAL MAINTENANCE TOOLS AND EQUIPMENT

3-1. Special Tools and Equipment

No special tools and equipment are required to perform organizational maintenance on the theodolite. A suitable assortment of screwdrivers, adjusting pins, and wrenches are provided in the accessory case (fig. 2-5).

3-2. Basic Issue Tools and Equipment

Tools and repair parts issued with or authorized for use with the theodolite are listed in the Basic Issue Items List, appendix B of this manual.

3-3. Organizational Maintenance Repair Parts

Organizational maintenance repair parts are listed and illustrated in TM 5-6675-297-25P when printed.

Section II. LUBRICATION

3-4. General Lubrication Information

All moving parts of the theodolite, with both smooth and threaded surfaces, are fitted within extremely fine tolerances. For this reason, most parts of the theodolite must be cleaned before being lubricated. Any attempt to lubricate the theodolite without first cleaning it may result in damage to the instrument, and may render it unfit for use. Unless specifically called for, no lubrication will be performed in the field.

NOTE

Never perform any lubrication operation other than that specified or use lubricants other than those that are specifically approved for use on the instrument.

3-5. Detailed Lubrication Information

a. Care of Lubricants. Special care should be taken to see that all surveying instrument lubricants are kept absolutely free from contamination by any foreign substance. Containers must be stored in a clean, dry place and wiped free of dirt or dust before they are opened. All lids or bottle tops must be kept airtight.

b. Approved Lubricants. No lubricants other than those approved for use on surveying instruments will be stocked. Approved lubricants are noncorrosive and highly refined and must be free from all paint removing ingredients. Ordinary machine oil is not an approved lubricant. The following lubricants are approved for use on this theodolite:

(1) OCW: oil, clock and watch MIL-L-3918.

(2) GL: grease, aircraft and instrument MIL-G-23827.

c. Components Requiring Lubrication.

(1) *Footscrews.* Turn the footscrews (fig. 1-1) outward to the extreme limit of their travel. Clean well with a lint-free cloth. Apply grease (GL) sparingly and run screws through their travel several times to distribute the grease evenly. Wipe off all excess grease.

(2) *Horizontal axis bearing journals.* With horizontal axis and telescope removed, clean bearing journal at each end of horizontal axis with a lint free cloth. Apply a thin film of grease (GL) to each bearing journal.

(3) *Vertical clamping ring.* If clamping ring of vertical clamp arm (fig. 1-3) becomes dirty so that movement of the telescope becomes stiff, separate halves of clamping ring. Clean all wearing surfaces with a lint-free cloth, moistened with oil

(OCW). Wipe clean with a clean, dry, lint-free cloth. Apply a few drops of oil (OCW) to each half of clamping ring and reassemble.

(4) *Horrebow-Talcott level carrier.* If Horrebow-Talcott level carrier movement becomes stiff; separate halves of carrier. Clean all wearing surfaces with a lint-free cloth moistened with oil (OCW). Wipe clean with a clean, dry, lint-free cloth. Apply a few drops of oil (OCW) to each half of carrier and reassemble.

d. Lubrication Procedure. Cleaning and lubrication services which require partial or complete disassembly of the instrument must be performed in the dust-free atmosphere of an instrument repair shop, and then only by qualified instrument repair personnel. Taking the instrument apart under any other condition, particularly where dust might get into recesses, will do more harm than good. Since the lubricants must be applied sparingly, never use a container with a spout, such as an oil can, to squirt oil on parts or into assemblies.

CAUTION

Never attempt to take the theodolite apart in the field.

Section III. PREVENTIVE MAINTENANCE SERVICES

3-6. General

To insure that the theodolite is ready for operation at all times, it must be inspected systematically so that defects may be discovered and corrected before they result in serious damage or failure. The necessary preventive maintenance services to be performed are listed and described in paragraphs 3-7 and 3-8. Item numbers indicate the sequence of minimum inspection requirements. Defects discovered during operation of the unit shall be noted for future correction, to be made as soon as operation has ceased. Stop operation immediately if a deficiency is noticed which could damage the equipment if operation were continued. All deficiencies and shortcomings will be recorded together with the corrective action taken on DA Form 2404 (Equipment Inspection and Maintenance Worksheet) at the earliest possible opportunity.

3-7. Daily Preventive Maintenance Services

This paragraph contains an illustrated tabular listing of preventive maintenance services which must be performed by the operator. The item numbers are listed consecutively and indicate the sequence of minimum requirements. Refer to figure 3-1 for the daily preventive maintenance services.

3-8. Quarterly Preventive Maintenance Services

a. This paragraph contains an illustrated tabulated listing of preventive maintenance services which must be performed by organizational maintenance personnel at quarterly intervals. A quarterly interval is equal to 3 calendar months, or 250 hours of operation, whichever occurs first.

b. The item numbers are listed consecutively and indicate the sequence of minimum requirements. Refer to figure 3-2 for the quarterly preventive maintenance services.

Section IV. OPERATOR'S MAINTENANCE

3-9. General

Instructions in this section are published for the information and guidance of the operator to maintain the theodolite.

3-10. Battery Replacement

Refer to figure 2-4 and replace unserviceable batteries.

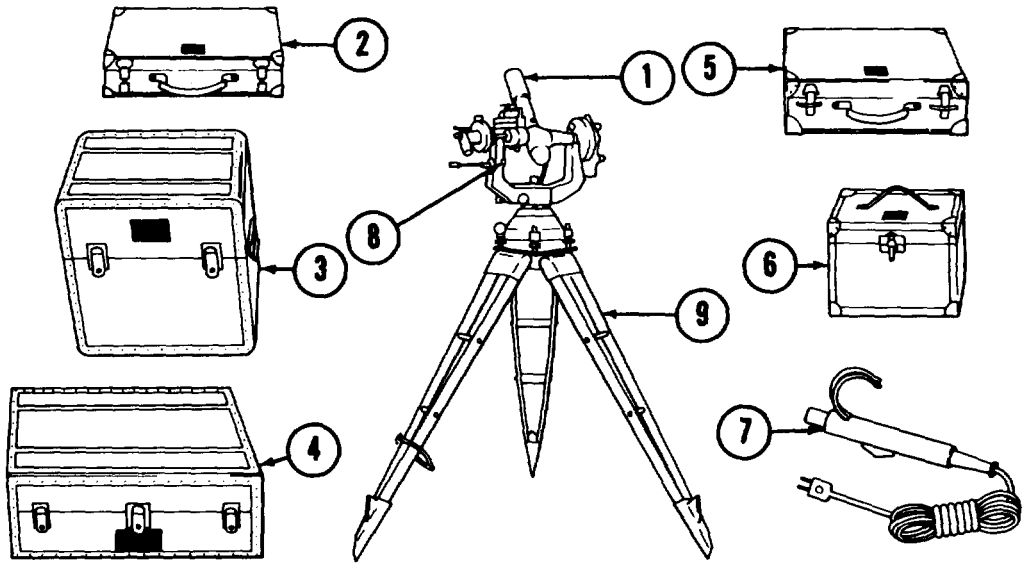
3-11. Cleaning Lenses and Prisms

Clean all dust from optical parts with a soft brush, preferably of the anti-static type. Wash the brush from time to time in ether or chemically pure benzine and dry thoroughly before using it. After all dust has been removed, clean optical parts with a soft, clean chamois, moistening the glasses slightly by breathing on it.

PREVENTIVE MAINTENANCE SERVICES

DAILY

TM5-6675-297-15 WILD HEERBRUGG MODEL T4A-68 DIRECTIONAL THEODOLITE



ITEM	LUBRICATE IN ACCORDANCE WITH CURRENT LUBRICATION ORDER	PAR REF
1	THEODOLITE. Check eyepieces, adjusting and clamping knobs, and adjusting screws for proper operation. Check lenses, level vials, and mirrors for dryness, cleanliness, and serviceable condition. Clean lenses, level vials, and mirrors.	2-3 a 2-3 b
2	ACCESSORY CASE. Check case for serviceability and presence of components.	2-3 d
3	BASE AND U FRAME TRANSPORT BOX. Check transport box for serviceability. Check base packing mount for security and presence of components.	
4	HORIZONTAL AXIS AND TELESCOPE TRANSPORT BOX. Check transport box for serviceability.	
5	SUSPENSION LEVEL TRANSPORT BOX. Check transport box for serviceability.	
6	BATTERY BOX. Check battery box for serviceability and presence of components. Check batteries and wiring for serviceability. Check rheostat for tight and clean connections and proper operation.	
7	HAND LIGHT. Check light for serviceability and proper operation.	

ME 6675-297-15/3-1 (1)

Figure 3-1. Daily preventive maintenance services.

ITEM		PAR REF
8	CONTROLS AND INSTRUMENTS. Check the controls and instruments for serviceability and proper operation.	
9	TRIPOD. Check the tripod for serviceability.	
	NOTE 1. OPERATION. During operation, observe all components for proper fun c-tion, alignment, adjustment, and cali-bration.	

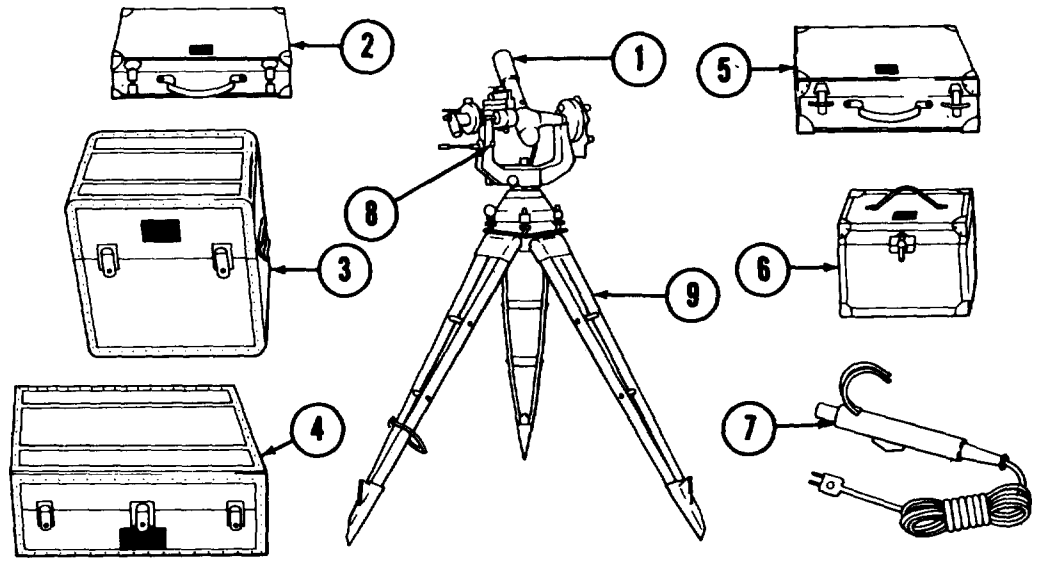
ME 6675-297-15/3-1 (2)

Figure 3-1. - Continued.

PREVENTIVE MAINTENANCE SERVICES

QUARTERLY

TM5-6675-297-15 WILD HEERBRUGG MODEL T4A-68 DIRECTIONAL THEODOLITE



ITEM	LUBRICATE IN ACCORDANCE WITH CURRENT LUBRICATION ORDER	PAR REF
1	THEODOLITE. Check suspension level, Horrebow-Talcott level, eyepieces adjusting and clamping knobs, and adjusting screws for proper operation. Check lenses, level vials, and mirrors for dryness, cleanliness, and serviceable condition. Clean lenses, level vials, and mirrors,	2-3 a 2-3 b
2	ACCESSORY CASE. Check case for serviceability and presence of components.	2-3 d
3	BASE AND U FRAME TRANSPORT BOX. Check transport box for serviceability. Check base packing mount for security and presence of components.	
4	HORIZONTAL AXIS AND TELESCOPE TRANSPORT BOX. Check transport box for serviceability.	
5	SUSPENSION LEVEL TRANSPORT BOX. Check transport box for serviceability.	
6	BATTERY BOX. Check battery box for serviceability and presence of components. Check batteries and wiring for serviceability. Check rheostat for tight and clean contacts and proper operation.	
7	HAND LIGHT. Check light for serviceability and proper operation.	

ME 6675-297-15/3-2 (1)

Figure 3-2. Quarterly preventive maintenance services.

ITEM		PAR REF
8	CONTROLS AND INSTRUMENT. Check controls and instruments for serviceability and proper operation.	
9	TRIPOD. Check tripod for serviceability.	
	NOTE 1. OPERATIONAL TEST. During operation observe for proper function, alignment, adjustment, and calibration.	
	NOTE 2. ADJUSTMENTS. Make all necessary adjustments during operational test.	

ME 6675-297-15/3-2 (2)

Figure 3-2. - Continued.

Section V. TROUBLESHOOTING

3-12. General

This section provides information useful in diagnosing and correcting unsatisfactory operation or failure of the theodolite and its components. Each trouble symptom stated is followed by a list of probable causes. The possible remedy recommended is described opposite the probable cause. Any trouble beyond the scope of organizational maintenance shall be reported to direct support maintenance.

3-13. Theodolite Will Not Stay On Line

Probable cause	*Possible remedy*
Footscrew pads not properly seated	Set footscrew pads flat on support or within recesses of tripod head (para 2-4).
Instrument not level	Level the instrument (para 2-13).
One or more footscrews	Adjust tension on footloose screws (para 2-3).

3-14. Circular Level Bubble Does Not Stay Centered

Probable cause	*Possible remedy*
Instrument not level	Level the instrument, (para 2-13).
Circular level out of adjustment	Adjust level (para 2-12).

3-15. Footscrews Turn Hard

Probable cause	*Possible remedy*
Footscrews dirty	Clean and lubricate footscrews (para 3-5).
Footscrews tension out of adjustment	Adjust tension (para 2-3).

3-16. Footscrews Turn Too Freely

Probable cause	*Possible remedy*
Footscrews tension out of adjustment	Adjust tension (para 2-3).

3-17. Alidade Turns Hard

Probable cause	*Possible remedy*
Horizontal clamp locked- Arresting ring locked	Release clamp (para 2-10). Release arresting ring (fig. 2-10).

3-18. Horizontal Axis Turns Hard

Probable cause	*Possible remedy*
Vertical clamp locked	Release clamp (para 2-10).
Vertical clamping ring	Clean and lubricate dirty clamping ring (para 3-5).

3-19. Horrebow-Talcott Level Carrier Turns Hard

Probable cause	*Possible remedy*
Carrier clamp locked	Release clamp (para 2-10).
Carrier dirty	Clean and lubricate carrier (para 3-5).

3-20. Horizontal Slow Motion Screw Turns Hard

Probable cause	*Possible remedy*
Slow motion screw dirty	Clean and lubricate screw (para 3-5).
Slow motion screw tension out of adjustment	Adjust tension (para 2-3).

3-21. Horizontal Slow Motion Screw Turns Too Freely

Probable cause	*Possible remedy*
Slow motion screw tension out of adjustment	Adjust tension (para 2-3).

3-22. Vertical Slow Motion Screw Turns Too Hard

Probable cause	*Possible remedy*
Slow motion screw dirty	Clean and lubricate screw (para 3-5).
Slow motion screw tension out of adjustment	Adjust tension (para 2-3).

3-23. Vertical Slow Motion Screw Turns Too Freely

Probable cause	*Possible remedy*
Slow motion screw tension out of adjustment	Adjust tension (para 2-3).

3-24. Telescope Crosslines Will Not Focus Sharply

Probable cause	*Possible remedy*
Telescope eyepiece lens dirty	Clean lens (para 3-11).
Telescope objective lens dirty	Clean lens (para 3-11).
Telescope eyepiece defective	Replace eyepiece (para 3-43).

3-25. Horizontal Circle Image Will Not Focus Sharply

Probable cause	*Possible remedy*
Microscope eyepiece lens dirty	Clean lens (para 3-11).
Microscope eyepiece defective	Replace eyepiece (para 3-45).

3-26. Vertical Circle Image Will Not Focus Sharply

Probable cause	*Possible remedy*
Microscope eyepiece lens dirty	Clean lens (para 3-11).
Microscope eyepiece defective	Replace eyepiece (para 3-46).

3-27. Setting Circle Image Will Not Focus Sharply

Probable cause	*Possible remedy*
Microscope eyepiece lens dirty	Clean lens (para 3-11).
Microscope eyepiece defective	Replace eyepiece (para 3-44).

3-28. Suspension Level Bubble Does Not Stay Centered

Probable cause	*Possible remedy*
Suspension level out of adjustment	Adjust level (para 2-12).

3-29. Parallax Observed Between Target and Fixed Reticle

Probable cause	*Possible remedy*
Reticle not in focal plane of telescope	Adjust reticle (para 2-12).

3-30. Reticle Center Moves Off Target When Eyepiece is Rotated

Probable cause	*Possible remedy*
Fixed reticle off center	Center reticle crosslines (para 2-12).

3-31. Target Moves Off Horizontal Crossline as Alidade is Rotated

Probable cause	*Possible remedy*
90-degree stop out of adjustment	Adjust stop (para 2-12).

3-32. Target Moves Off Verticle Crossline as Telescope Elevation is Varied

Probable cause	*Possible remedy*
90-degree stop out of adjustment	Adjust stop (para 2-12).

3-33. Movable Crossline Not Centered When Measuring Drum Reads Zero

Probable cause	*Possible remedy*
Measuring drum out of calibration	Adjust contact drum and measuring drum (para 2-12).

3-34. Difference in Horizontal Circle Readings Not 180° ±3 seconds When Sighting Target in Normal and Reverse Positions

Probable cause	*Possible remedy*
Horizontal collimation out of adjustment	Adjust collimation (para 2-12).

3-35. With Alidade Reversed, Readings of Vertical Circle Do Not Differ by 180°

Probable cause	*Possible remedy*
Vertical circle level out of adjustment	Adjust level (para 2-12).

3-36. With Alidade Reversed, Readings of Vertical Setting Circle Do Not Differ By 180 °

Probable cause	*Possible remedy*
Vertical setting circle level out of adjustment	Adjust level (para 2-12).

Section VI. PACKING CASES

3-37. General

The four packing cases are specially fitted containers having hinged covers and carrying handles. They provide a safe and convenient means for transporting the theodolite and accessories ill the field and serve as dust-proof containers for the equipment when it is ill storage.

3-38. Base and U-Frame Assembly Packing Case

a. Disassembly. Refer to figure 3-3 and disassemble the base and U-frame assembly packing case.

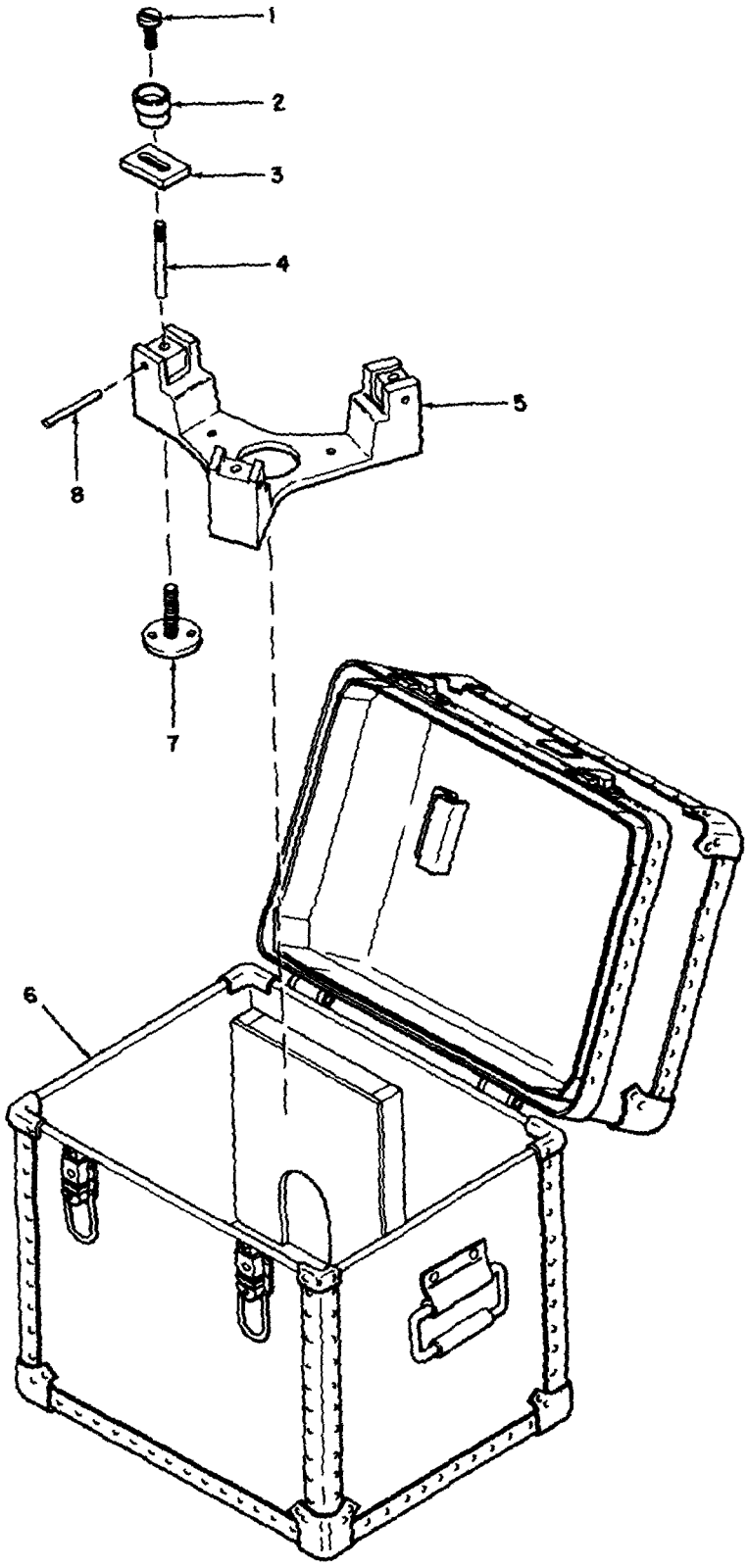
b. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent and dry thoroughly. Using a stiff bristle brush, brush interior thoroughly to loosen all dirt and foreign particles. Use a vacuum cleaner to remove all loose dirt and foreign matter.

(2) Wipe exterior of case clean with a clean cloth moistened with tile cleaning solvent.

(3) Inspect carrying handle for cuts, cracks, and excessive wear. Inspect all mounting hardware for security, checking to be certain that mounting holes are not enlarged by age and wear.

(4) Inspect base star for cracks,



1 Screw (3)
2 Knob (3)
3 Slide (3)
4 Threaded pin (3)
5 Star base
6 Case
7 Screw (6)
8 Pin (3)

Figure 3-3. Base and U-frame assembly packing case, disassembly and reassembly.

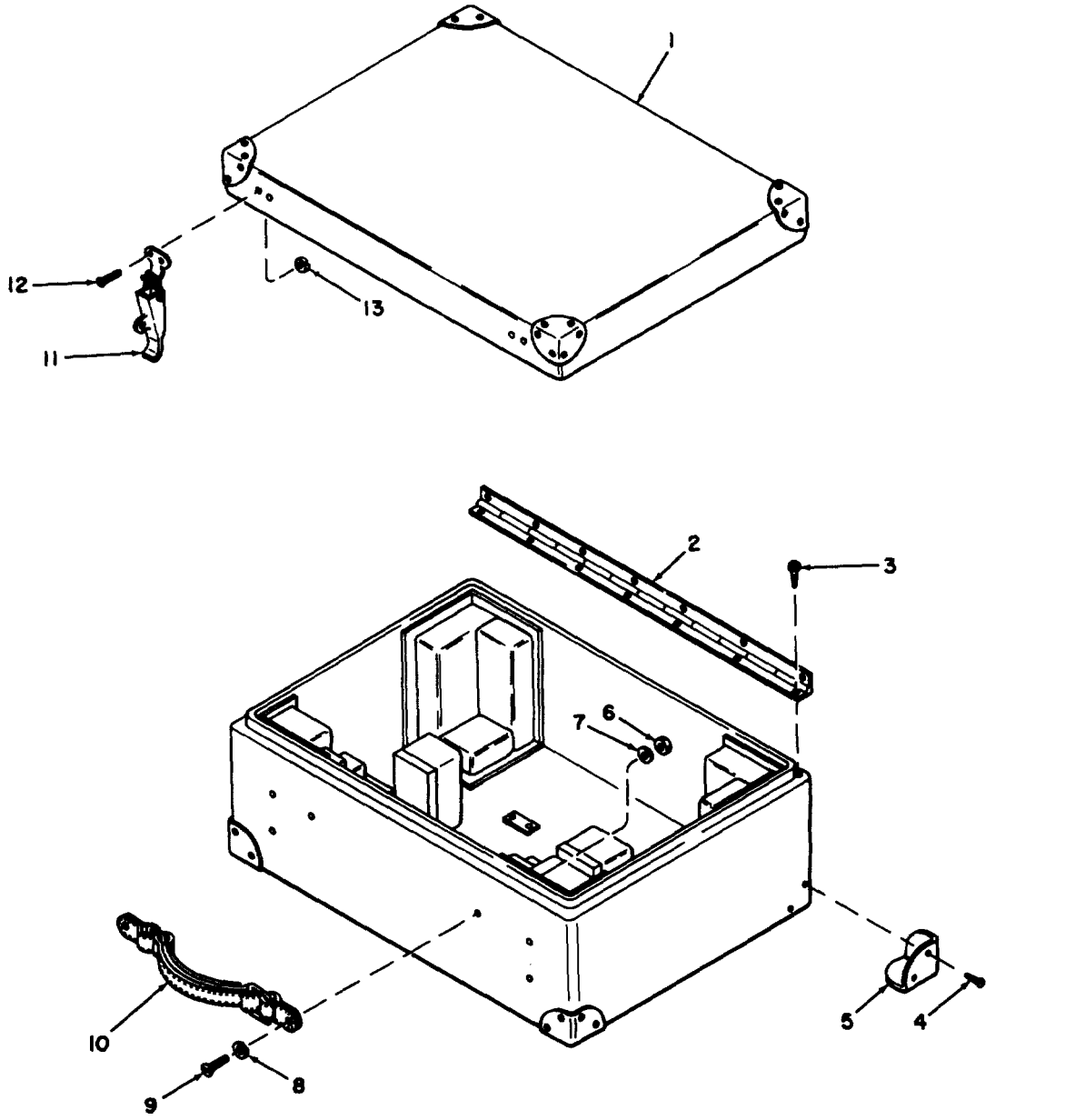
deformation, or other damage. Inspect three milled knobs and associated threaded pills for cracks, stripped or crossed threads, or other damage. Inspect three adjustable slides for deformation or other damage.

(5) Replace all defective or missing parts.

c. Reassembly. Refer to figure 3-3 and reassemble the base and U-frame assembly packing case.

3-39. Suspension Level Packing Case

a. Disassembly. Refer to figure 3-4 and disassemble the suspension level packing case.



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1 Case	4 Screw (24)	7 Washer (2)	10 Handle	13 Nut (8)
2 Hinge	5 Corner (8)	8 Washer (2)	11 Lock (2)	
3 Screw (16)	6 Nut (2)	9 Screw (2)	12 Screw (8)	

Figure 3-4. Suspension level packing case, disassembly and reassembly.

b. Cleaning, Inspection and Repair.

(1) Clean all metal parts with all approved cleaning solvent and dry thoroughly. Using a stiff bristle brush, brush interior thoroughly to loosen all dirt and foreign particles. Use a vacuum cleaner to remove all loosened dirt and foreign matter.

(2) Wipe exterior of case clean with a clean cloth moistened with the cleaning solvent.

(3) Inspect carrying handle for cuts, cracks, and excessive wear. Inspect all mounting hardware for security, checking to be certain that mounting holes are not enlarged by age and wear.

(4) Inspect two locks for bent, broken, or missing I)arts.

(5) Replace all defective or missing parts.

c. Reassembly. Refer to figure 3-4 and reassemble the suspension level packing case

3-40. Accessory Case With Accessories

a. Disassembly. Refer to figure 3-5 and disassemble the suspension level packing case.

b. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent and dry thoroughly. Using a stiff bristle brush, brush interior thoroughly to loosen all dirt and foreign particles. Use a vacuum cleaner to remove all loose dirt and foreign matter.

(2) Wipe exterior of case clean with a clean cloth moistened with the cleaning solvent. Wash chamois with mild soap and water.

(3) Inspect carrying handle for cuts, cracks, and excessive wear. Inspect all mounting hardware for security, checking to be certain that mounting holes are not enlarged by age and wear.

(4) Inspect two locks for bent, broken, or missing parts.

(5) Inspect drawer for cracks or other damage.

(6) Inspect all tools for serviceability.

(7) Inspect oil applicator and lubricant container for leaks or other damage.

(8) Inspect all electrical accessories for defective connectors, loosen or broken connections, broken leads, and indications of damaged insulation.

(9) Inspect chamois for presence of imbedded particles which could scratch surfaces of lenses or prisms.

(10) Using a fine file, remove all nicks and burrs from tools.

(11) Replace all unserviceable tools.

(12) Replace all defective or missing parts.

c. Reassembly. Refer to figure 3-5 and reassemble the accessory case.

3-41. Battery Box Assembly

a. Disassembly. Refer to figure .3-6 and disassemble the battery box assembly.

1 Corner (8)	14 Washer (2)	27 Housing
2 Screw (48)	15 Screw (12)	28 Tongue
3 Strap (2)	16 Terminal (2)	29 Plate
4 Screw (4)	17 Cable	30 Plate
5 Handle	18 Screw (2)	31 Spring
6 Screw (4)	19 Rivet (2)	32 Hinge
7 Plate (2)	20 Cover	33 Nut (2)
8 Case	21 Setscrew (2)	34 Nut (2)
9 Knob	22 Setscrew (2)	35 Screw (2)
10 Terminal	23 Connector (2)	36 Key
11 Contact	24 Cover	37 Washer (2)
12 Plate	25 Axis	38 Nut (4)
13 Washer (2)	26 Sleeve	39 Washer (4)

b. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent and dry thoroughly. Using a stiff bristle brush, brush interior thoroughly to loosen all dirt and foreign particles. Use a vacuum cleaner to remove all loosened dirt and foreign matter.

(2) Wipe exterior clean with a clean cloth moistened with the cleaning solvent.

(3) Wipe clean all electrical leads with a clean dry cloth.

CAUTION

Do not use cleaning solvent on electrical insulation.

(4) Inspect carrying handle for cuts, cracks, and excessive wear. Inspect all mounting hardware for security, checking to be certain that mounting holes are not enlarged by age or wear.

(5) Inspect lock for bent, broken, or missing parts.

(6) Inspect all electrical leads for loose or otherwise defective terminals or damaged insulation.

(7) Replace all defective or missing parts.

e. Reassembly. Refer to figure 3-6 and reassemble the battery box assembly.

Section VII. TELESCOPE AND MICROSCOPE EYEPIECES

3-42. General

The telescope and microscope eyepieces provide the magnification for viewing the target and the several graduated circles. They are individually

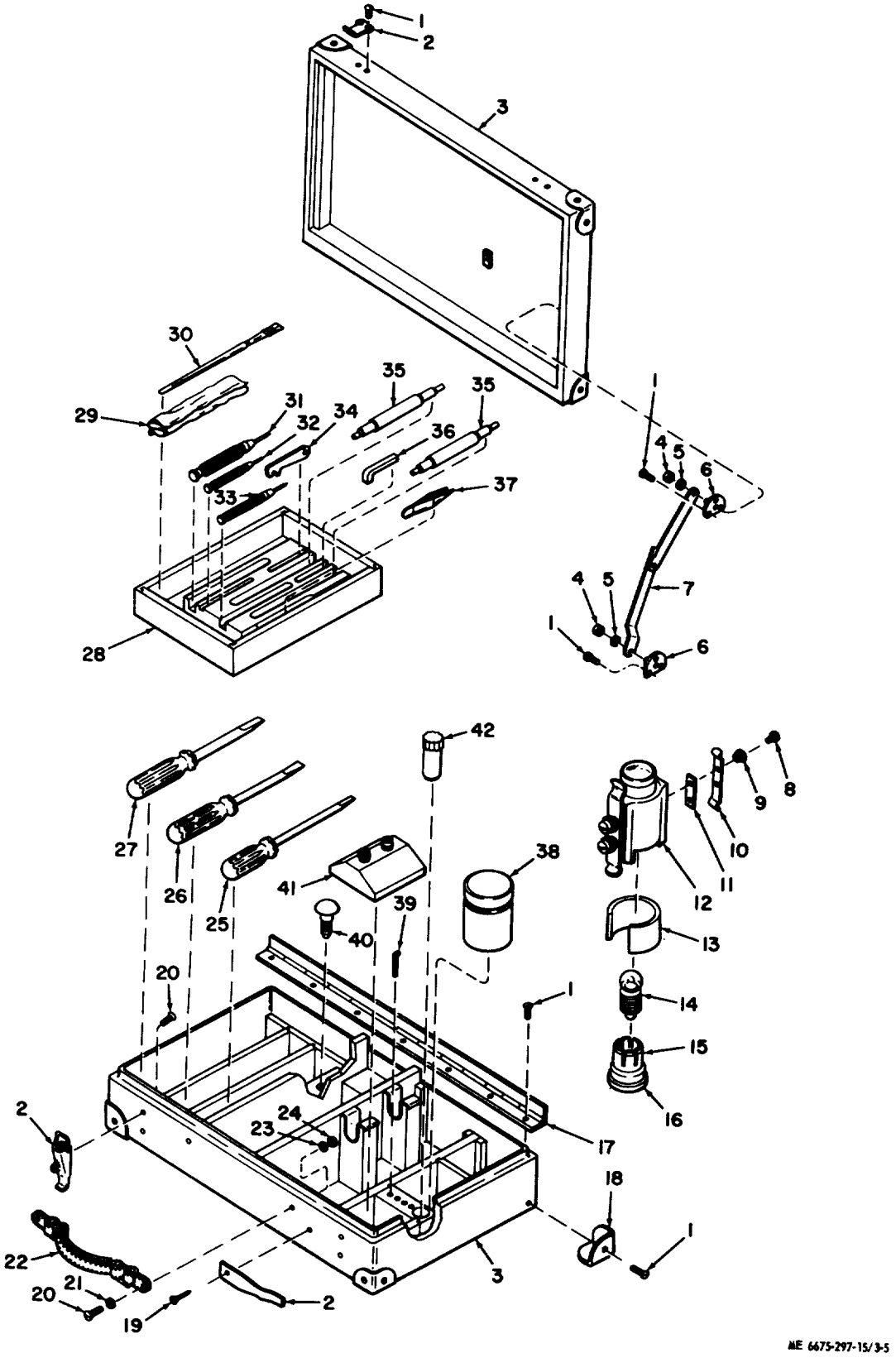

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Figure 3-5. Accessory case with accessories, disassembly and reassembly.

removable and may be replaced as assemblies.

3-43. Telescope Eyepiece Assembly

a. Removal. Refer to figure 3-7 and remove the telescope eyepiece assembly.

b. Cleaning and Inspection.

(1) Clean the eyepiece lenses with a lint-free cloth moistened with acetone or alcohol. Dry and polish with chamois or lens tissue.

(2) Inspect the lenses for scratches, chips, cracks, and etching. Inspect all threaded surface for worn or damaged threads.

(3) Replace telescope eyepiece assembly if found defective.

c. Installation. Refer to figure 3-7 and install the telescope eyepiece assembly.

3-44. Setting Circle Eyepiece Assembly

a. *Removal.* Refer to figure 3-7 and remove the setting circle eyepiece assembly.

b. Cleaning and Inspection.

(1) Clean the eyepiece lenses with a lint-free cloth moistened with acetone or alcohol. Dry and polish with chamois or lens tissue.

(2) Inspect the lenses for scratches, chips, (cracks, and etching. Inspect all threaded surfaces for worn or damaged threads.

(3) Replace setting circle eyepiece assembly if found defective.

c. Installation. Refer to figure 3-7 and install the setting circle eyepiece assembly.

3-45. Horizontal Circle Eyepiece Assembly

a. Removal. Refer to figure 3-7 and remove the horizontal circle eyepiece assembly.

b. Cleaning and Inspection.

(1) Clean the eyepiece lenses with a lint-free cloth moistened with acetone or alcohol. Dry and polish. with chamois or lens tissue.

(2) Inspect the lenses for scratches, chips, cracks, and etching. Inspect all threaded surfaces for worn or damaged threads.

(3) Replace the horizontal circle eyepiece assembly if found defective.

c. Installation. Refer to figure 3-7 and install the horizontal circle eyepiece assembly.

3-46. Vertical Circle Eyepiece Assembly

a. Removal. Refer to figure 3-7 and remove the vertical circle eyepiece assembly.

b. Cleaning and Inspection.

(1) Clean the eyepiece lenses with a lint-free cloth moistened with acetone or alcohol. Dry and polish with chamois or lens tissue.

(2) Inspect the lenses for scratches, chips, cracks, and etching. Inspect all threaded surfaces for worn or damaged threads.

(3) Replace the vertical circle eyepiece assembly if found defective.

c. Installation. Refer to figure 3-7 and install the vertical circle eyepiece assembly.

Section VIII. ILLUMINATION MIRROR ASSEMBLY

1 Screw (38)
2 Lock (2)
3 Case
4 Nut (2)
5 Washer (2)
6 Bracket (2)
7 Plate
8 Screw (8)
9 Insulator (4)
10 Spring (2)
11 Insulator (2)
12 Housing
13 Cover
14 Lamp
15 Lampholder
16 Housing
17 Hinge
18 Corner (8)
19 Screw (14)
20 Screw (2)
21 Washer (2)
22 Handle
23 Washer (2)
24 Nut (2)
25 Screwdriver
26 Screwdriver
27 Screwdriver
28 Drawer
29 Chamois
30 Brush
31 Screwdriver
32 Screwdriver
33 Screwdriver
34 Spanner wrench
35 Adjusting pin (2)
36 Allen wrench
37 Tweezers
38 Container
39 Adjusting pin (4)
40 Lamp (4)
41 Bracket
42 Applicator

3-47. General

The two rotatable illumination mirror assemblies are used to reflect available natural light through illuminating prisms, within the theodolite, onto the horizontal and vertical circles. At night and on dark days they are replaceable by electric illuminating lamps.

3-48. Illumination Mirror Assembly

a. Removal. Refer to figure 3-8 and remove illuminating mirror assembly.

b. Cleaning and Inspection

(1) Clean the metal parts with a soft cloth moistened with an approved cleaning solvent.

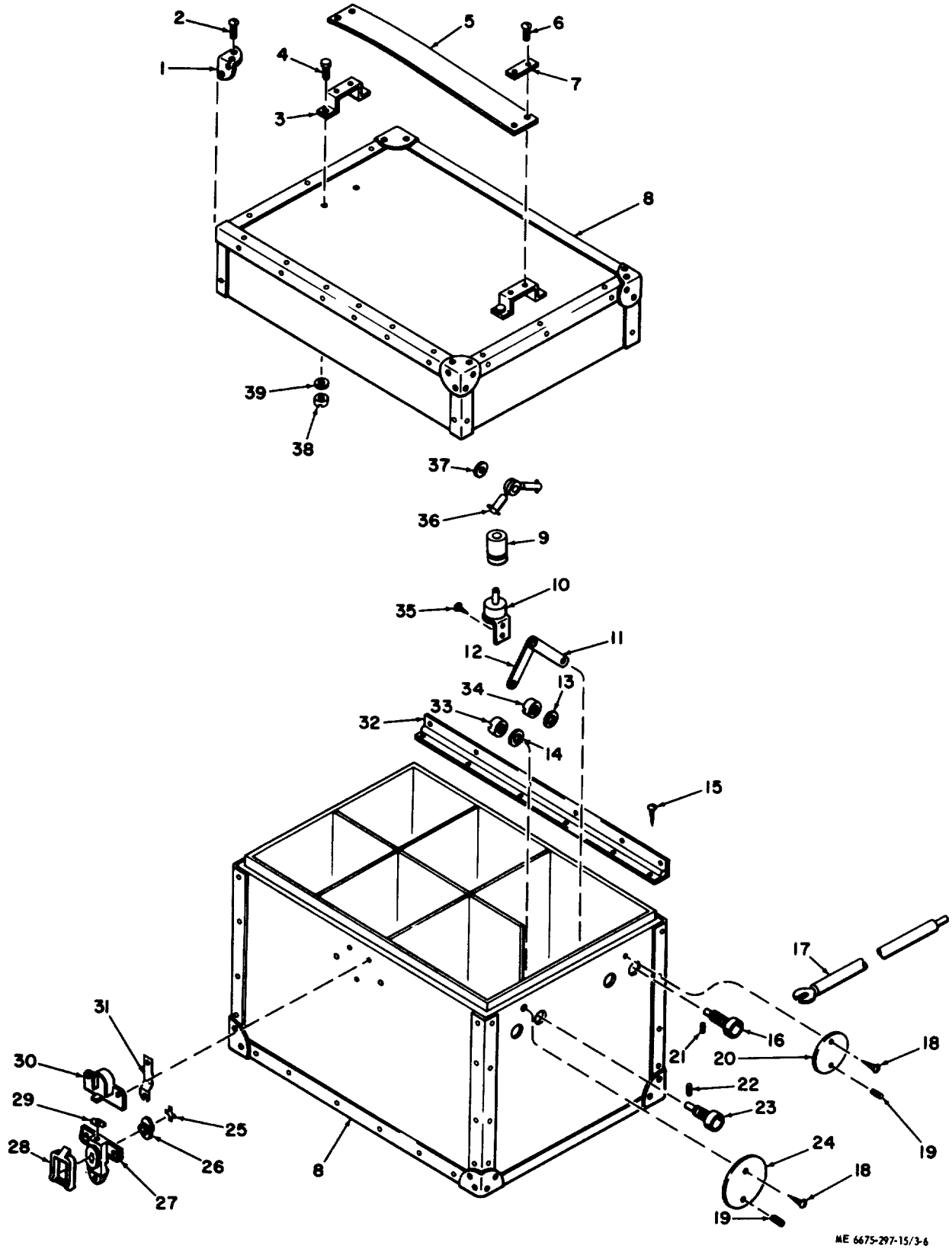


Figure 3-6. Battery box assembly, disassembly and reassembly.

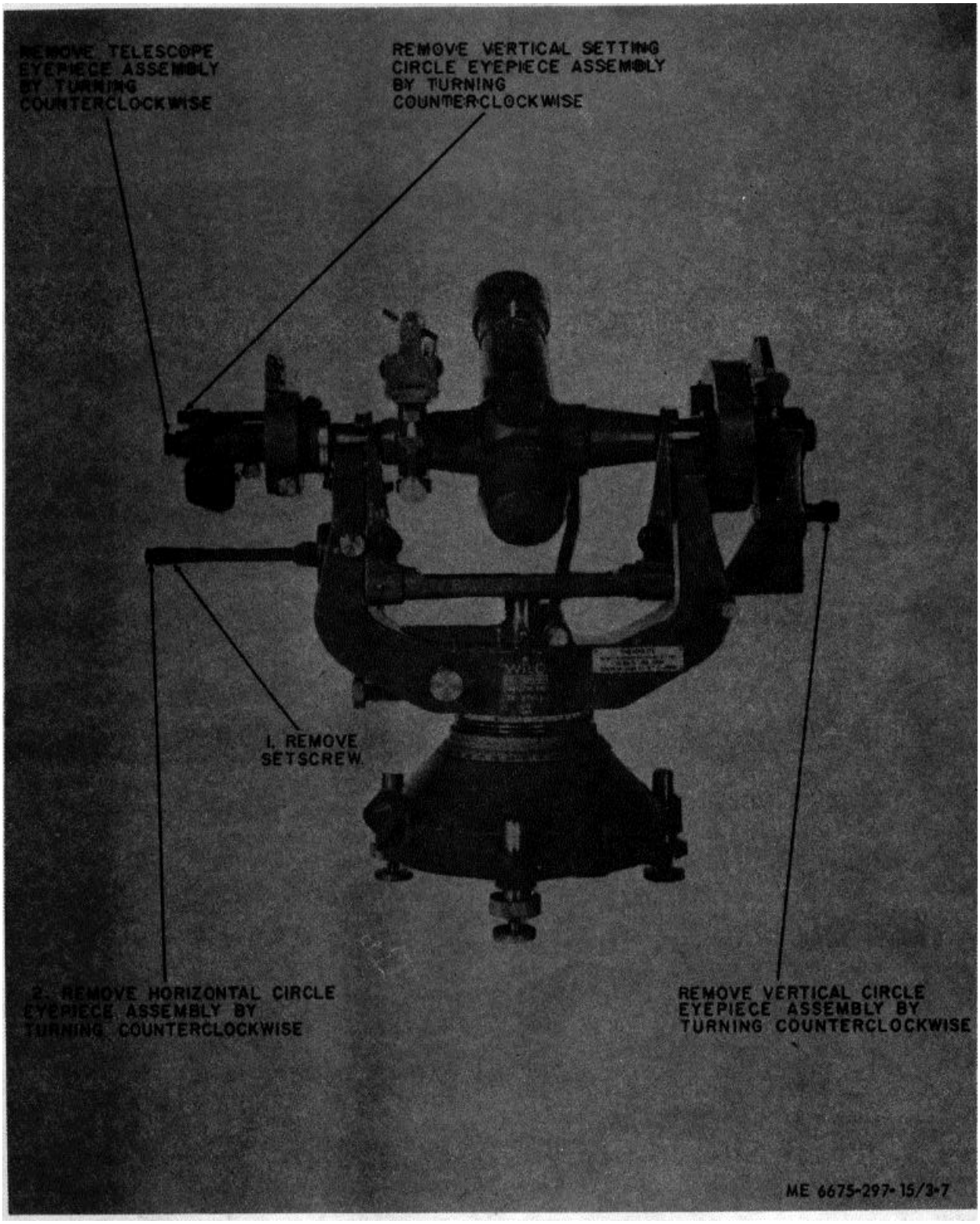


Figure 3-7. Telescope and microscope eyepiece assemblies, removal and installation.

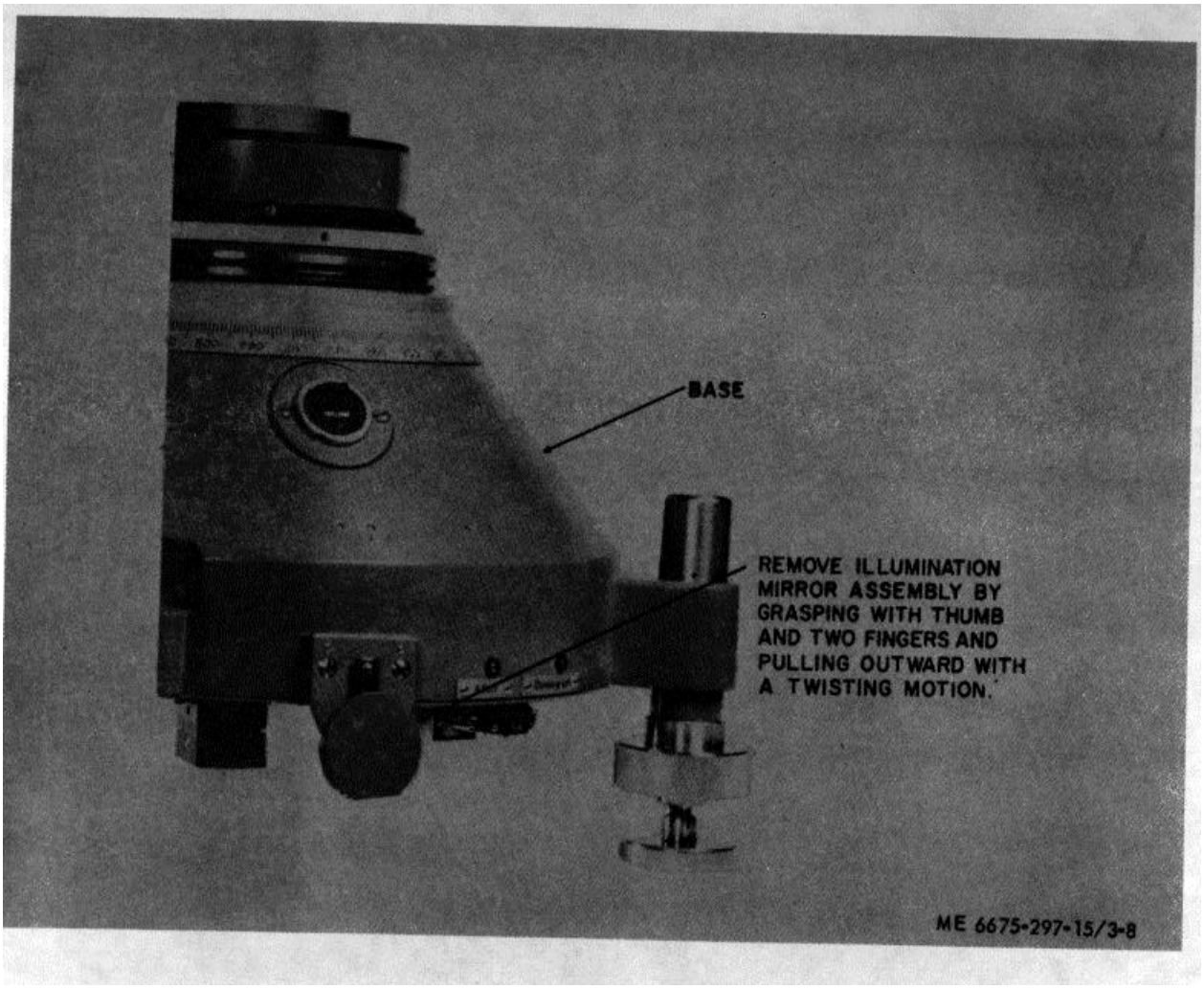


Figure 3-8. Illuminating mirror assembly, removal and installation.

(2) Clean the mirror with a lint-free cloth moistened with acetone or alcohol. Dry and polish with chamois or lens tissue.

(3) Check that hinge action is not too stiff but is sufficiently stiff to hold position at ally point at which it is set.

(4) Inspect mounting for distortion or other damage. Mounting shall fit snugly into base socket but shall be readily installed or removed.

(5) Inspect mirror for scratches, chips, cracks, and etching.

(6) Replace illumination mirror assembly if found defective.

c. Installation. Refer to figure 3-8 and install illumination mirror assembly.

CHAPTER 4

DIRECT AND GENERAL SUPPORT AND DEPOT MAINTENANCE INSTRUCTIONS

Section I. GENERAL

4-1. Scope

These instructions are published for the use of direct and general support and depot maintenance personnel maintaining the Wild Heerburgg model T4 theodolite. They provide information on the maintenance of the equipment, which is beyond the scope of tools, equipment, personnel, or supplies normally available to using organizations.

Section II. DESCRIPTION AND TABULATED DATA

4-2. Description

For a complete description of the theodolite, see paragraph 1-3.

4-3. Tabulated Data

a. General. Tabulated data are listed in paragraph 1-4. Engineering data, such as tolerances, wear limits, and the like are not available since all parts of each theodolite are hand-fitted during manufacture.

b. Time Standards. The following table lists the number of man-hours required under normal conditions to perform the indicated maintenance and repair for the directional theodolite. Components are listed under the appropriate functional index. The times listed are not intended to be rigid standards. Under adverse conditions, the operations will take longer; but under ideal conditions with highly skilled mechanics, most of the operations can be accomplished in considerably less time.

Time standards

Man-hours

(1) *Lubrication and Service*
67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL
6700 Theodolite
Theodolite:
Clean (general) 0.5
(Use soft cloth, free from dirt and oil, only on exterior parts, not to include lens and mirrors. Do not use water, oil, or liquids when cleaning.)
Clean (special) 0.5
(Use cheese cloth to clean mirrors and lens. Use linseed oil on tripod legs and all wood material.)

Man-hours

(2) *Remove and Replace*
18 BODY; CAB; HOOD; HULL
1808 Carrying Cases
Case, base and alidade assembly 1.0
Case, telescope assembly 0.3
Case, suspension level 0.3
Case, accessory 1.0
67 PRECISION INSTRUMENTS, MECHANICAL OR ELECTRICAL
6700 Theodolite
Theodolite 1.0
(Includes adjustment.)
6701 Telescope Assembly
Telescope assembly 6.0
Axis, telescope 6.0
(Includes removal and installation of microscope telescope eyepiece, and reticle bearing, reticle mirror, and telescope level.)
6702 Optics (Reflecting and Transmitting types)
Objective assembly, telescope 1.0
Eyepiece assembly, telescope 1.0
Eyepiece assembly, setting circle 1.0
Eyepiece assembly, vertical circle 1.0
Eyepiece assembly, horizontal circle 2.0
Mirror assembly, illumination 0.5
Circle assembly, vertical 5.0
(Includes removal and installation of vertical collimation housing and lower assemblies)

Circle assembly, setting 2.0
6703 Structural, and Precision Parts
Base assembly, horizontal 2.0
U-Frame assembly 2.0
Drive assembly, horizontal circle 2.0
Clamp, vertical, horizontal 1.0
Footscrew assembly 2.0
Screw assemblies, vertical and horizontal collimation 2.5
Axis assembly, horizontal and vertical 3.0
Level assembly, collimation 1.0
6704 Batteries
Battery, dry 0.2
6705 Fuses and Lamps
Housing lamp 0.5
Emergency light 0.5
6711 Controls and Special Components
Rheostat assembly 0.5
Lamp switch 0.5
6712 Mounted Connecting Devices
Contact ring segments 4.0
Receptacles 1.0
Illumination housing 0.5
6713 Miscellaneous Wiring and Fittings
Cable, electrical (internal) 3.0
Battery, box assembly 0.5
Cable, electrical (external) 0.1
6717 Power Supply: Self Contained
Battery box 0.2
6718 Compass and Levels
Level assembly, circular 0.5
Level assembly, Horrebow 2.0
Level assembly, vertical circle 8.0
Level suspension 3.0
Level assembly, setting circle 2.0
6719 Tripods
Tripod assembly 3.0

CHAPTER 5

GENERAL MAINTENANCE INSTRUCTIONS

Section I. SPECIAL TOOLS AND EQUIPMENT

5-1. Special Tools and Equipment

No special tools and equipment are required by direct and general support and depot maintenance on the theodolite.

5-2. Specially Designed Tools and Equipment

No specially designed tools and equipment are required by direct and general support and depot maintenance personnel for performing maintenance on the theodolite.

Section II. TROUBLESHOOTING

5-3. General

This section provides information useful in diagnosing and correcting unsatisfactory operation or failure of the theodolite or any of its components. Each trouble symptom stated is followed by a list of probable causes. The possible remedy recommended is described opposite the probable cause.

5-4. Theodolite Will Not Stay On Line

Probable cause	*Possible remedy*
One or more footscrews defective	Replace defective foot screws (para 5-43).

5-5. Footscrews Turn Hard or Have Excessive Play

Probable cause	*Possible remedy*
Footscrew defective	Replace footscrew (para 5-53).

5-6. Circular Level Bubble Cannot Be Centered

Probable cause	*Possible remedy*
Spring washer defective	Replace spring washer (para 5-42).

5-7. Illumination of Horizontal Circle Image Uneven

Probable cause	*Possible remedy*
Illumination mirror cracked/broken	Replace illumination mirror (para 5-44).
Illumination prism dirty	Clean illumination prism (para 5-47).
Illumination prism cracked	Replace Illumination prism (para 5-47).

5-8. Horizontal Circle Lamp Does Not Light

Probable cause	*Possible remedy*
Lamp socket defective	Replace lamp socket (para 5-46).
Lamp switch defective	Replace lamp switch (para 5-48).
Wiring defective	Resolder faulty connections, replace defective parts (para 5-48).

5-9. Alidade Rotates Unevenly and Will Not Stay On Line

Probable cause	*Possible remedy*
Damaged or missing bearing balls	Replace bearing balls (para 5-9).
Defective bearing surface	Replace vertical axis and/or shell (para 5-49).

5-10. Image of Horizontal Circle Cannot Be Focused Sharply

Probable cause	*Possible remedy*
Lenses and/or prisms of horizontal microscope dirty	Clean lenses and prisms (para 5-49).

5-11. Image of Horizontal Circle Distorted

Probable cause	*Possible remedy*
Lens or prism of horizontal microscope cracked	Replace lens or prism (para 5-49).

5-12. Vertical Circle Lamp and Vertical Setting Circle Lamp Do Not Light

Probable cause	*Possible remedy*
Dirty or defective slip ring	Clean and it necessary replace defective slip ring (para 5-50).
Defective slip ring	Replace defective slip ring (para 5-50).

5-13. Horizontal Circle Turns Hard

Probable cause	*Possible remedy*
Axis gear dirty or defective	Clean axis gear. Replace if defective (para 5-50).
Sleeve gear dirty or defective	Clean sleeve gear. Replace if defective (para 5-50).

5-14. Horizontal Clamp Does Not Hold Alidade Positioned

Probable cause	*Possible remedy*
Threads on knob or clamp defective	Replace defective parts (para 5-50).
Clamp shoe defective or missing	Replace clamp shoe (para 5-50).

5-15. U-Frame Turns Hard

Probable cause	*Possible remedy*
Horizontal clamp shoe burred or cracked	Replace clamp shoe (para 5-50).
Vertical axis dirty	Clean vertical axis (para 5-49).

5-16. One or More Slow Motion Screws Turn Hard

Probable cause	*Possible remedy*
Moving parts clogged with dirt or other foreign matter	Disassemble and clean all parts (para 5-52).
Threaded parts damaged	Replace all threaded parts if damaged (para 5-52).
One or more parts bent or deformed	Replace all deformed parts (para 5-52).

5-17. Horizontal Micrometer Turns Hard

Probable cause	*Possible remedy*
Moving parts clogged with dirt or foreign matter	Disassemble and clean all parts (para 5-55).
Moving parts deformed	Replace all deformed parts (para 5-55).

5-18. Horizontal Micrometer Does Not Move Scale Image

Probable cause	*Possible remedy*
Spring broken	Replace spring (para 5-55).

5-19. Setting Circle, Vertical Circle, and/or Telescope Reticle Lamps Do Not Light

Probable cause	*Possible remedy*
Defective slipring contact	Replace defective contact (para 5-50).
Defective switch	Replace defective switch (para 5-56).
Defective wiring	Resolder defective connections, replace defective leads (para 5-56).

5-20. Eyepiece Micrometer Drive Turns Hard

Probable cause	*Possible remedy*
Moving parts clogged with dirt	Disassemble and clean all parts (para 5-57).
One or more gears damaged	Locate and replace defective parts (para 5-57).

5-21. Field of Telescope Image Not Clear

Probable cause	*Possible remedy*
Eyepiece lenses dirty	Disassemble and clean lenses (para 5-57).
Reticles dirty	Clean reticles (para 5-57).
Objective lenses dirty	Clean lenses (para 5-57).

5-22. Telescope Reticle Illumination Weak or Absent

Probable cause	*Possible remedy*
Diaphragm openings dirty	Clean diaphragm (para 5-57).
Telescope illumination mirror defective	Replace mirror (para 5-57).
Rotating contact in horizontal axis dirty or otherwise damaged	Clean or replace contact . (para 5-57).

5-23. Setting Circle Illumination Weak or Absent

Probable cause	*Possible remedy*
Defective lamp socket	Replace lamp socket (para 5-58).
Defective contact spring	Replace contact spring (para 5-58).

5-24. Setting Circle Image Not Clear

Probable cause	*Possible remedy*
Lenses of setting circle microscope dirty	Disassemble and clean lenses (para 5-58).
One or more lenses cracked or otherwise damaged	Replace defective lens or lenses (para 5-58).
Setting circle dirty .	Clean setting circle (para 5-58).

5-25. Setting Circle Tangent Screw Turns Hard

Probable cause	*Possible remedy*
Gears dirty	Disassemble and clean gears (para 5-58).
Gears defective	Replace defective gears para 5-58).

5-26. Horrebow-Talcott Level Assembly Turns Hard

Probable cause	*Possible remedy*
Clamp dirty	Disassemble and clean clamp (para 5-59).
Clamp shoe burred or otherwise damaged	Replace clamp shoe (para 5-59).

5-27. Horrebow-Talcott Level Clamp Cannot be Tightened

Probable cause	*Possible remedy*
Screw threads of knob or clamp stripped	Replace defective parts (para 5-59).
Clamp pin broken or missing	Replace clamp pin (para 5-59).

5-28. Horrebow-Talcott Level Vial Cannot Be Adjusted

Probable cause	*Possible remedy*
Plunger spring defective	Replace spring (para 5-59).
Threads of adjusting screw or sleeve stripped	Replace defective parts (para 5-59).

5-29. Vertical Circle Illumination Weak or Absent

Probable cause	*Possible remedy*
Illumination prism or microscope objective lenses dirty	Disassemble and clean prism and lenses (para 5-60).
Lamp contacts defective	Replace contacts (para 5-60).
Wiring defective	Repair or replace wiring (para 5-60).

5-30. Vertical Circle Image Not Clear

Probable cause	*Possible remedy*
Microscope lenses dirty.....	Disassemble and clean lenses (para 5-60).
Micrometer prisms dirty.....	Disassemble and clean prisms (para 5-60).
Splitting prisms dirty.....	Disassemble and clean prisms (para 5-60).

5-31. Image of Vertical Circle Distorted

Probable cause	*Possible remedy*
Lens or prism of vertical microscope cracked	Replace lens or prism (para 5-60).

5-32. Vertical Circle Turns Hard

Probable cause	*Possible remedy*
Drive gears dirty	Clean drive gears (para 5-64).
Drive gear or gears defective	Replace defective gears (para 5-64).

5-33. Vertical Collimation Level Cannot be Adjusted

Probable cause	*Possible remedy*
Adjust screw spring defective	Replace spring (para 5-61).
Threads of adjusting screw or bracket stripped	Replace adjusting screw and bracket (para 5-61).

5-34. Horizontal Axis Turns Hard

Probable cause	*Possible remedy*
Vertical clamp dirty	Disassemble and clean clamp (para 5-65).
Clamp shoe burred or otherwise defective	Replace clamp shoe (para 5-65).

5-35. Vertical Clamp Inoperative

Probable cause	*Possible remedy*
Threads of knob or arm stripped	Replace defective parts (para 5-65).
Actuating pin defective	Replace pin (para 5-65).

5-36. Telescope Image Not Clear

Probable cause	*Possible remedy*
Telescope mirror dirty	Remove and clean mirror (para 5-66).
Telescope objective lens dirty	Disassemble and clean lenses (para 5-68).

5-37. Telescope Image Distorted

Probable cause	*Possible remedy*
Telescope mirror cracked or otherwise damaged	Replace telescope mirror (para 5-66).
Telescope objective lens cracked or otherwise damaged	Replace damaged lens (para 5-68).

5-38. Telescope Illumination Mirror Turns Hard

Probable cause	*Possible remedy*
Axis and bearing dirty.....	Disassemble and clean parts (para 5-69).
Axis or bearing defective.....	Replace defective parts (para 5-69).

5-39. Telescope Illumination Diaphragm Turns Hard

Probable cause	*Possible remedy*
Dirt or other foreign matter obstructs rotation	Disassemble and clean all parts(para 5-69).
Diaphragm or sleeve deformed	Replace defective parts (para 5-69).

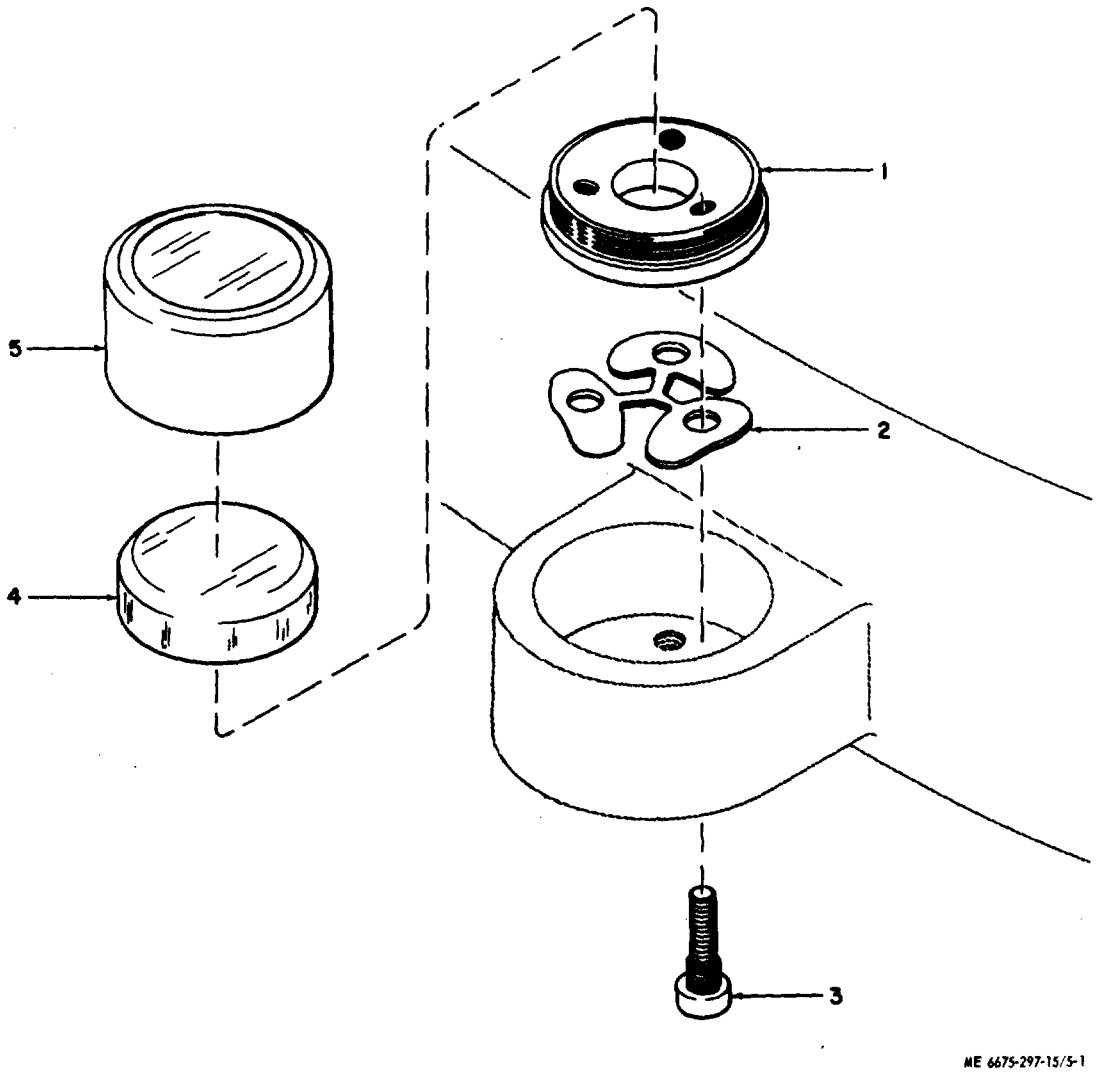
5-40. All Illumination Absent

Probable cause	*Possible remedy*
Connecting cable defective.	Disassemble and repair connecting cable (para 5-73).
Cable connector defective...	Replace cable connector (para 5-73).
Rheostat defective	Replace rheostat (para 5-73).

Section III. CIRCULAR LEVEL, FOOTSCREW ASSEMBLY, AND ILLUMINATION -MIRROR ASSEMBLY

5-41. General

The circular level, footscrew assembly, and illumination mirror assembly mount on the base assembly. The circular level provides for preliminary leveling of the theodolite. A footscrew assembly mounts in each of three lugs equally spaced around the base. They provide for adjusting the theodolite position so that the plane of rotation is level. The illumination mirror assembly mounts in the illumination lamp socket and can be positioned so as to direct daylight to an optical system which illuminates the horizontal circle.



1 Base
2 Spring Washer
3 Screw (3)
4 Level
5 Housing

Figure 5-1. Circular level, removal, disassembly, reassembly, and installation.

5-42. Circular Level

a. Removal and Disassembly. Refer to figure 5-1 and remove and disassemble the circular level.

b. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent. Clean the glass of the circular level with a soft, lint-free cloth or lens tissue.

(2) Inspect all threaded parts for worn or damaged threads. Inspect spring for deformation or other damage. Inspect level for cracks. Check to be certain that bubble is not larger than circle etched in center of level face.

(3) Remove all burred edges and minor dents from parts.

(4) Replace all parts that cannot be repaired.

c. Reassembly and Installation. Refer to figure 5-1 and reassemble and install the circular level.

5-43. Footscrew Assembly

a. Removal. Refer to figure 5-2 and remove the three footscrew assemblies.

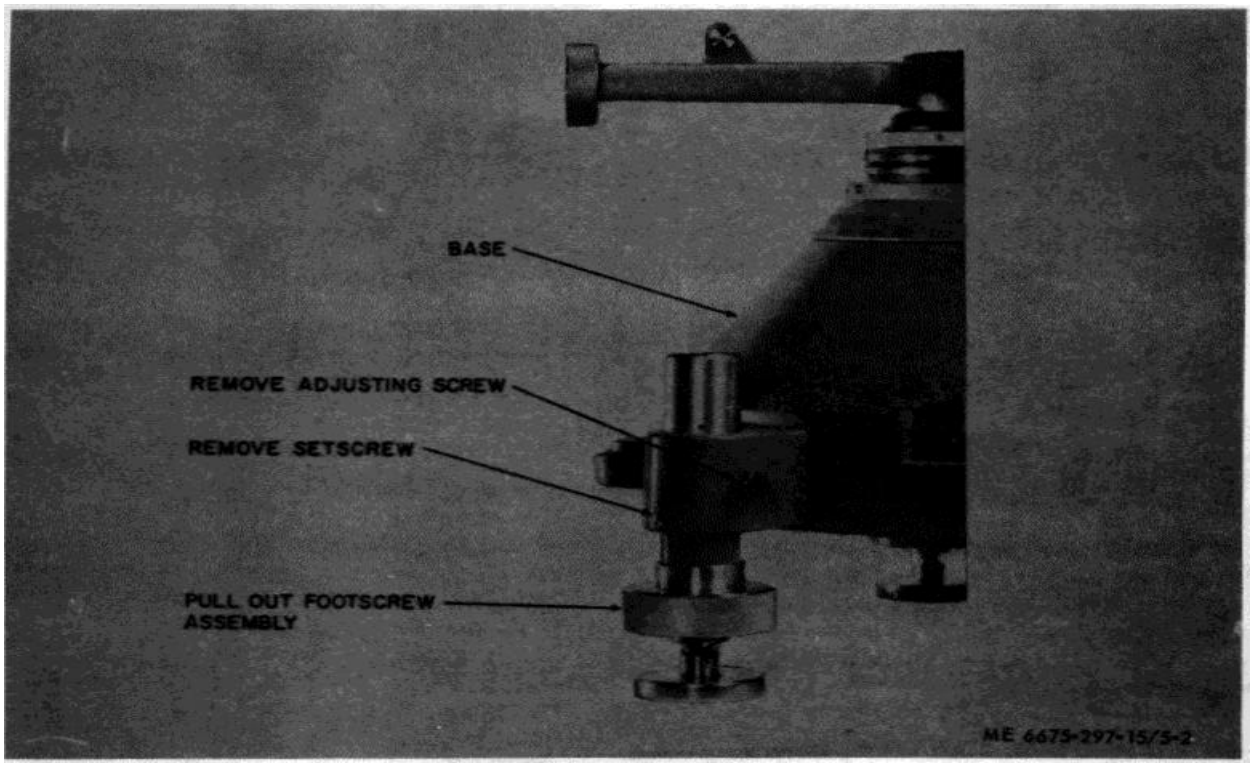
b. Assembly. Refer to figure 5-3 and disassemble the footscrew assembly.

c. Cleaning, Inspection, and Repair

(1) Clean all metal parts with an approved cleaning solvent.

(2) Inspect all threaded parts for worn or damaged threads. Check threaded components for binding or loose fit.

(3) Remove all burred edges and minor dents.



1 Cover
2 Setscrew
3 Setscrew
4 Adjusting screw
5 Nut
6 Pad
7 Footscrew
8 Knob
9 Lockscrew

Figure 5-2. Footscrew assembly, removal and installation.

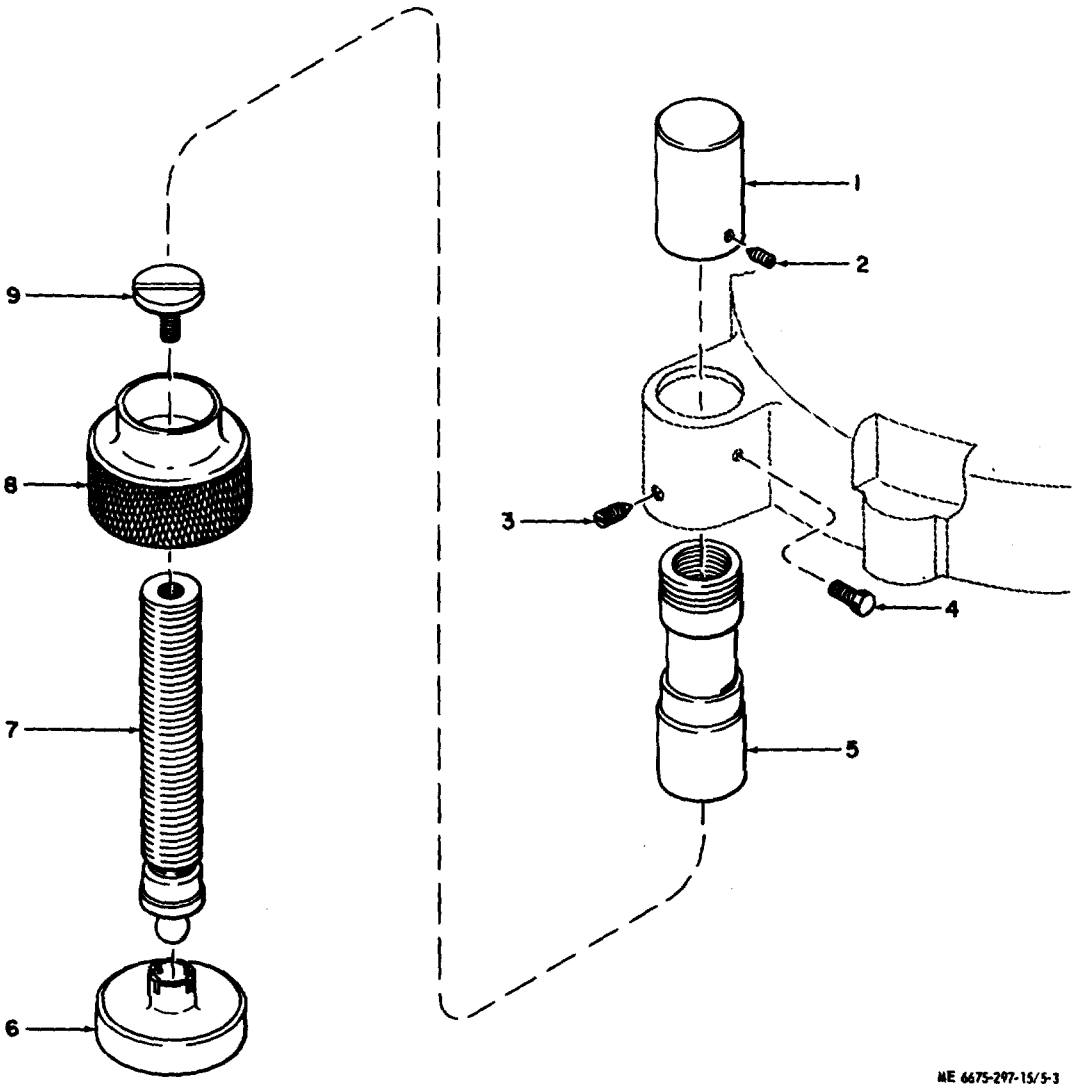


Figure 5-3. Footscrew assembly, disassembly and reassembly

(4) Replace all defective parts that cannot be repaired.

d. Reassembly. Refer to figure 5-3 and reassemble the footscrew assembly.

e. Installation. Refer to figure 5-2 and install the footscrew assembly.

5-44. Illumination Mirror Assembly

a. Removal. Pull illumination mirror assembly from lamp socket, twisting slightly to facilitate removal.

b. Disassembly. Refer to figure 5-4 and disassemble the illumination mirror assembly.

c. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent. Polish the mirror with a soft, lint-free cloth or lens tissue.

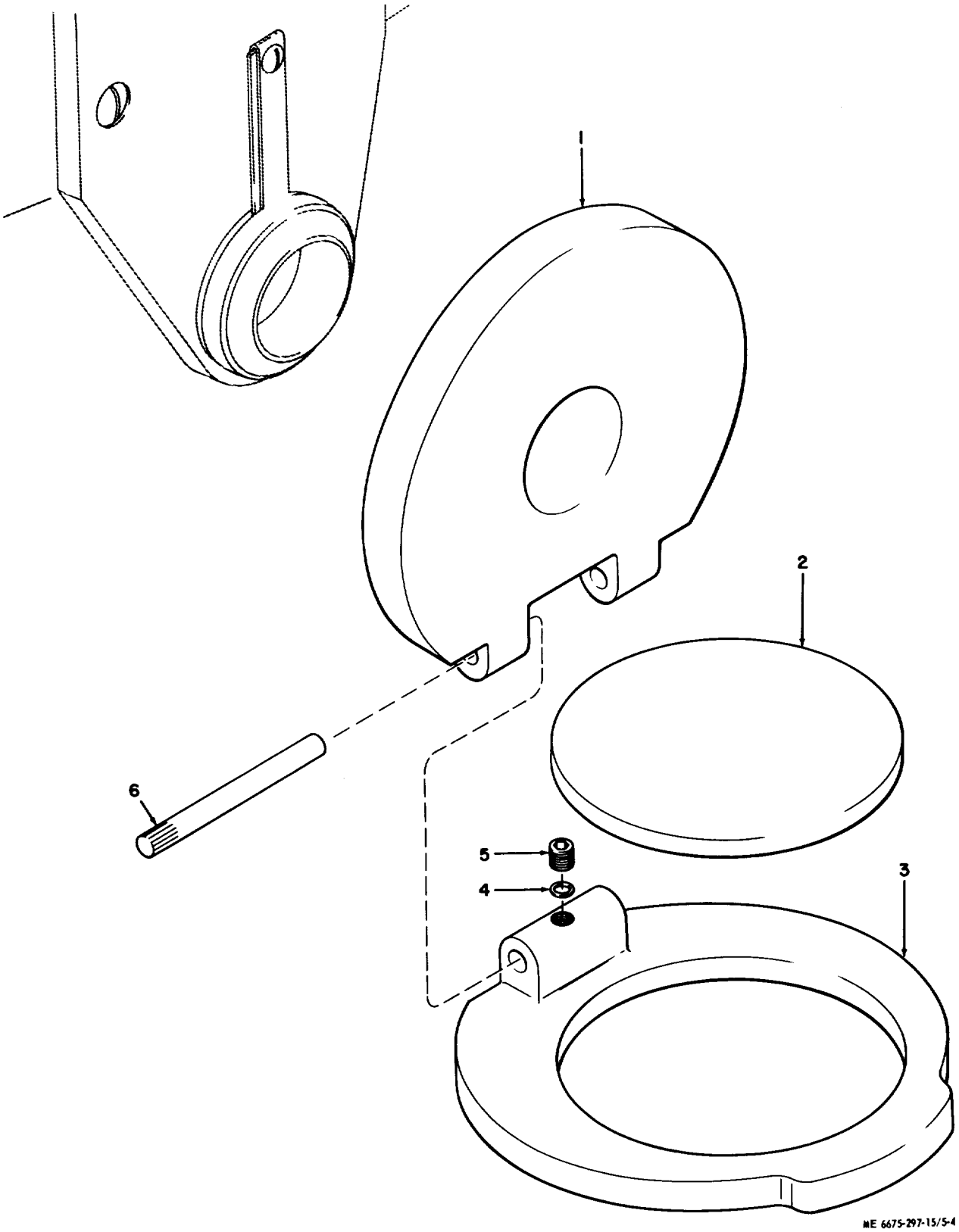
(2) Inspect all parts for burred edges or dents. Inspect mirror for scratches or etching.

(3) Remove all burred edges and minor dents.

(4) Replace defective parts which cannot be repaired.

d. Reassembly. Refer to figure 5-4 and reassemble illumination mirror assembly.

e. Installation. Press illumination mirror assembly into lamp socket.



1 Base 2 Mirror 3 Mount 4 Plug 5 Setscrew 6 Pin

Figure 5-4. Illumination mirror assembly, disassembly and reassembly.

Section IV. ILLUMINATION LAMP SOCKET, ILLUMINATION PRISM, BASE COVER AND ELECTRICAL PARTS

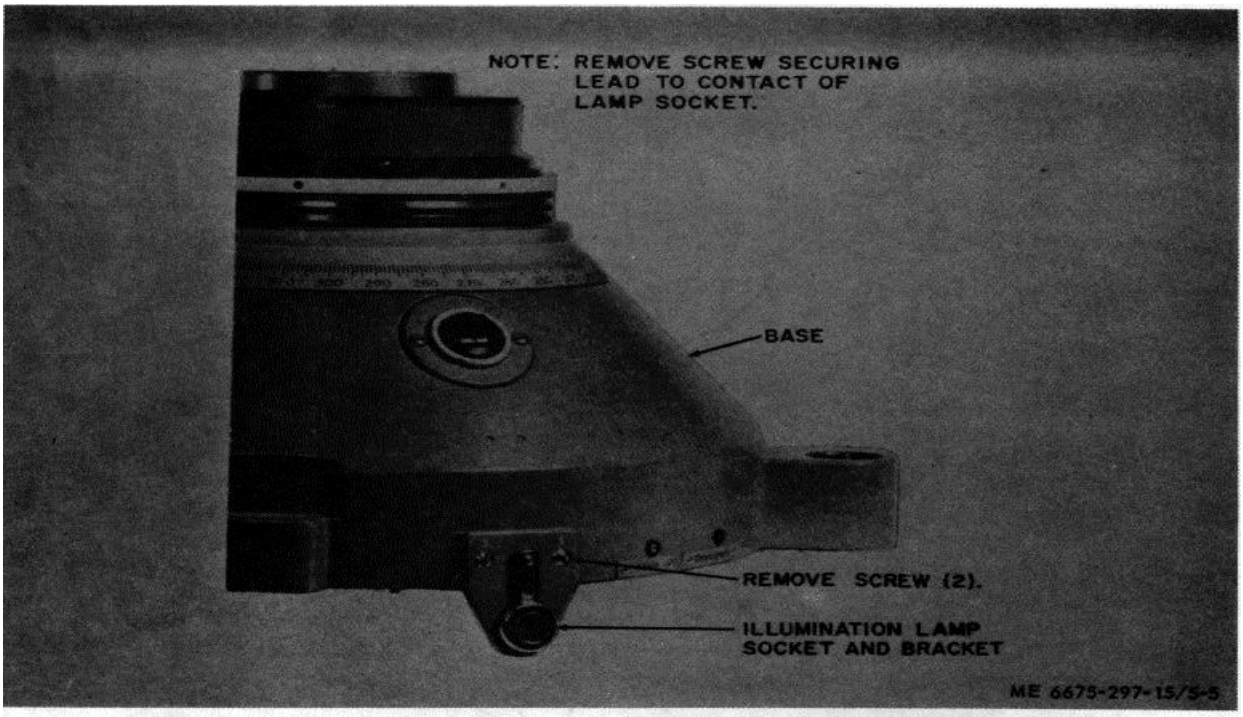
5-45. General

The illumination lamp socket mounts on a bracket at one side of the base. It provides for mounting the illumination mirror assembly or an illumination lamp. The illumination prism mounts at the center of the base cover and provides for reflecting light from the illumination mirror or lamp up into the splitting prisms which direct the light to the opposite sides of the horizontal circle.

5-46. Illumination Lamp Socket

a. Removal. Refer to figure 5-5 and remove illumination lamp socket and its mounting bracket.

b. Disassembly. Refer to figure 5-6 and disassemble the illumination lamp socket and mounting bracket.



1 Screw (2)
2 Switch and nut
3 Cover
4 Insulator (2)
5 Insulator (2)
6 Insulator
7 Connector
8 Screw (4)
9 Prism
10 Connector
11 Screw (12)
12 Setscrew
13 Terminal
14 Insulator
15 Lampholder
16 Clip
17 Setscrew
18 Bracket
19 Insulator
20 Insulator
21 Contact
22 Screw
23 Screw (2)
24 Pin (4)
25 Clip (3)
26 Screw (6)
27 Screw (2)
28 Contact
29 Screw (2)
30 Lens
31 Setscrew
32 Screw (2)
33 Prism
34 Screw (3)
35 Housing
36 Cover
37 Terminal (2)
38 Insulation
39 Cable assembly

Figure 5-5. Illumination lamp socket and bracket, removal and installation.

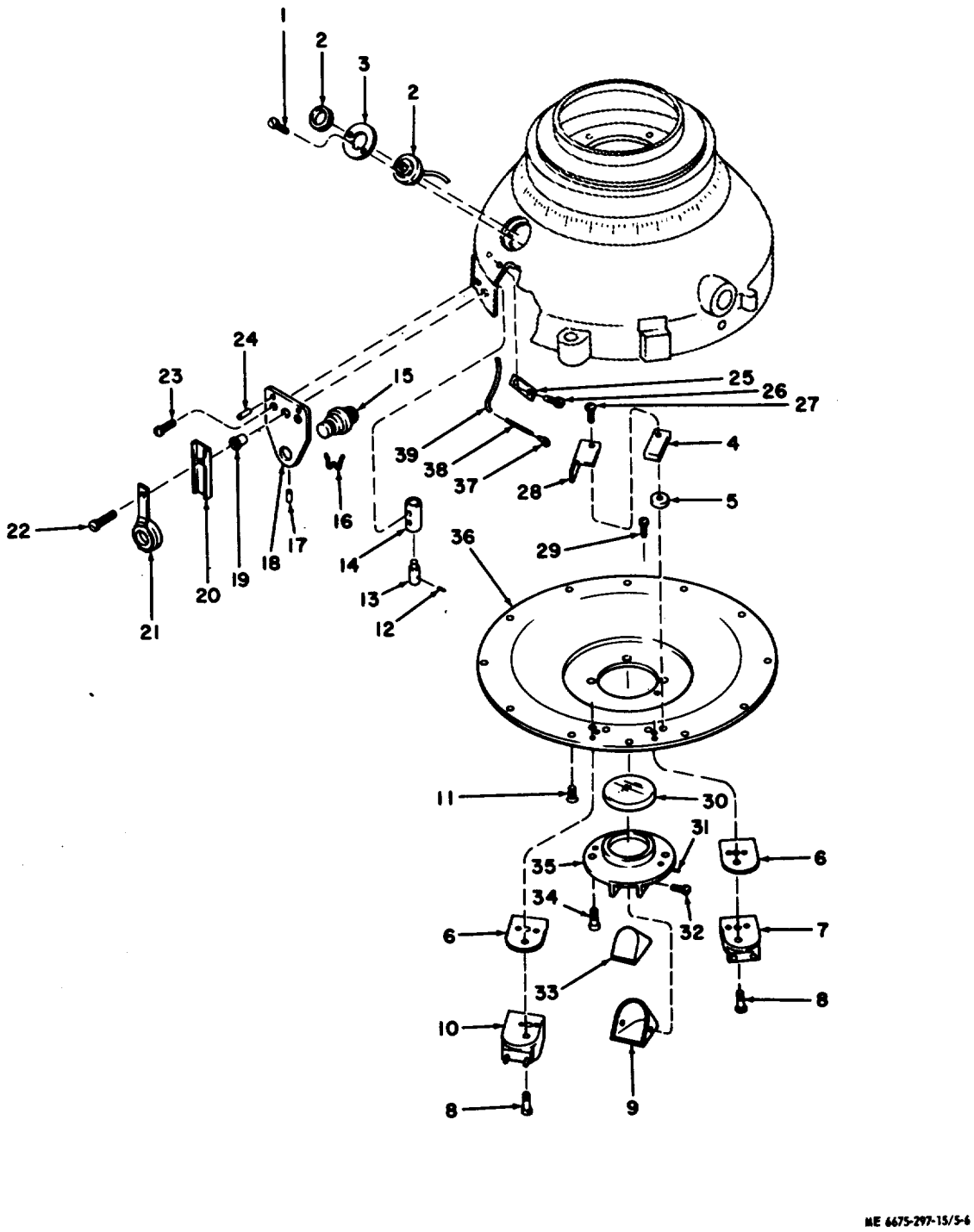


Figure 5-6. Illumination prism, base cover, and electrical parts, disassembly and assembly

c. Cleaning, Inspection, and Repair

(1) Clean all metal parts with an approved cleaning solvent. Burnish electrical contacts with fine crocus cloth.

(2) Inspect all parts for burrs and deformation. Inspect all threaded parts for worn or damaged threads. Inspect all insulating parts for cracks or other damage.

(3) Remove all burrs and minor dents.

(4) Reassembly all defective parts which cannot be repaired.

d. Reassembly. Refer to figure 5-6 and reassemble the illumination lamp socket mounting bracket.

e. Installation. Refer to figure 5-5 and install the illumination lamp socket and mounting bracket.

5-47. Illumination Prism

a. Removal. Refer to figure 5-7 and remove the illumination prism and mount.

b. Disassembly. Refer to figure 5-6 disassemble the illumination prism and mount.

c. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent. Clean the prism and lens with a soft, lint-free cloth or lens tissue.

(2) Inspect all threaded parts for worn or damaged threads. Inspect the prism mount for cracks or other damage. Inspect surfaces of prism and lens for scratches or etching.

(3) Remove all burrs from prism mount.

(4) Replace defective parts which cannot be repaired.

d. Reassembly. Refer to figure 5-6 and reassemble the prism and mount.

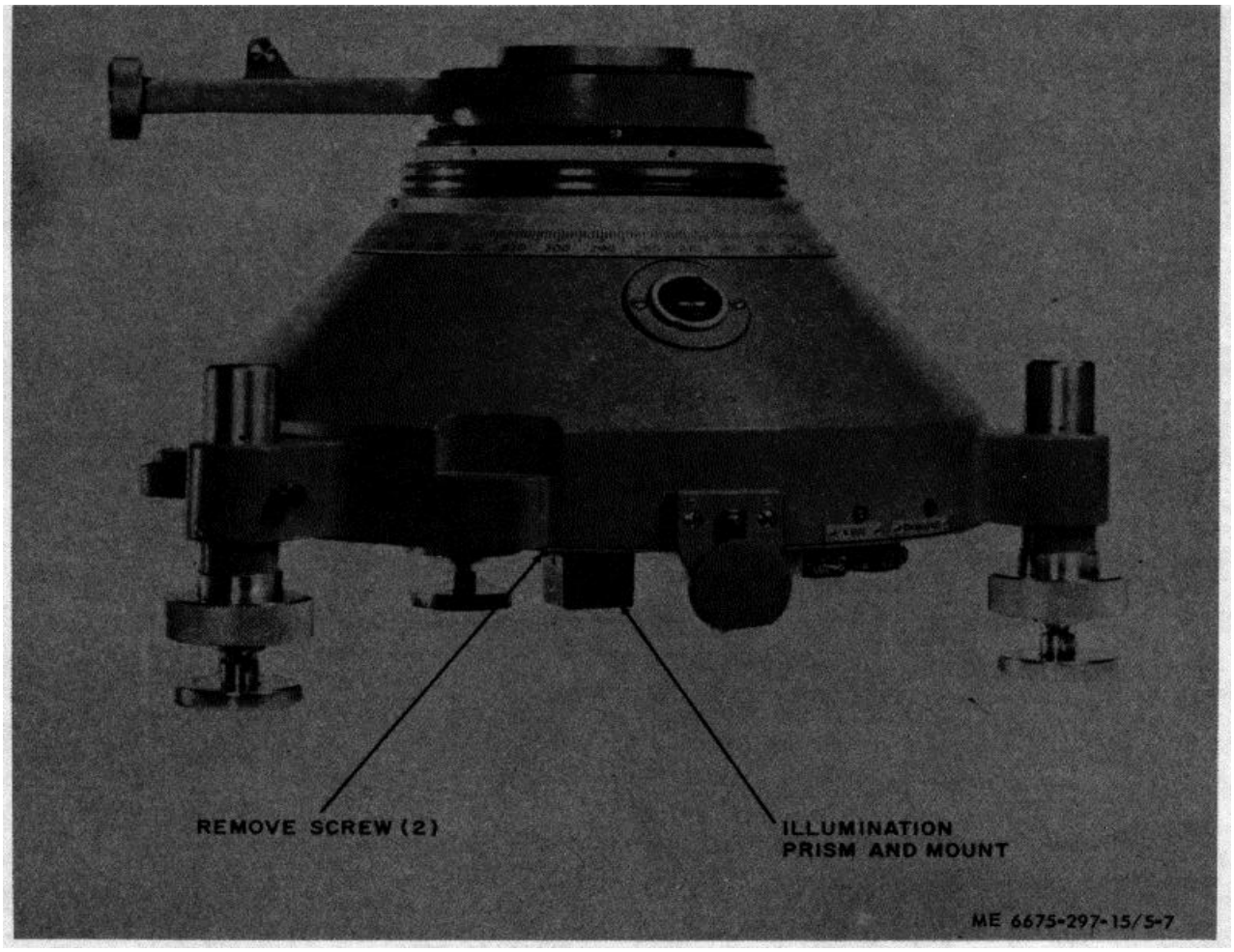


Figure 5-7. Illumination prism and removal and installation.

e. Installation. Refer to figure 5-7 and install the prism and mount.

5-48. Base Cover and Associated Parts

a. Removal. Refer to figure 5-8 and remove the base cover and associated parts.

b. Disassembly. Refer to figure 5-6 and disassemble the base cover and associated parts.

c. Cleaning, Inspection, and Repair

(1) Clean all metal parts with an approved cleaning solvent. Wipe electrical l)arts and wires clean with a clean cloth or stiff bristle brush.

(2) Inspect cover for cracks, dents, and deformation. Inspect electrical connectors for cracked insulation; bent, broken, or missing contacts; and evidence of overheating. Inspect all threaded parts for worn or damaged threads.

(3) Remove all minor dents from cover.

(4) Replace all defective parts which cannot be repaired.

d. Reassembly. Refer to figure 5-6 and reassembly the base, cover and electrical parts.

e. Installation. Refer to figure 5-8 and install the base cover and associated parts.

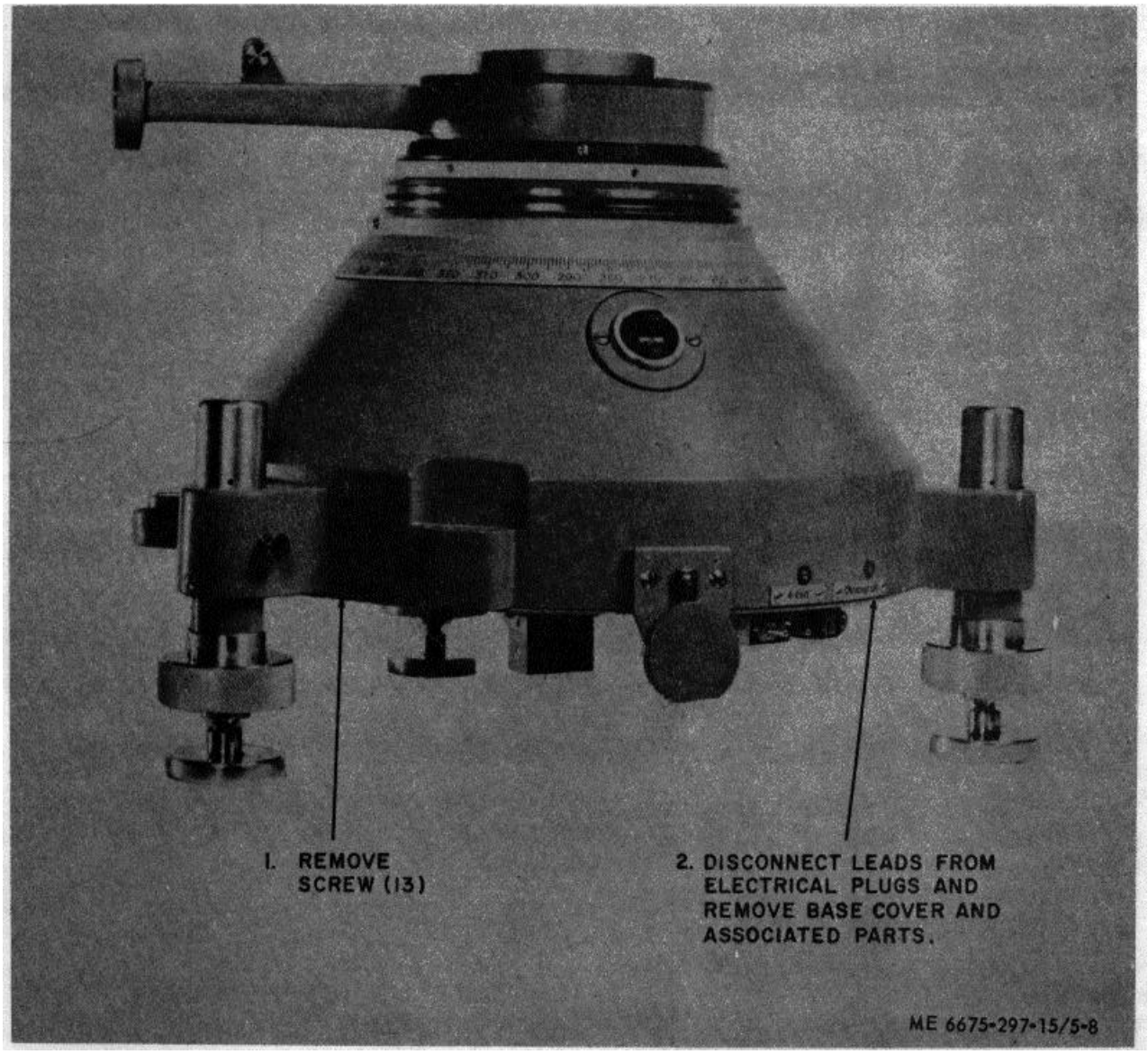


Figure 5-8. Base cover and associated parts, removal and installation.

Section V. HORIZONTAL CIRCLE AND VERTICAL AXIS, BASE, SLIPRINGS, HORIZONTAL CIRCLE DRIVE, AND CLAMP

5-49. Horizontal Circle and Vertical Axis

a. General. The horizontal circle and vertical axis are mounted within the base. The vertical axis supports the alidade so that it can be rotated freely about the axis. The horizontal circle is a graduated glass disc mounted on a sleeve which also rotates about the vertical axis.

b. Removal and Disassembly.

(1) Remove base cover and associated parts (para 548).

(2) Refer to figure 5-9 and remove the U-frame assembly.

(3) Refer to figure 5-10 and remove and disassemble the horizontal circle and vertical axis.

c. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent.

(2) Carefully wipe horizontal circle clean with a clean, soft, lint-free cloth or lens tissue.

(3) Inspect all parts for burrs, excessive wear, or deformation. Inspect horizontal circle for cracks, scratches, or damage to engraved scale. Inspect bearing balls for flat spots, cracks, or other damage. Inspect all threaded parts for worn or damaged threads.

(4) Remove burrs or minor dents.

(5) Replace defective parts which cannot be repaired.

d. Reassembly and Installation.

(1) Refer to figure 5-10 and reassemble and install the horizontal circle and vertical axis.

(2) Refer to figure 5-9 and install the U-frame assembly.

(3) Refer to paragraph 5-48 and install the base cover and associated parts.

5-50. Base, Sliprings, Horizontal Circle Drive, and Clamp

a. General. The sliprings and clamp mount on the top of the base together with horizontal setting circle.

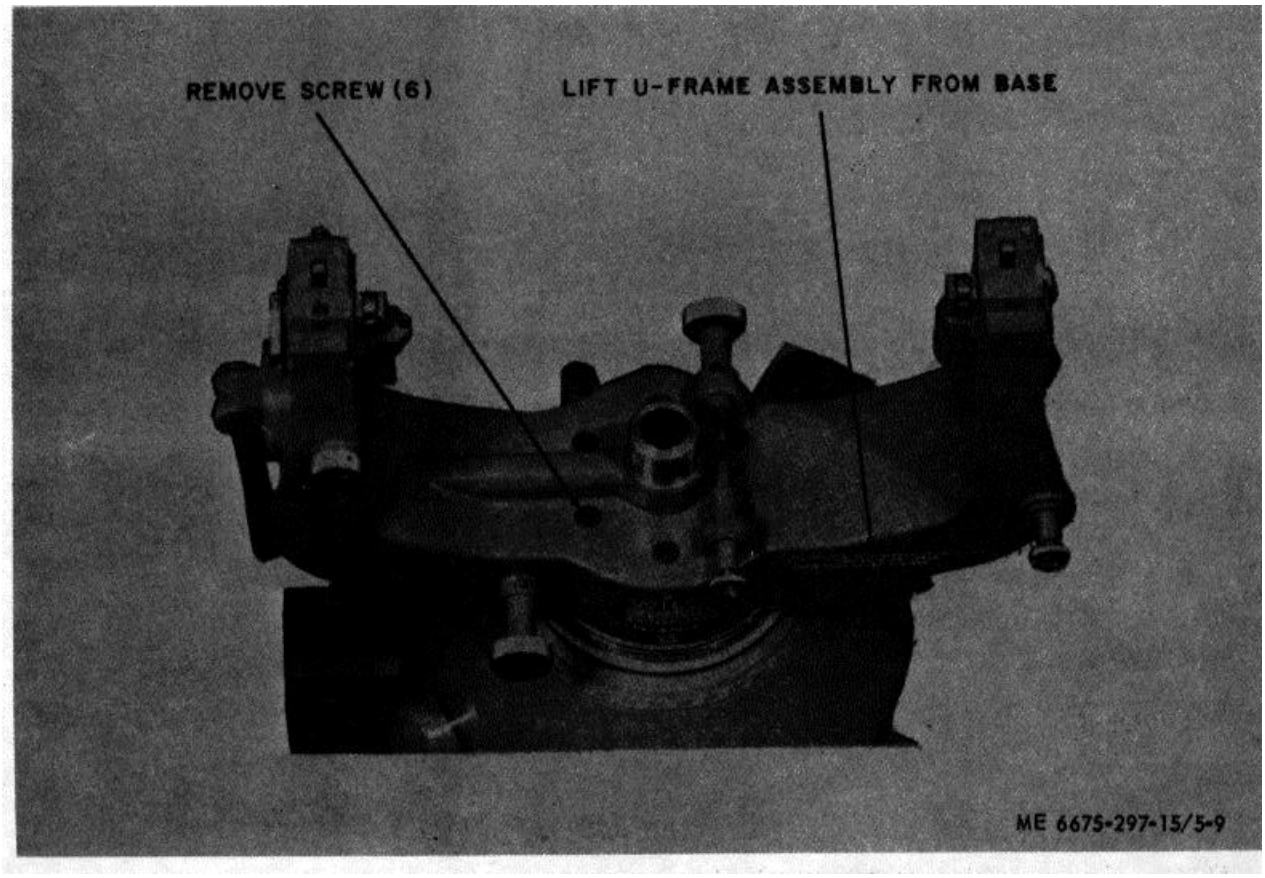
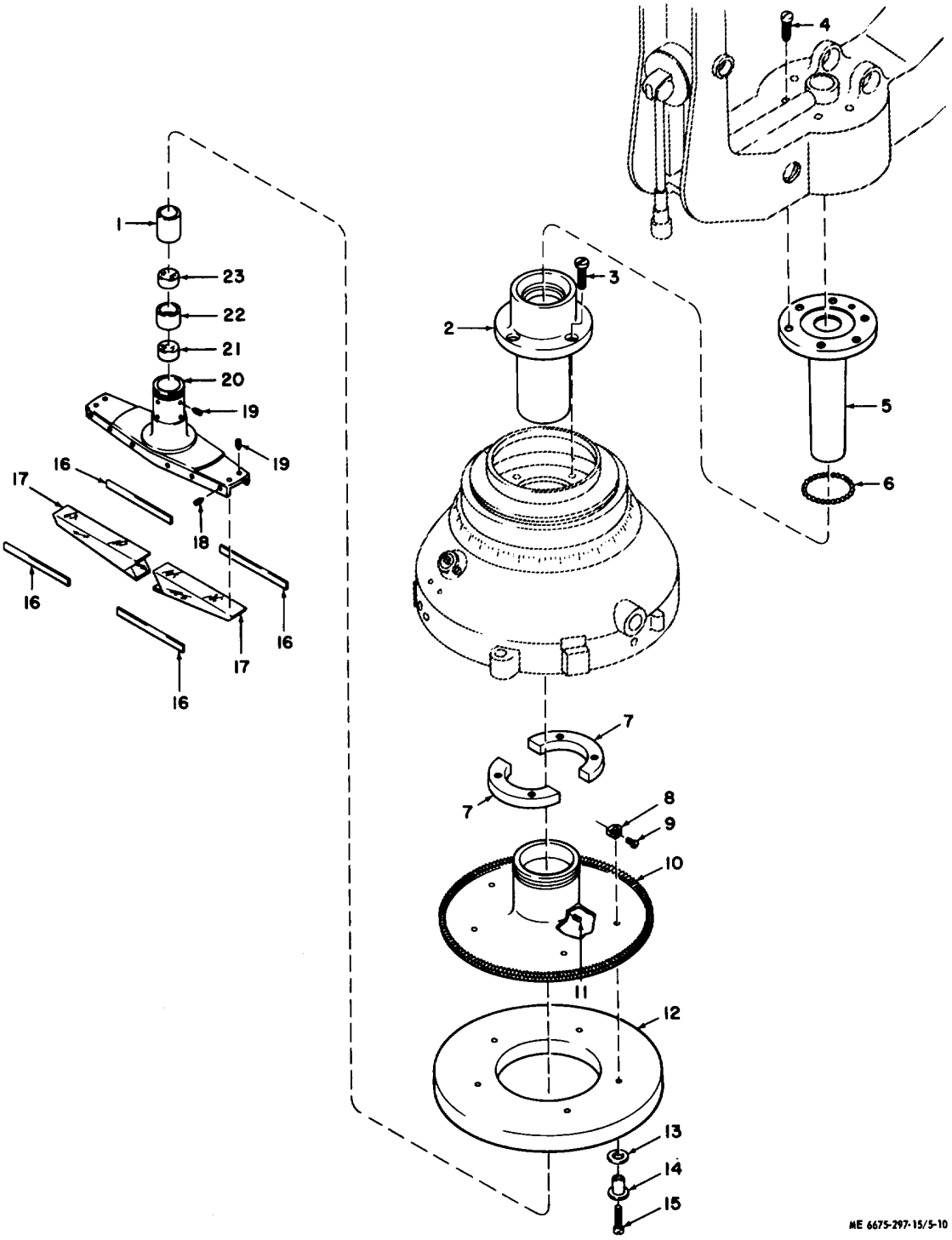


Figure 5-9. U-frame assembly, removal and installation.



1 Holder
2 Shell
3 Screw (4)
4 Screw (6)
5 Axis
6 Bearing ball (20)
7 Ring
8 Nut clamp (4)
9 Screw (4)
10 Sleeve
11 Setscrew (4)
12 Index circle
13 Washer (4)
14 Bushing
15 Screw (5)
16 Plate (4)
17 Prism assembly (2)
18 Setscrew (12)
19 Setscrew (6)
20 Carrier
21 Lens
22 Holder
23 Lens

Figure 5-10. Horizontal circle and vertical axis; removal, disassembly, reassembly, and installation.

The sliprings provide for connecting the electrical outlets in the base to components mounted on the rotating alidade. The clamp provides for holding the alidade in a fixed position and the setting circle provides for rough positioning of the alidade. The horizontal circle drive extends through the bottom of the base to engage the gear teeth of the horizontal circle mounting sleeve.

b. Removal and Disassembly.

(1) Remove horizontal circle and vertical axis (para 5-49).

(2) Refer to figure 5-11 and remove and disassemble base, sliprings, horizontal circle drive, and clamp.

c. Cleaning, Inspection, and Repair

(1) Clean all metal parts with an approved cleaning solvent.

(2) Inspect all parts for burrs, dents, and deformation. Inspect all threaded parts for worn or damaged threads. Inspect axis of horizontal circle drive for cracked or otherwise damaged gear teeth.

(3) Remove all burrs and minor dents from parts.

(4) Replace defective parts which cannot be repaired.

d. Reassembly and Installation.

(1) Refer to figure 5-11 and reassemble and install base, sliprings, horizontal circle drive, and clamp.

(2) Install horizontal circle and vertical axis (para 5-49).

Section VI. U-FRAME ASSEMBLY

5-51. Horizontal Axis Supporting Bearings

a. General. The horizontal axis supporting bearings consist of two pairs ball bearings mounted on separate housings, together with two spring loaded bearing assemblies. The paired ball bearings are mounted on the tops of the U-frame arms. One pair is adjustable in height to permit accurate leveling of the horizontal axis. The spring-loaded bearing assemblies are mounted at the side of the U-frame arms in such position that they bear most of the weight of the horizontal axis.

b. Removal and Disassembly. Refer to figure 5-12 and 5-13 and remove and disassemble the horizontal axis supporting bearings.

c. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent.

(2) Inspect all parts for burrs, dents, and deformation. Inspect ball bearings for smooth, free-running rotation. Inspect all threaded parts for worn or damaged threads.

(3) Remove all burrs and minor dents from parts.

(4) Replace defective parts which cannot be repaired.

d. Reassembly and Installation. Refer to figures 5-12 and 5-13 and reassemble and install the horizontal supporting bearings.

5-52. Slow Motion Screws

a. General. The horizontal slow motion screw mounts at the lower edge of one side of the U-frame. It operates against a lever on the horizontal clamp. A spring loaded sleeve on the opposite side of the lever maintains constant pressure to ensure reverse rotation of the alidade. The vertical slow motion screw is mounted at the middle of the U-frame. It operates against the vertical clamp arm. Reverse pressure is maintained against the vertical clamp arm by a springloaded bushing. The collimation slow motion screw is mounted near the bottom of the U-frame on the side opposite the horizontal slow motion

1 Setscrew (2)
2 Retaining ring
3 Shoe
4 Clamp
5 Pin
6 Screw
7 Knob
8 Ring
9 Retaining ring
10 Screw (3)
11 Screw (2)
12 Setscrew
13 Axis
14 Bushing
15 Setscrew
16 Knob
17 Axle
18 Pin
19 Spring
20 Cover
21 Screw
22 Screw (3)
23 Bushing
24 Stop
25 Rivet (2)
26 Spring (4)
27 Contact (2)
28 Setscrew (2)
29 Insulator
30 Base
31 Designation plate
32 Screw (2)
33 Insulator (2)
34 Drive screw (4)
35 Designation Plate
36 Pin (4)
37 Index ring
38 Screw (2)
39 Screw (2)
40 Insulator (2)
41 Slipring
42 Insulator
43 Insulator
44 Slipring
45 Insulator
46 Spring washer
47 Rivet (2)

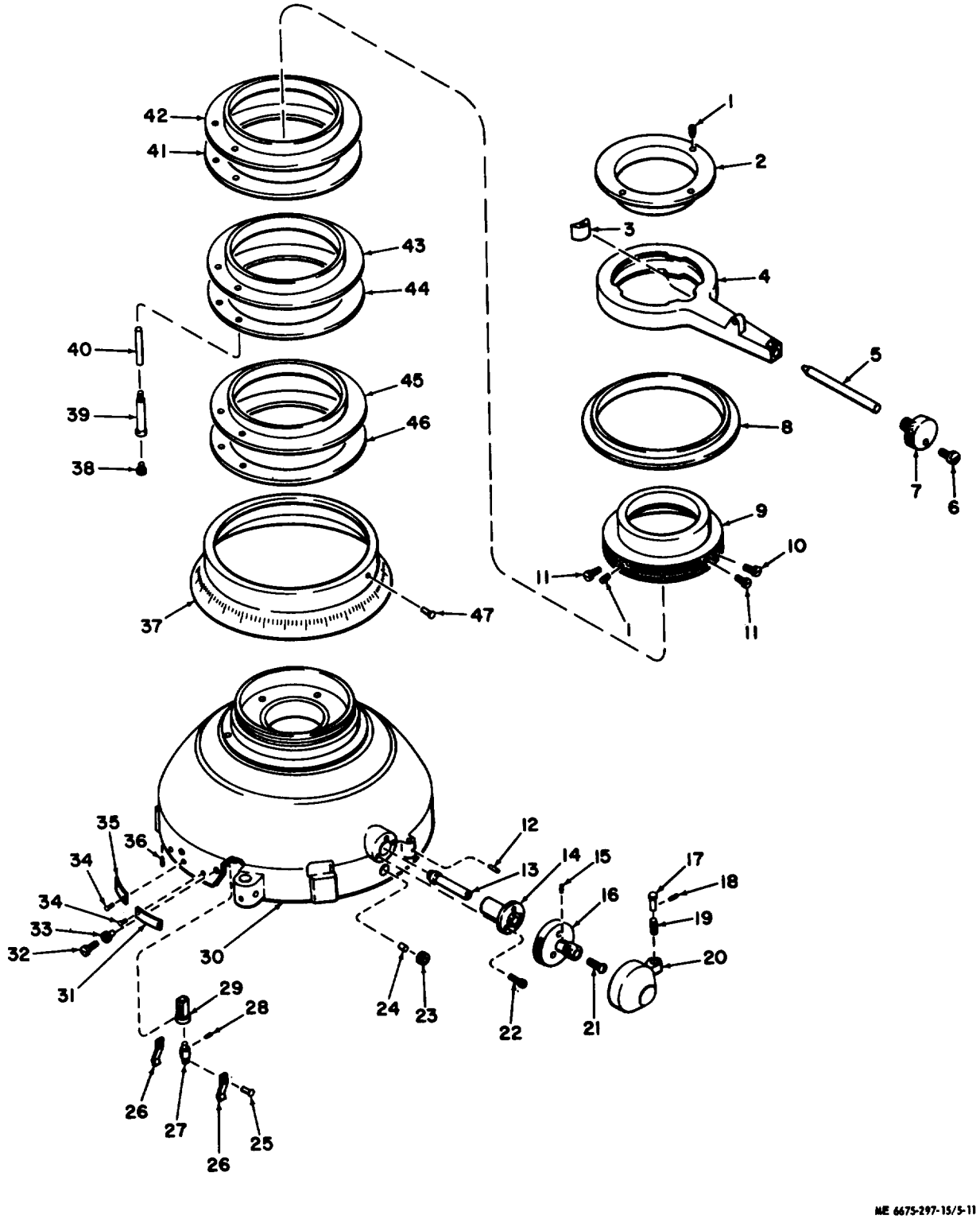
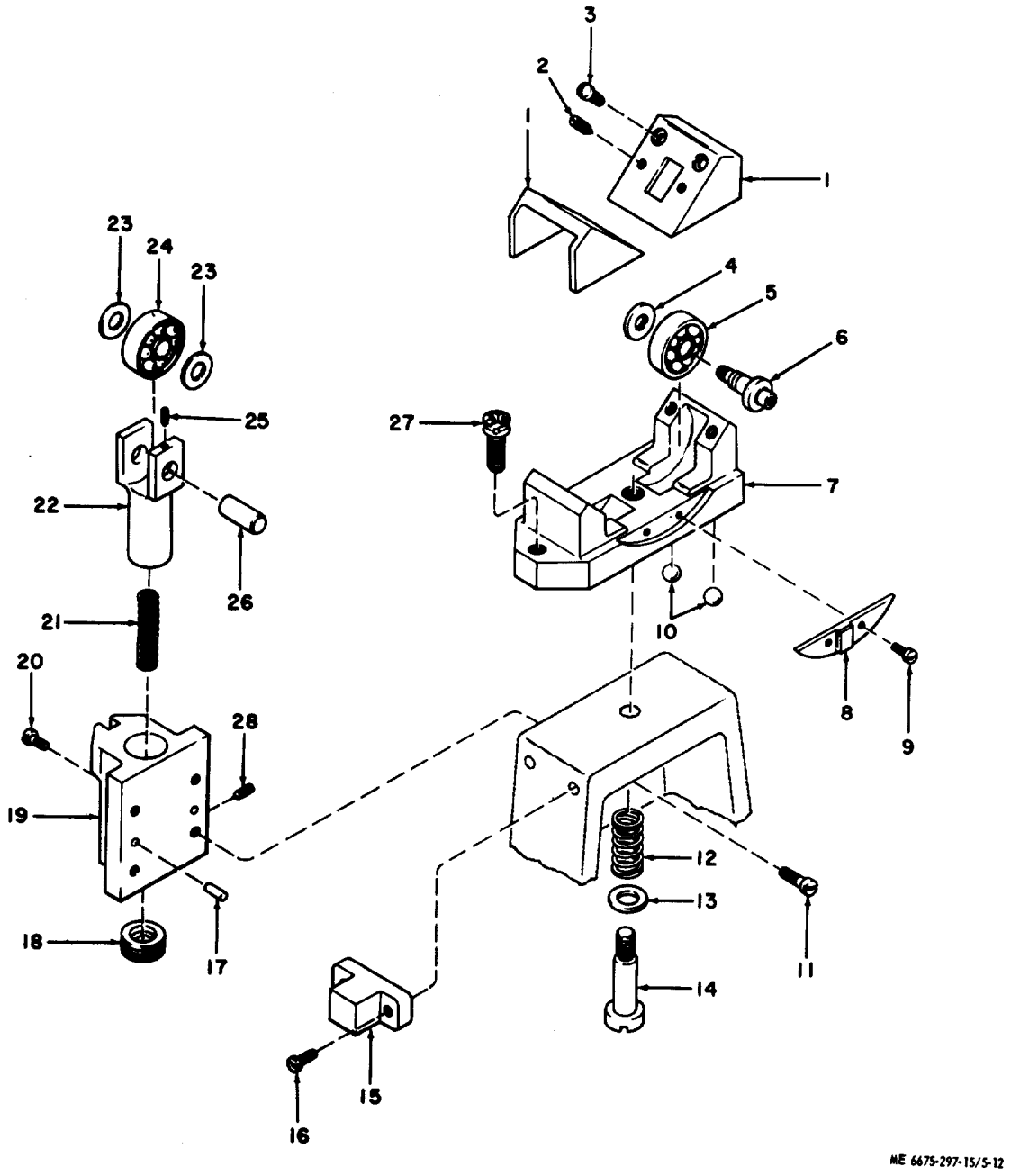
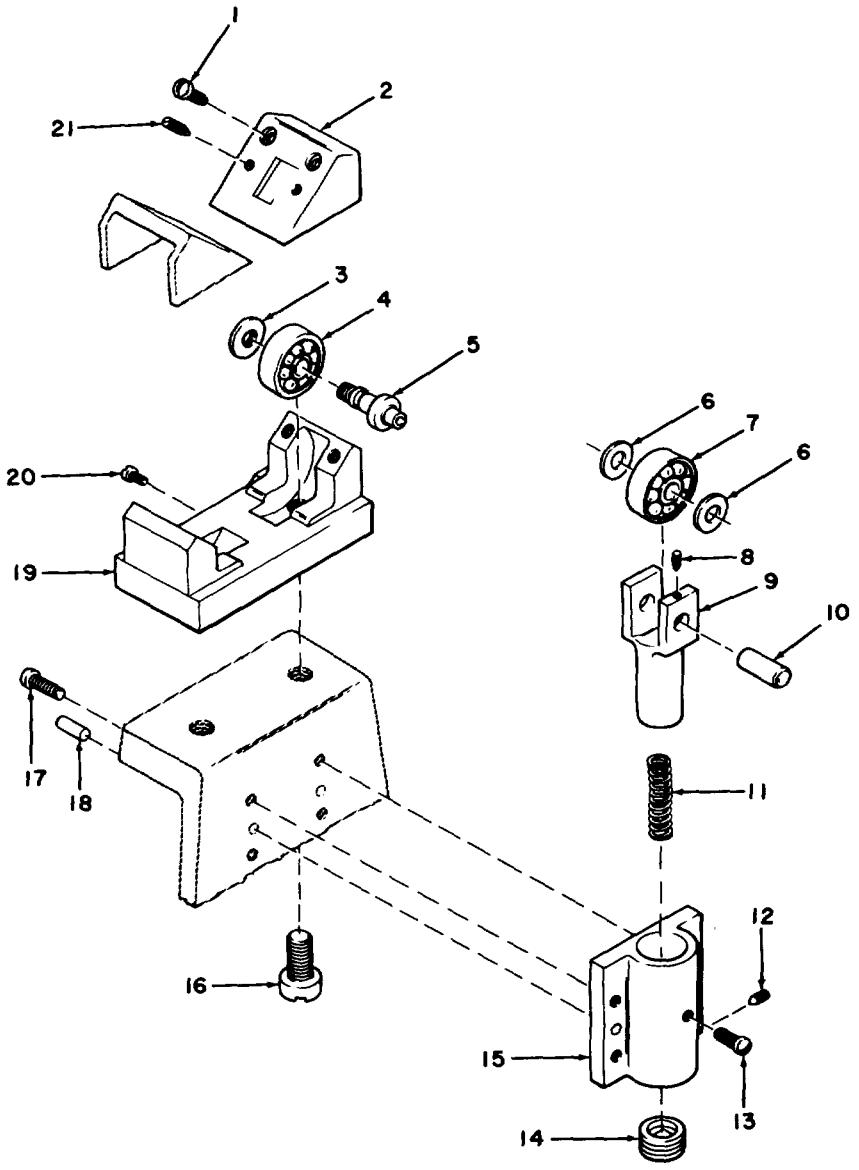


Figure 5-11. Base, Sliprings, horizontal circle drive, and clamp; removal, disassembly, reassembly, and installation.



1 Bearing cover (2)	8 Stop plate	15 Bracket	22 Bushing
2 Setscrew (4)	9 Screw (2)	16 Screw (2)	23 Washer (2)
3 Screw (4)	10 Ball bearing (2)	17 Pin (2)	24 Ball bearing
4 Nut (2)	11 Screw (4)	18 Nut	25 Setscrew
5 Ball bearing	12 Spring	19 Sleeve	26 Pin
6 Axis (2)	13 Washer	20 Screw	27 Adjusting screw
7 Housing	14 Screw	21 Spring	28 Setscrew

Figure 5-12. Horizontal axis adjustable supporting bearing; removal, disassembly, reassembly, and installation.



1 Screw (4)
2 Bearing cover (2)
3 Nut (2)
4 Ball bearing
5 Axis (2)
6 Washer (2)
7 Ball bearing
8 Setscrew
9 Bushing
10 Pin
11 Spring
12 Setscrew
13 Screw
14 Nut
15 Sleeve
16 Screw (2)
17 Screw (4)
18 Pin (2)
19 Housing
20 Screw
21 Setscrew (4)

Figure 5-13. Horizontal axis fixed supporting bearing; removal, disassembly, reassembly, and installation.

screw. It operates against a lug on the bottom of the collimation housing. Reverse pressure is maintained against the lug by spring-loaded bushing.

b. Removal and Disassembly. Refer to figure 5-14 and remove and disassemble the horizontal, vertical, and collimation slow motion screws and their associated components.

c. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent.

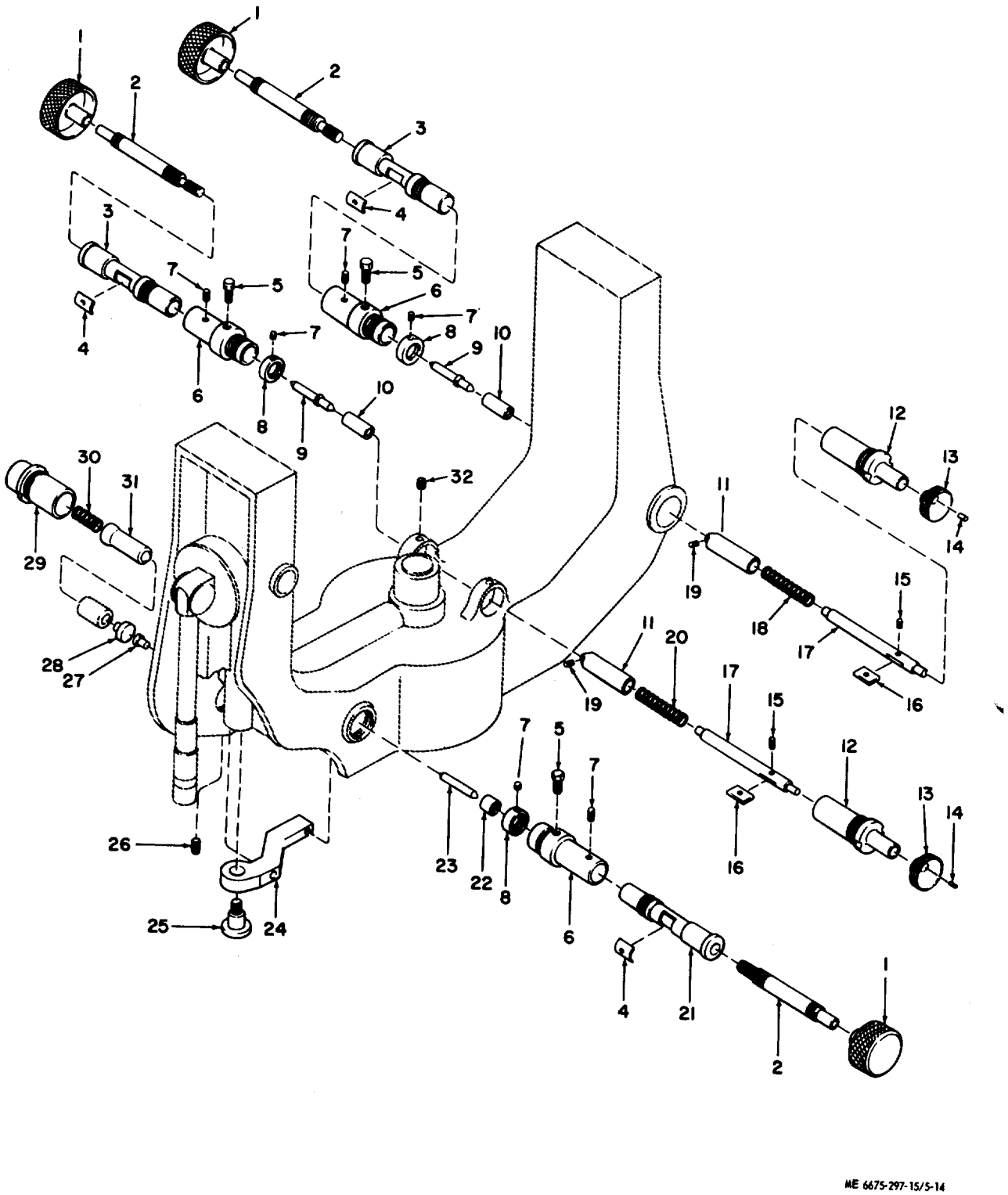


Figure 5-14. Slow motion screws; removal, disassembly, reassembly, and installation.

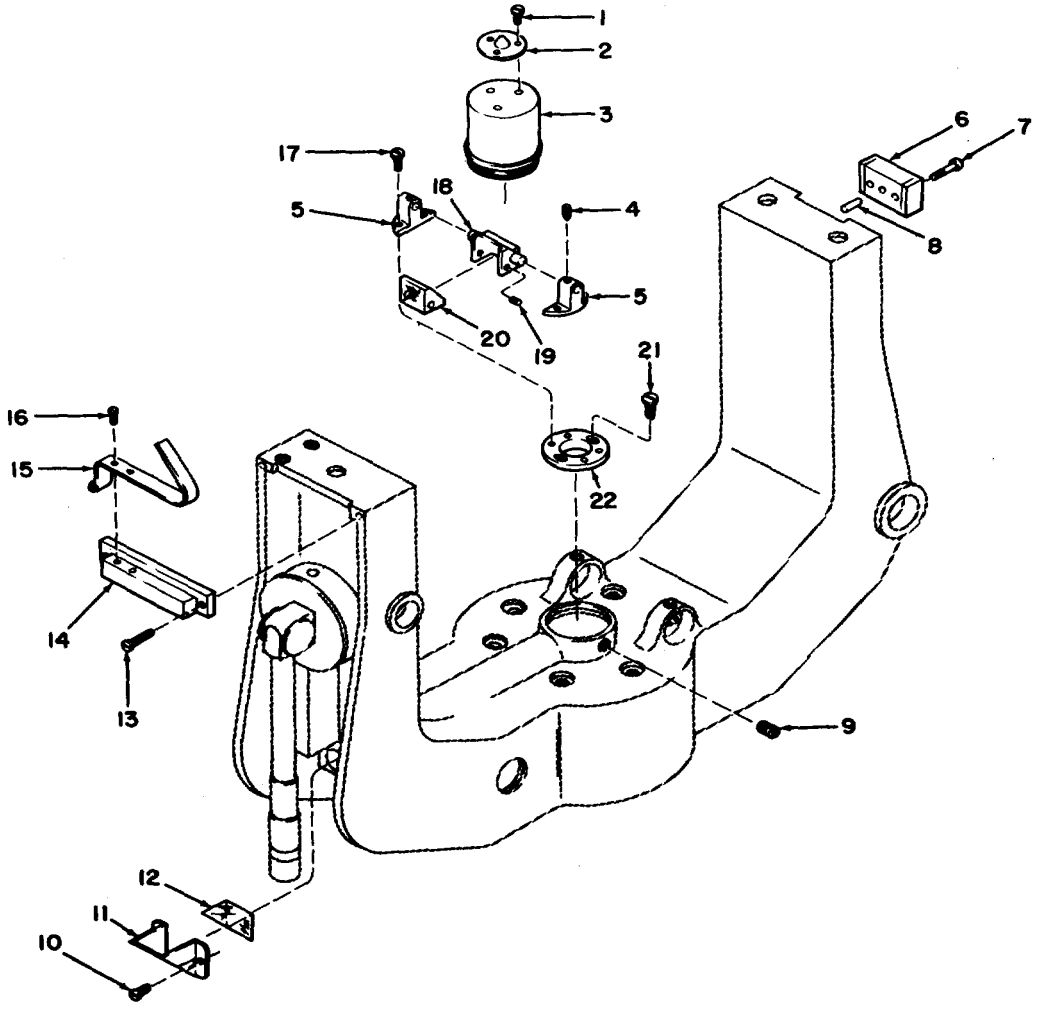
1 Knob
2 Spindle
3 Adjusting nut
4 Shoe
5 Adjusting screw
6 Bushing
7 Setscrew (6)
8 Lock nut
9 Pin
10 Nut
11 Housing
12 Housing
13 Knob
14 Setscrew
15 Setscrew
16 Key
17 Pin
18 Spring
19 Setscrew
20 Spring
21 Adjusting nut
22 Nut
23 Pin
24 Lever
25 Screw
26 Setscrew (2)
27 Bearing
28 Bearing
29 Housing
30 Spring
31 Housing
32 Setscrew (2)

(2) Inspect all parts for burrs, dents, or other deformation. Inspect all threaded parts for worn or damaged threads.

(3) Remove all burrs and minor dents from parts.

(4) Replace defective parts which cannot be repaired.

d. Reassemble and Installation. Refer to figure 4-14 and reassemble and install the horizontal, vertical, and collimation screws and their associated components.



1 Screw (3)
2 Center
3 Cover
4 Setscrew (2)
5 Bearing (2)
6 Stop
7 Screw (2)
8 Pin
9 Screw
10 Screw (2)
11 Housing
12 Prism
13 Screw (2)
14 Insulator
15 Spring
16 Screw
17 Screw (4)
18 Housing
19 Setscrew
20 Prism
21 Screw (2)
22 Sleeve

Figure 5-15. Prisms and mounts; removal, disassembly, reassembly, and installation.

5-53. Horizontal Circle Reading Prisms and Mounts

a. General. Two horizontal circle reading prisms are mounted within the bottom of the U-frame. They serve to direct the image rays of the opposite points of the horizontal circle from the splitting prisms to the horizontal microscope. Each prism is carried in a separate mount. That located at the center of the U-frame can be adjusted to center the images ill the microscope field.

b. Removal and Disassembly. Refer to figure 5-15 and remove and disassemble the prisms and mounts.

c. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent. Polish prisms with a soft, lint free cloth.

(2) Inspect all parts for burrs, dents, or deformation. Inspect threaded parts for worn or damaged threads. Inspect surfaces of prisms for scratches or etching.

(3) Remove all burrs and minor dents from parts.

(4) Replace defective parts which cannot be repaired.

d. Reassembly and Installation. Refer to figure 5-15 and reassemble and install the prisms and mounts.

5-54. Horizontal Reading Microscope

a. General. The horizontal reading microscope mounts on a bracket on one side of the U-frame. It is pivoted so that when not in use it can be swung down against the U-frame to facilitate

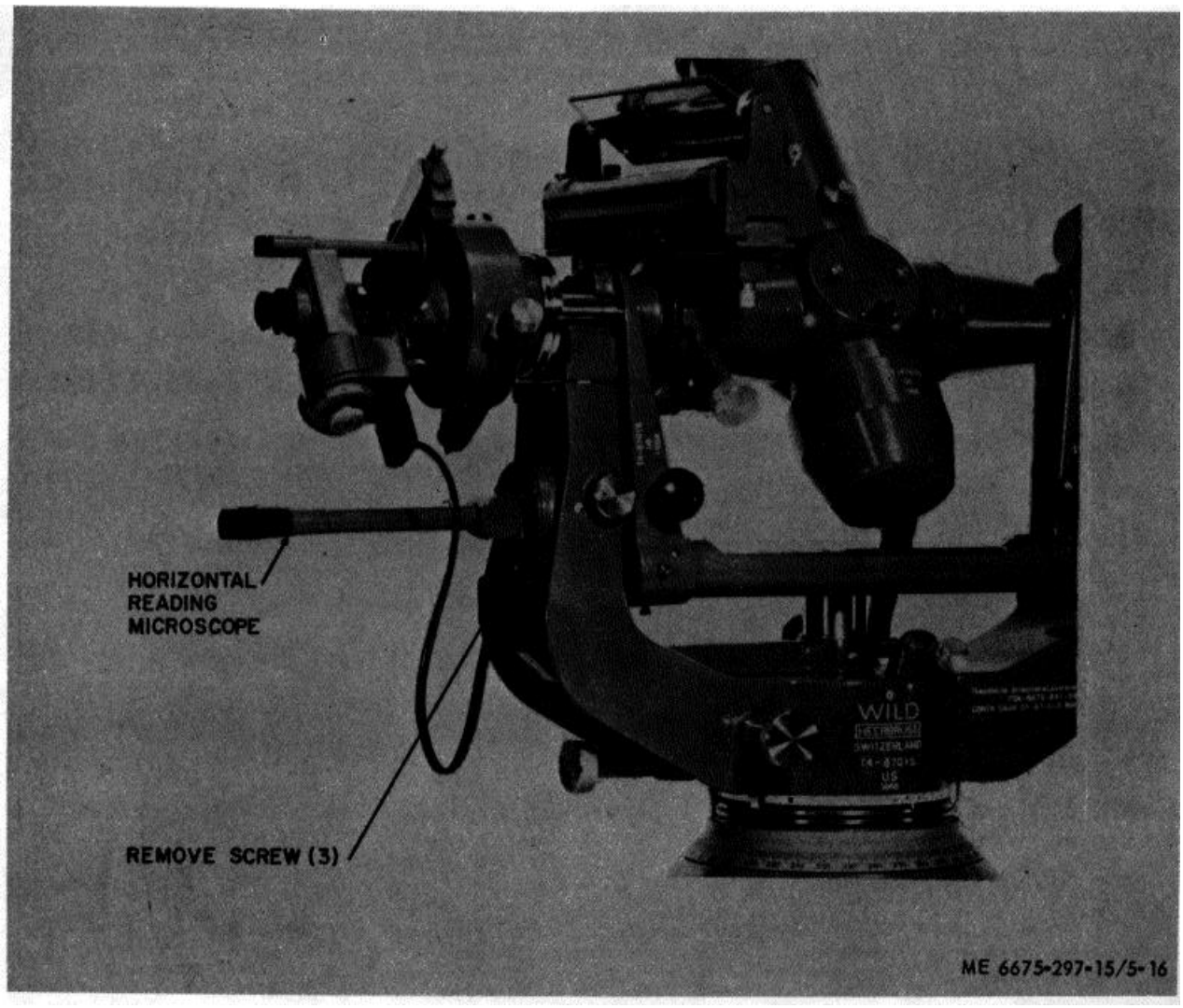
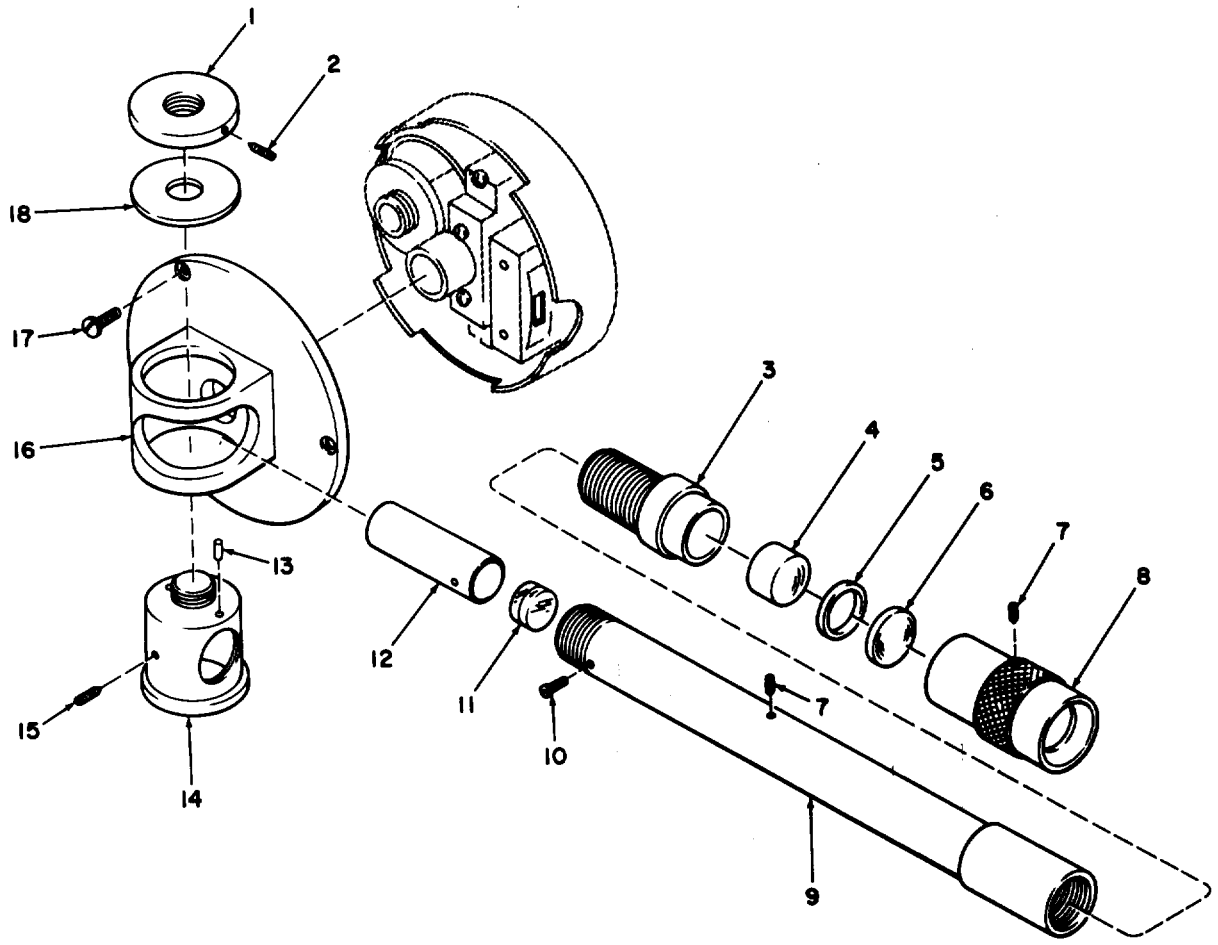


Figure 5-16. Horizontal Reading Microscope, removal and installation.



NE 6675-297-15/5-17

1 Nut	5 Spacer	9 Tube	13 Pin (2)	17 Screw (3)
2 Setscrew	6 Lens	10 Screw (2)	14 Bearing	18 Spring washer
3 Housing	7 Setscrew 92)	11 Lens assembly	15 Setscrew	
4 Lens assembly	8 Knob	12 Housing	16 Bracket	

Figure 5-17. Horizontal reading microscope, disassembly and reassembly.

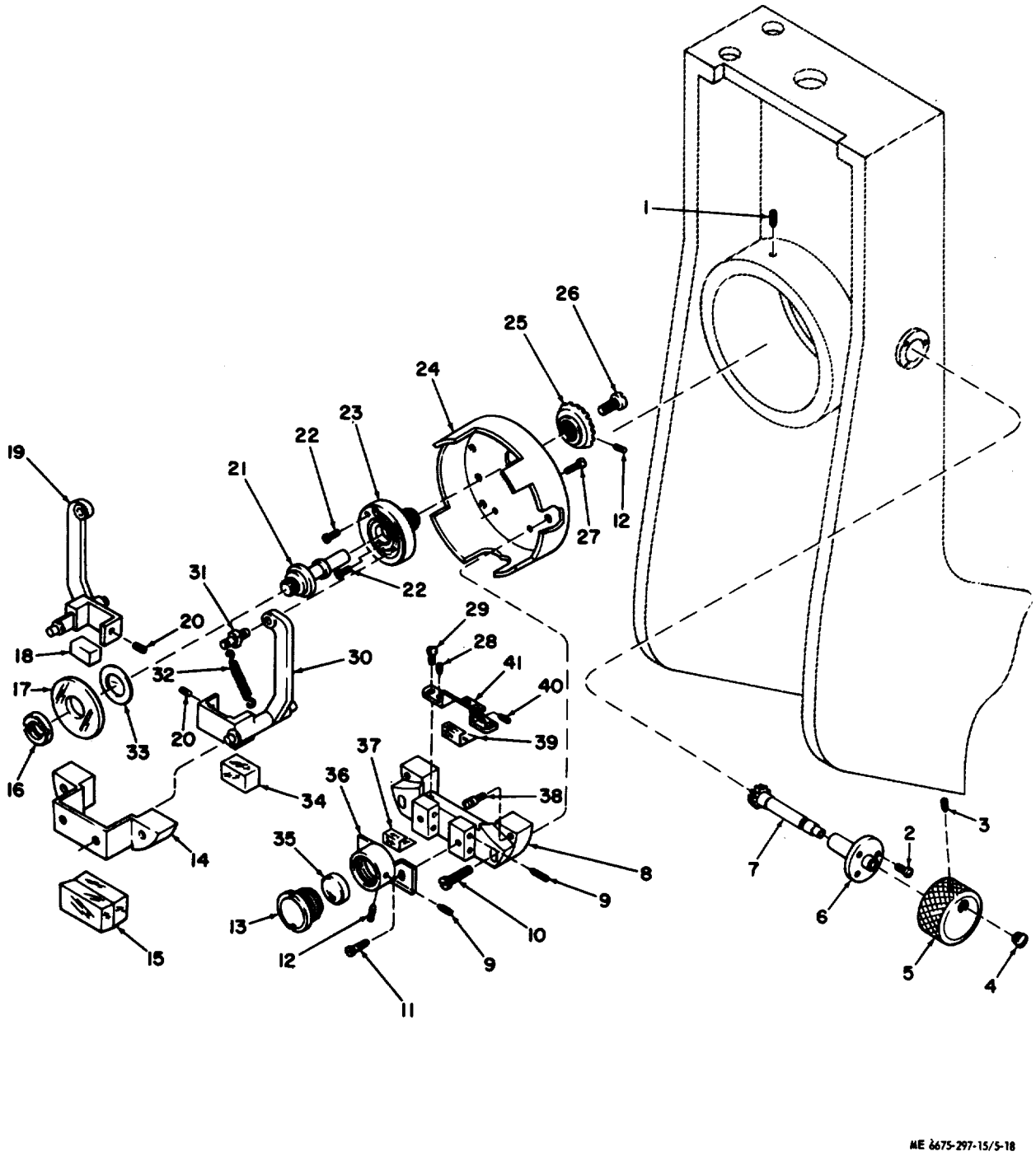


Figure 5-18. Horizontal Micrometer; removal, disassembly, reassembly, and installation.

1 Setscrew (3)
2 Screw (3)
3 Screw
4 Setscrew
5 Knob
6 Bushing
7 Gear axis
8 Mount
9 Setscrew (5)
10 Screw (2)
11 Screw (2)
12 Setscrew (3)
13 Retainer
14 Bearing
15 Prism assembly
16 Nut
17 Circle
18 Plate
19 Right lever
20 Setscrew (2)
21 Axis
22 Screw (2)
23 Wheel
24 Housing
25 Bevel gear
26 Screw
27 Screw (2)
28 Setscrew (3)
29 Screw (3)
30 Left lever
31 Pin (2)
32 Spring
33 Spacer (2)
34 Plate
35 Lens
36 Housing
37 Prism
38 Screw (2)
39 Prism
40 Setscrew
41 Mount

packing and prevent damage during transport. The micrometer magnifies the images of the horizontal scale to permit accurate readings.

b. Removal. Refer to figure 5-16 and remove the horizontal reading microscope.

c. Disassembly. Refer to figure 5-17 and disassemble the horizontal reading microscope.

d. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent. Polish all lenses with a clean, soft, lint-free cloth or lens tissue.

(2) Inspect all parts for burrs, dents, or deformation. Inspect all threaded parts for worn or damaged threads. Inspect all lenses for scratches and etching.

(3) Remove all burrs and minor dents.

(4) Replace defective parts which cannot be repaired.

e. Reassembly. Refer to figure 5-17 and reassemble the horizontal reading microscope.

f. Installation. Refer to figure 5-16 and install the horizontal reading microscope.

5-55. Horizontal Micrometer

a. General. The horizontal micrometer is mounted within the U-frame behind the horizontal reading microscope bracket. It consists of adjustable prisms which move one image of the horizontal circle with respect to the other to provide a vernier measurement. A graduated glass circle indicates the relative positions of the images.

b. Removal and Disassembly. Refer to figure 5-18 and remove and disassemble the horizontal micrometer.

c. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent. Polish all lenses and prisms and the graduated glass circle with a soft, clean, lint free cloth or lens tissue.

(2) Inspect all parts for burrs, dents, or deformation. Inspect all threaded parts for worn or damaged threads. Inspect lenses and prisms for scratches and etching.

(3) Remove all burrs and minor dents.

(4) Replace defective parts which cannot be repaired.

d. Reassembly and Installation. Refer to figure 5-18 and reassemble and install the horizontal micrometer.

5-56. U-frame and Electrical Parts

a. General. The U-frame is the rotating support for the horizontal axis and telescope assembly. In addition, contacts at the base of the U-frame maintain electrical connections with electrical receptacles on the base assembly by means of the sliprings on the base assembly. Switches and electrical receptacles on the U-frame provide for applying electrical power to the illumination lamps on the horizontal axis and telescope assembly. Interconnection between the eyepiece micrometer and an electrical receptacle on the base assembly is also provided for by means of an electrical receptacle and a pair of slipring contacts.

b. Removal and Disassembly. Refer to figures 5-19 and 5-20 and remove the electrical parts from the U-frame.

c. Cleaning, Inspection, and Repair.

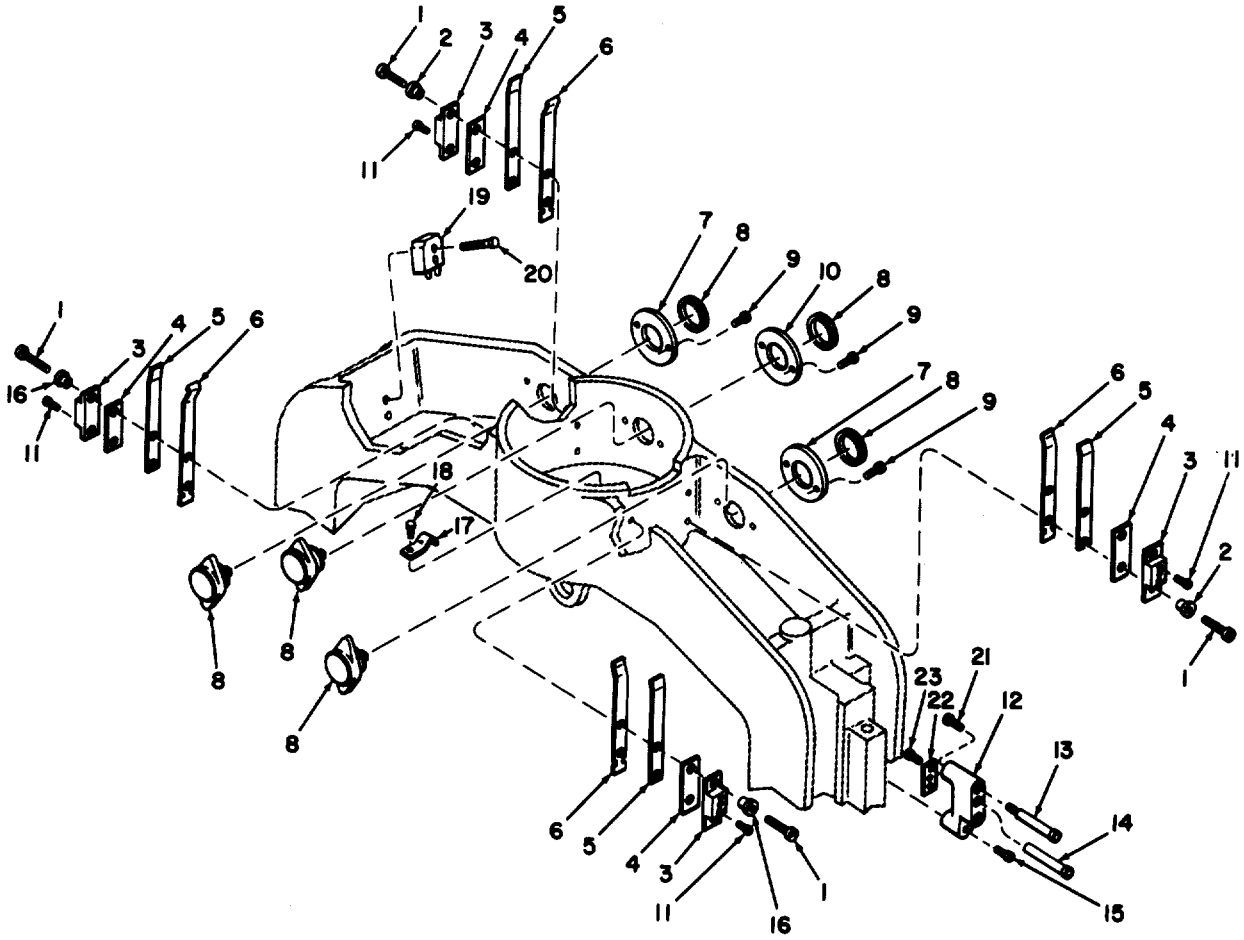
(1) Clean all metal parts with an approved cleaning solvent.

(2) Inspect all parts for burrs, dents, and deformation. Inspect all electrical parts for cracks, breaks, and damaged insulation. Inspect all threaded parts for worn or damaged threads.

(3) Remove all burrs and minor dents.

(4) Replace defective parts which cannot be repaired.

d. Reassembly and Installation. Refer to figure 5-19 and 5-20 and reassemble and install electrical parts in U-frame.



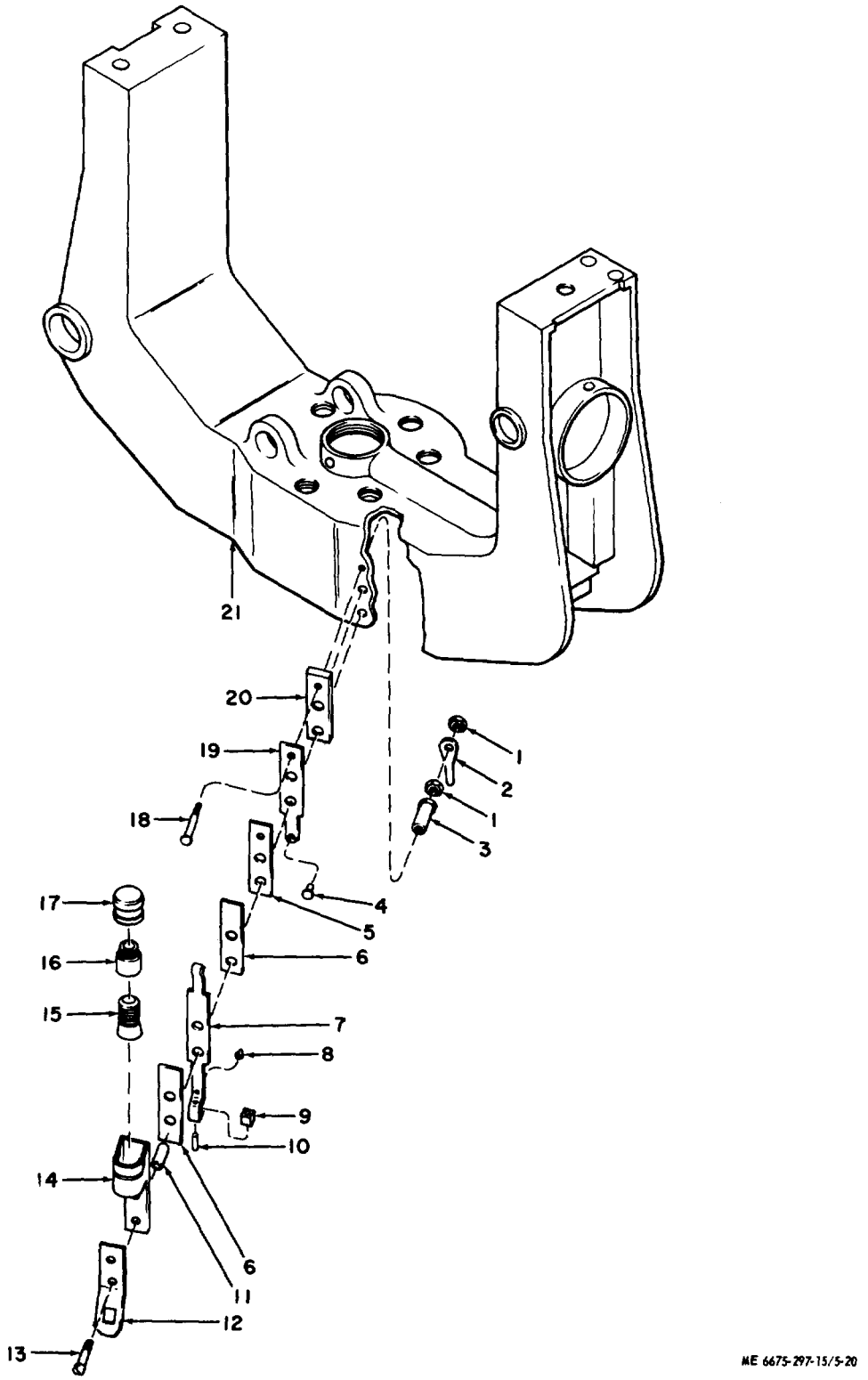
1 Screw (7)	6 Spring (4)	11 Screw (4)	16 Insulator (2)	21 Screw (2)
2 Insulator (6)	7 Cover (2)	12 Housing	17 Clamp (3)	22 Insulator
3 Bracket (4)	8 Switch (3)	13 Terminal	18 Screw (3)	23 Screw
4 Insulator (4)	9 Screw (6)	14 Terminal (2)	19 Connector	
5 Plate	10 Cover	15 Screw	20 Screw (2)	

Figure 5-19. U-frame and electrical parts; removal, disassembly, reassembly, and installation.

Section VII. HORIZONTAL AXIS AND TELESCOPE ASSEMBLY

5-57. Telescope Eyepiece Micrometer Assembly

a. General. The telescope eyepiece micrometer assembly mounts in the eyepiece end of the horizontal axis. It comprises the telescope eyepiece, the fixed and movable reticle assemblies, the eyepiece micrometer and associated commutator, and the micrometer drive.



1 Nut (2)	5 Spacer	9 Insulator (2)	13 Screw (2)	17 Cover	21 U-Frame
2 Terminal	6 Spacer(2)	10 Pin	14 Housing	18 Screw	
3 Insulator	7 Spring	11 Insulator	15 Lamp	19 Spring	
4 Contact	8 Contact	12 Pointer	16 Lamp holder	20 Insulator	

Figure 5-20. Index pointer and lamp; removal, disassembly, reassembly, and installation.

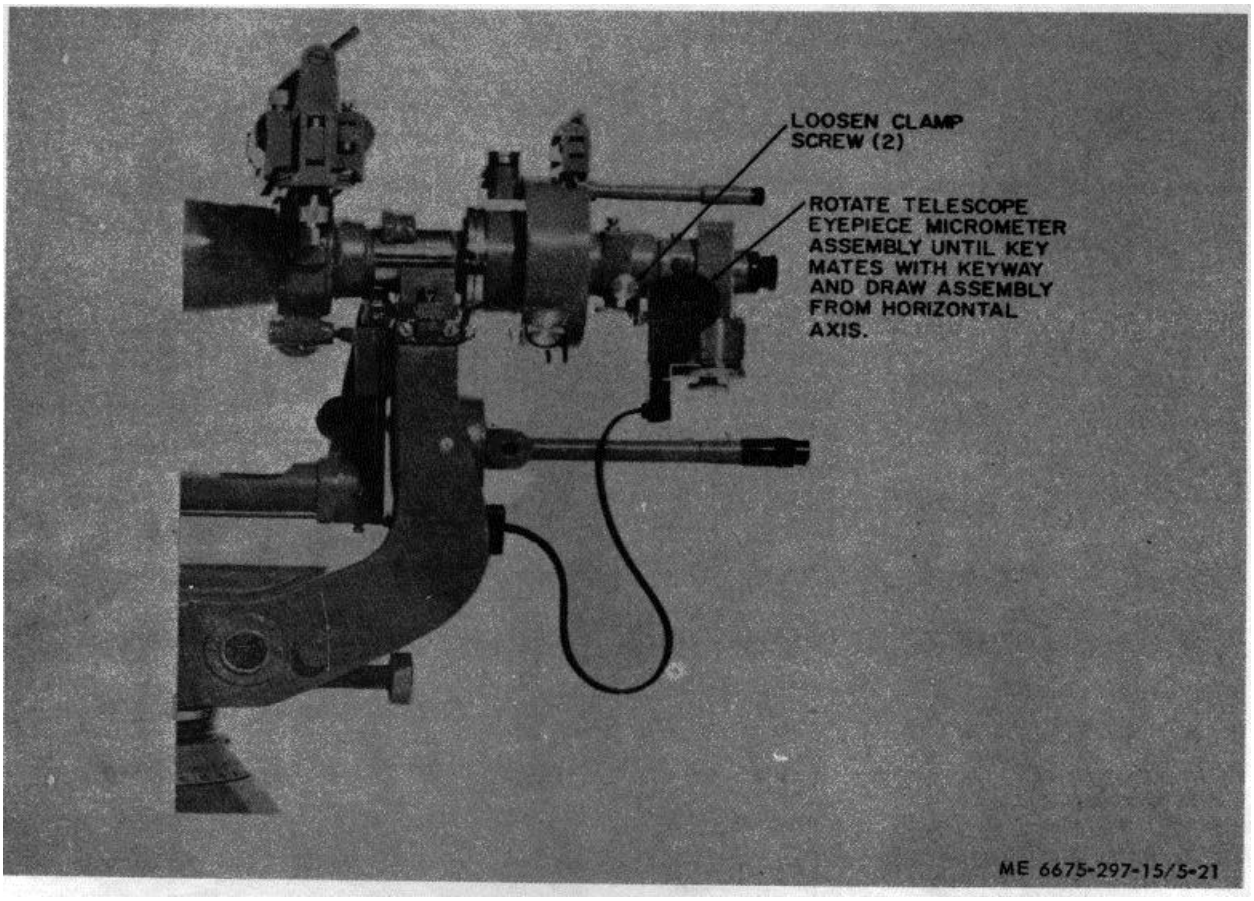


Figure 5-21. Telescope eyepiece micrometer assembly, removal and installation.

b. Removal. Refer to figure 5-21 and remove the telescope eyepiece micrometer assembly.

c. Disassembly.

(1) Refer to figure 5-22 and disassemble the telescope eyepiece.

(2) Refer to figure 5-23 and disassemble tile telescope eyepiece micrometer.

d. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent. Polish all lenses and reticle assemblies with a clean, soft, lint-free cloth.

(2) Inspect all parts for burrs and dents. Inspect all threaded parts for worn or damaged threads. Inspect all gears for worn or damaged teeth. Inspect all lenses and reticle assemblies for scratches and etching.

1 Plate
2 Plate
3 Sleeve
4 Screw (2)
5 Bushing
6 Nut
7 Lens
8.Spacer
9 Lens assembly
10 Spacer
11 Lens assembly
12 Housing
13 Setscrew (3)
14 Cap
15 Sleeve
16 Setscrew (2)
17 Screw (8)
18 Adjusting screw (4)
19 Washer (4)
20 Plate
21 Screw (4)
22 Sleeve
23 Setscrew (3)
24 Diaphragm
25 Housing
26 Setscrew
27 Lockring
28 Pin (2)
29 Plate
30 Screw (2)
31 Screw (6)
32 Setscrew
33 Mount
34 Reticle
35 Reticle
36 Pin (2)
37 Carriage
38 Screw
39 Mount
40 Spring (2)
41 Screw (2)
42 Key

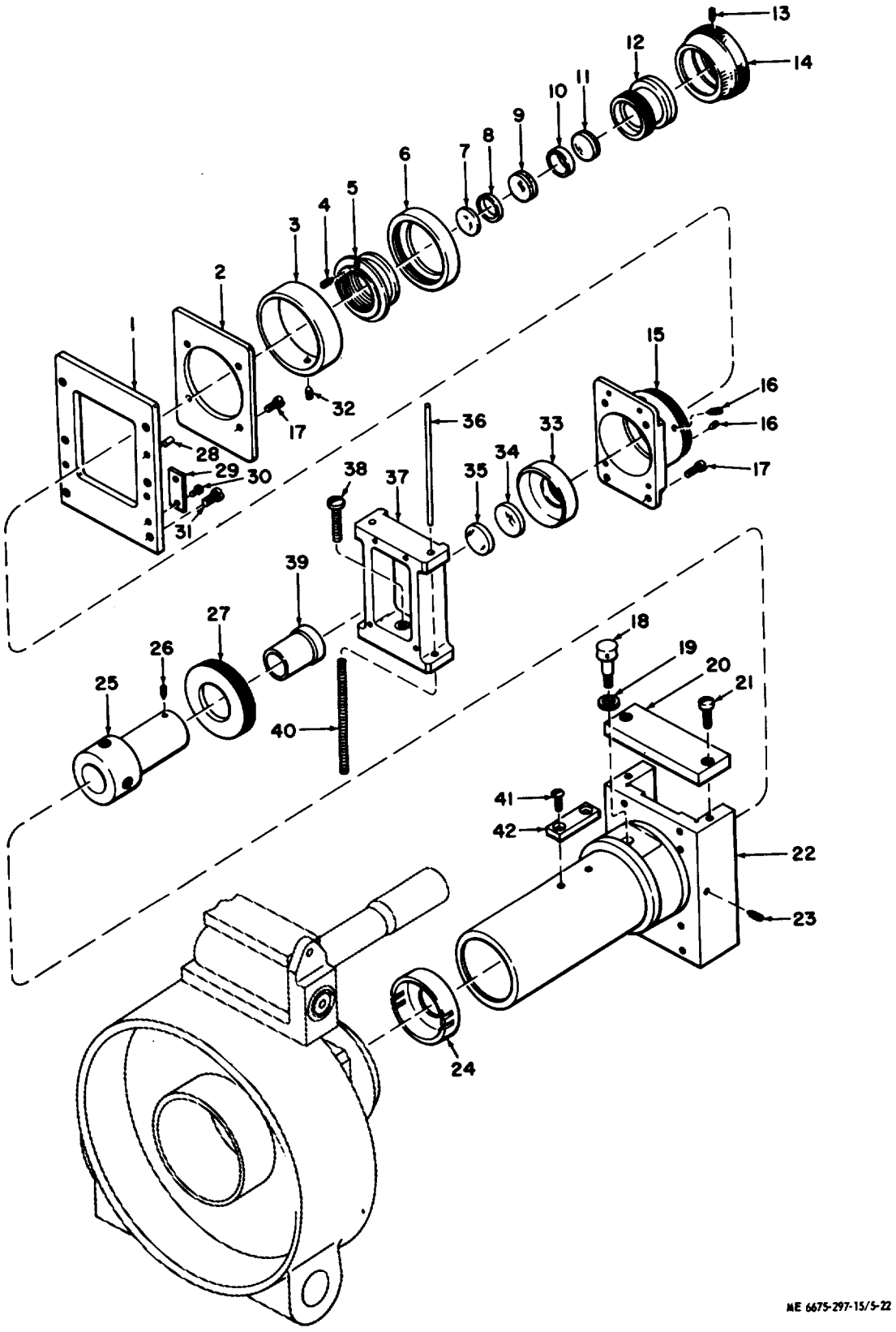


Figure 5-22. Telescope eyepiece, disassembly and reassembly.

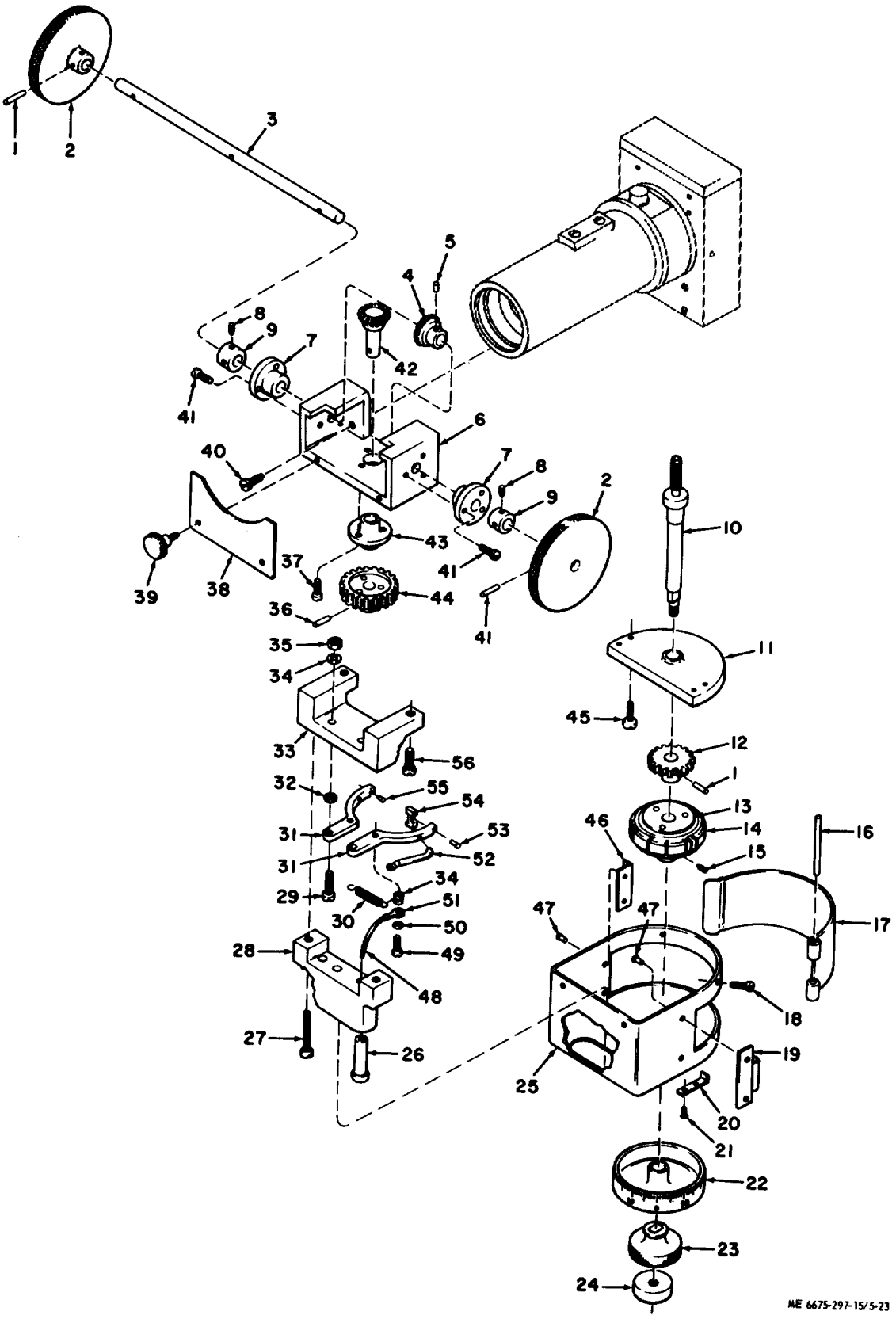


Figure 5-23. Telescope eyepiece micrometer, disassembly and reassembly.

1 Pin (8)
2 Knob (2)
3 Axis
4 Bevel gear
5 Pin
6 Housing
7 Bushing (2)
8 Setscrew (4)
9 Collar (2)
10 Shaft
11 Bushing
12 Spur gear
13 Bushing
14 Disks
15 Setscrew
16 Pin
17 Cover
18 Screw (4)
19 Hinge
20 Plate
21 Screw (2)
22 Drum
23 Knob
24 Nut
25 Housing
26 Contact (3)
27 Screw (2)
28 Insulator
29 Screw (2)
30 Spring
31 Lever (2)
32 Insulator (2)
33 Bracket
34 Washer (4)
35 Nut (2)
386 Pin
37 Screw (3)
38 Plate
39 Thumbscrew (2)
40 Screw (4)
41 Screw (6)
42 Bevel gear
4$ Bushing
44 Spur gear
45 Screw (8)
46 Clip
47 Rivet (4)
48 Cable
49 Screw (5)
50 Washer (2)
51 Terminal (2)
52 Cable Assembly (2)
53 Rivet
54 Contact
55 Rivet
56 Screw (2)

(3) Remove all burrs and minor dents.

(4) Replace defective parts which cannot be repaired.

e. Reassembly.

(1) Refer to figure 5-23 and reassemble the telescope eyepiece micrometer.

(2) Refer to figure 5-22 and reassemble the telescope eyepiece.

f. Installation. Refer to figure 5-21 and install the telescope eyepiece micrometer assembly.

5-58. Vertical Setting Circle Microscope and Vertical Setting Circle Assemblies

a. General. The vertical setting circle microscope assembly mounts on the outer sleeve of the vertical setting circle assembly. The microscope assembly magnifies the image of the vertical setting circle to permit accurate readings. The vertical setting circle

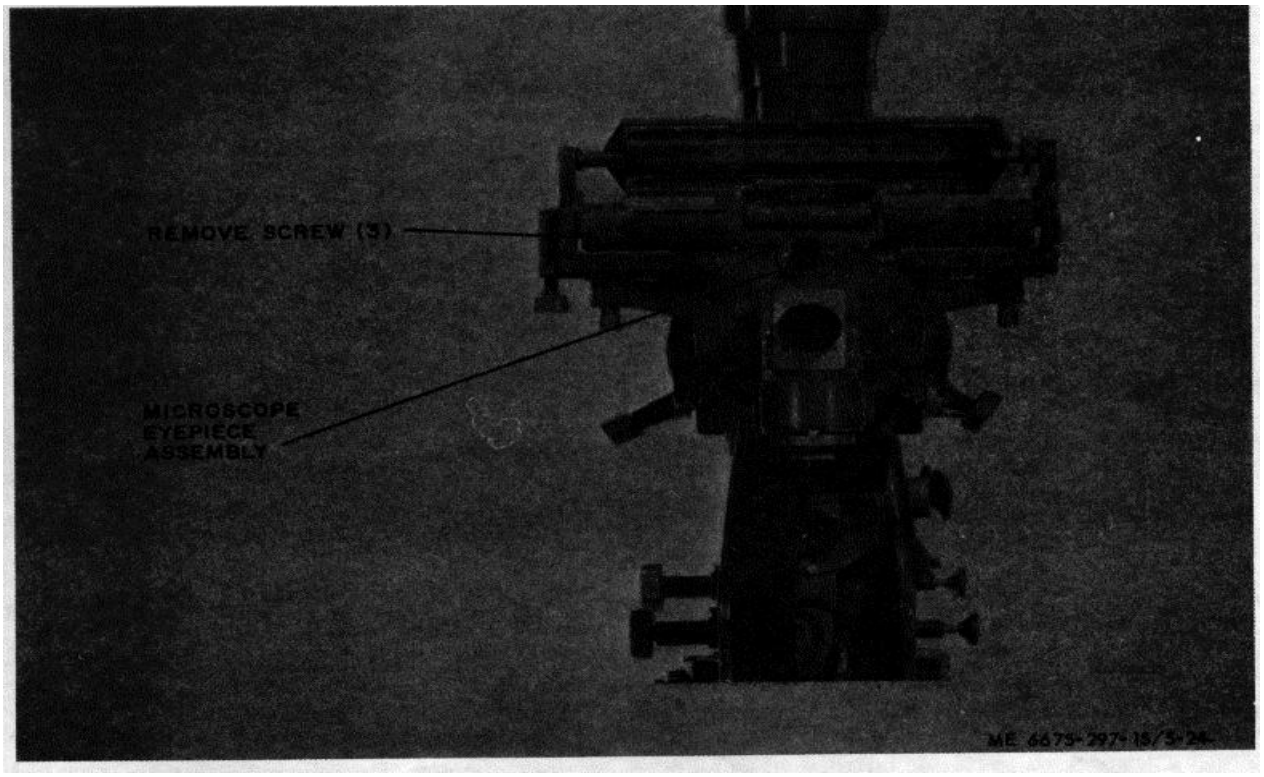


Figure 5-24. Vertical setting circle microscope assembly, removal and installation.

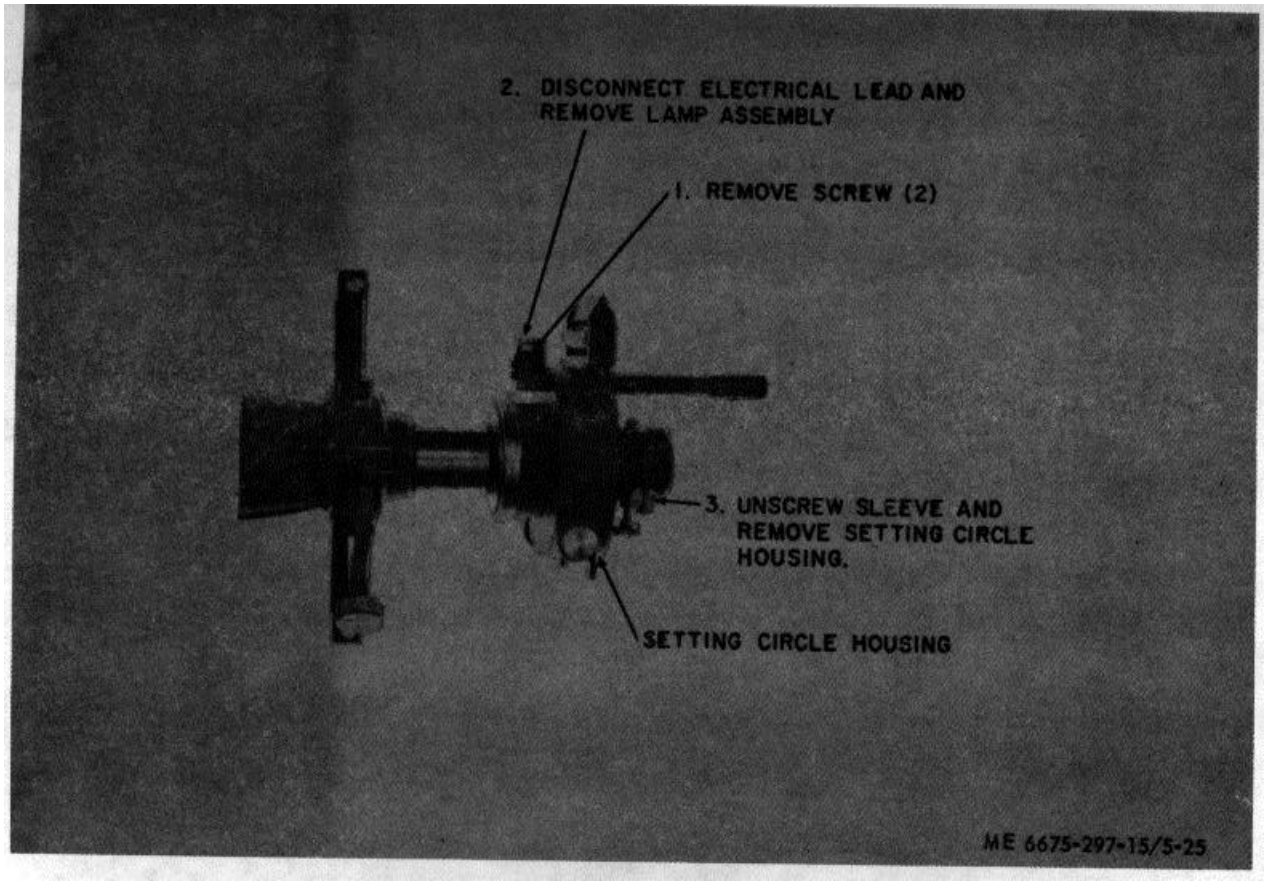


Figure 5-25. Vertical setting circle assembly, removal and installation.

assembly mounts on the eyepiece end of the horizontal axis. It comprises a housing and graduated scale which can be rotated about the fixed outer sleeve. A level mounted on the housing provides for positioning the housing ill relation to the vertical axis of the theodolite.

b. Removal.

(1) Refer to figure 5-24 and remove the vertical setting circle microscope assembly.

(2) Refer to figure 5-25 and remove the vertical setting circle assembly.

c. Disassembly. Refer to figure 5-26 and disassemble the vertical setting circle microscope and vertical setting circle assemblies.

d. Cleanings, Inspection, and Repair.

(1) Cleaning all metal parts with and approved cleaning solvent. Polish all lenses and the graduated circle with a soft, clean, lint-free cloth or lens tissue.

(2) Inspect all parts for burrs, dents, or deformation. Inspect all threaded parts or worn or damaged threads. Inspect lenses, graduated scale, and level vial for scratches and etching.

(3) Remove all burrs and minor dents.

(4) Replace defective parts which cannot be repair red.

e. Reassembly. Refer to figure 5-26 and reassemble the vertical setting circle and vertical setting circle microscope assemblies.

f. Installation.

(1) Refer to figure 5-25 and install the vertical setting circle assembly.

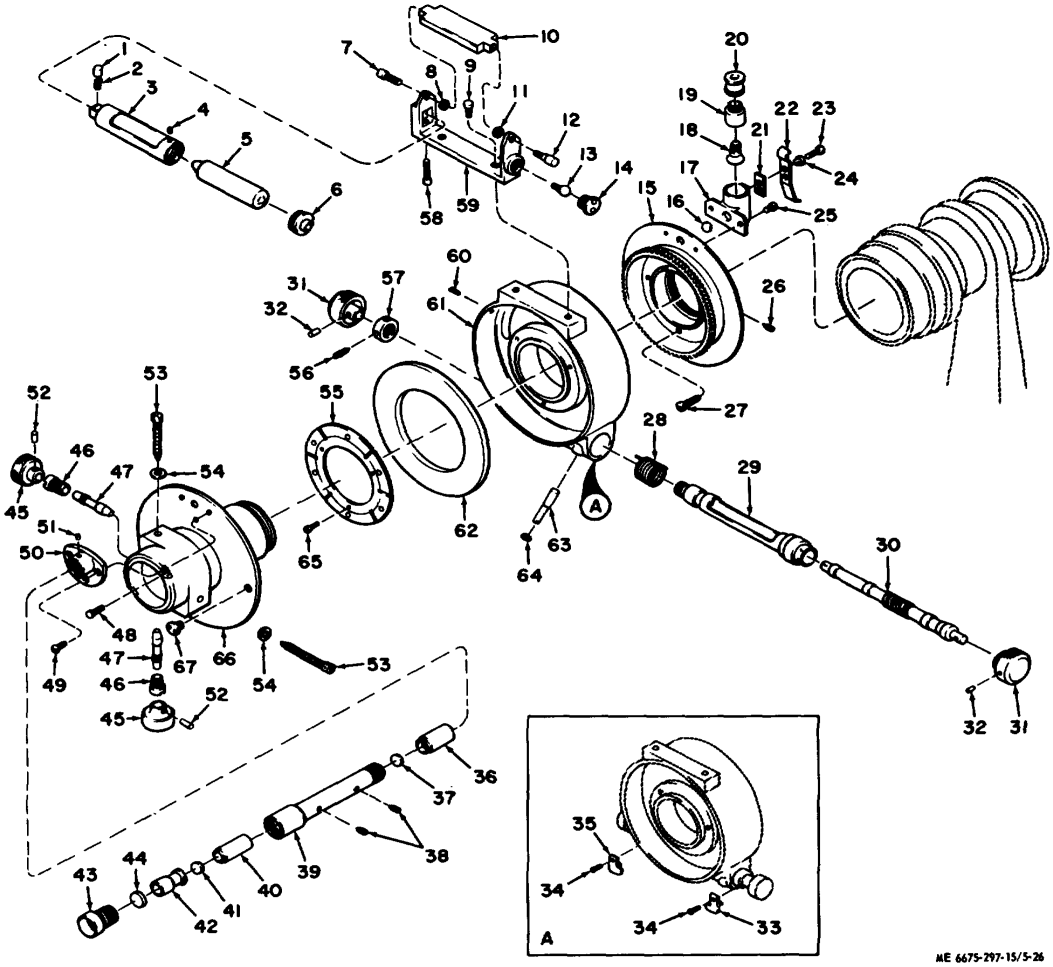
(2) Refer to figure 5-24 and install the vertical setting circle microscope assembly.

5-59. Horrebow-Talcott Level Assembly and Carrier

a. Critical. The Horrebow-Talcott level assembly mounts on the carrier which in turn is mounted on the horizontal axis.

b. Removal.

(1) Remove Horrebow-Talcott level assembly (para 2-5).



1	Plunger	18	Lamp	35	Right lever	52	Pin (2)
2	Spring	19	Lampholder	36	Mount	53	Adjusting screw (2)
3	Housing	20	Housing	37	Lens	54	Nut
4	Setscrew	21	Insulator	38	Setscrew (2)	55	Spring washer
5	Vial	22	Contact	39	Tube	56	Setscrew (2)
6	Cap	23	Screw (2)	40	Mount	57	Ring
7	Screw	24	Insulator (2)	41	Reticle	58	Adjusting Screw
8	Spring washer	25	Screw (2)	42	Sleeve	59	Base
9	Screw (2)	26	Setscrew	43	Housing	60	Setscrew (4)
10	Mirror	27	Screw (4)	44	Lens assembly	61	Housing
11	Spring washer	28	Spring	45	Knob (2)	62	Setting circle
12	Knob	29	Bushing	46	Bushing (2)	63	Screw
13	Screw	30	Worm gear	47	Screw (2)	64	Nut
14	Cap	31	Knob (2)	48	Adjusting screw	65	Screw (3)
15	Worm wheel	32	Pin (2)	49	Screw (3)	66	Sleeve
16	Lens	33	Left lever	50	Sleeve	67	Screw
17	Housing	34	Screw (4)	51	Setscrew		

Figure 5-26. Vertical setting circle microscope and vertical setting circle assemblies, disassembly and reassembly.

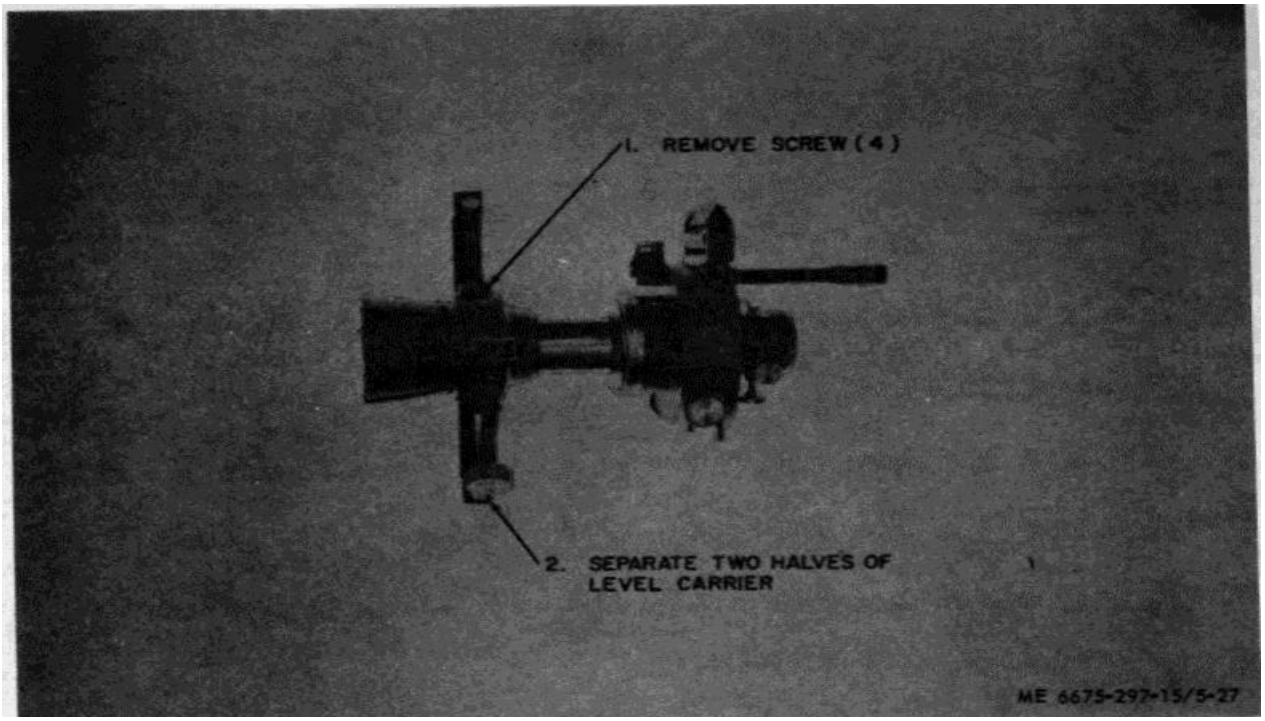


Figure 5-27. Horrebow-Talcott level carrier, removal and installation.

(2) Refer to figure 5-27 and remove level carrier.

c. Disassembly. Refer to figure 5-28 and 5-29 and disassemble the Horrebow-Talcott level assembly and carrier.

d. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent. Polish the level vial with a soft, lint-free cloth.

(2) Inspect all parts for burrs, dents, and deformation. Inspect all threaded parts for worm or damaged threads. Inspect level vial for cracks, scratches, or etching.

(3) Remove all burrs and minor dents.

(4) Replace defective parts which cannot be repaired.

e. Reassembly. Refer to figure 5-28 and 5-29 and reassemble the Horrebow-Talcott level assembly and carrier.

f. Installation.

(1) Refer to figure 5-27 and install the level carrier.

(2) Install Horrebow-Talcott level assembly (para 2-5).

5-60. Vertical Illumination and Microscope Assemblies

a. General. The vertical illumination and microscope assemblies are mounted on the collimation housing. The vertical illumination assembly consists of a lamp socket and associated wiring and an optical system for directing the light onto the vertical circle through the objective lenses of the reading microscope. The micro-

1 Bracket	6 Shaft	11 Knob	16 Pin	21 Cap	26 Screw (2)
2 Pin	7 Pin (2)	12 Pin	17 Spring	22 Shoe	27 Pin (2)
3 Setscrew (2)	8 Knob (2)	13 Pin	18 Clamp half	23 Screw	28 Frame
4 Base	9 Stop	14 Lever	19 Screw (4)	24 Plunger	29 Screw
5 Clamp	10 Screw	15 Screw	20 Setscrew	25 Spring	

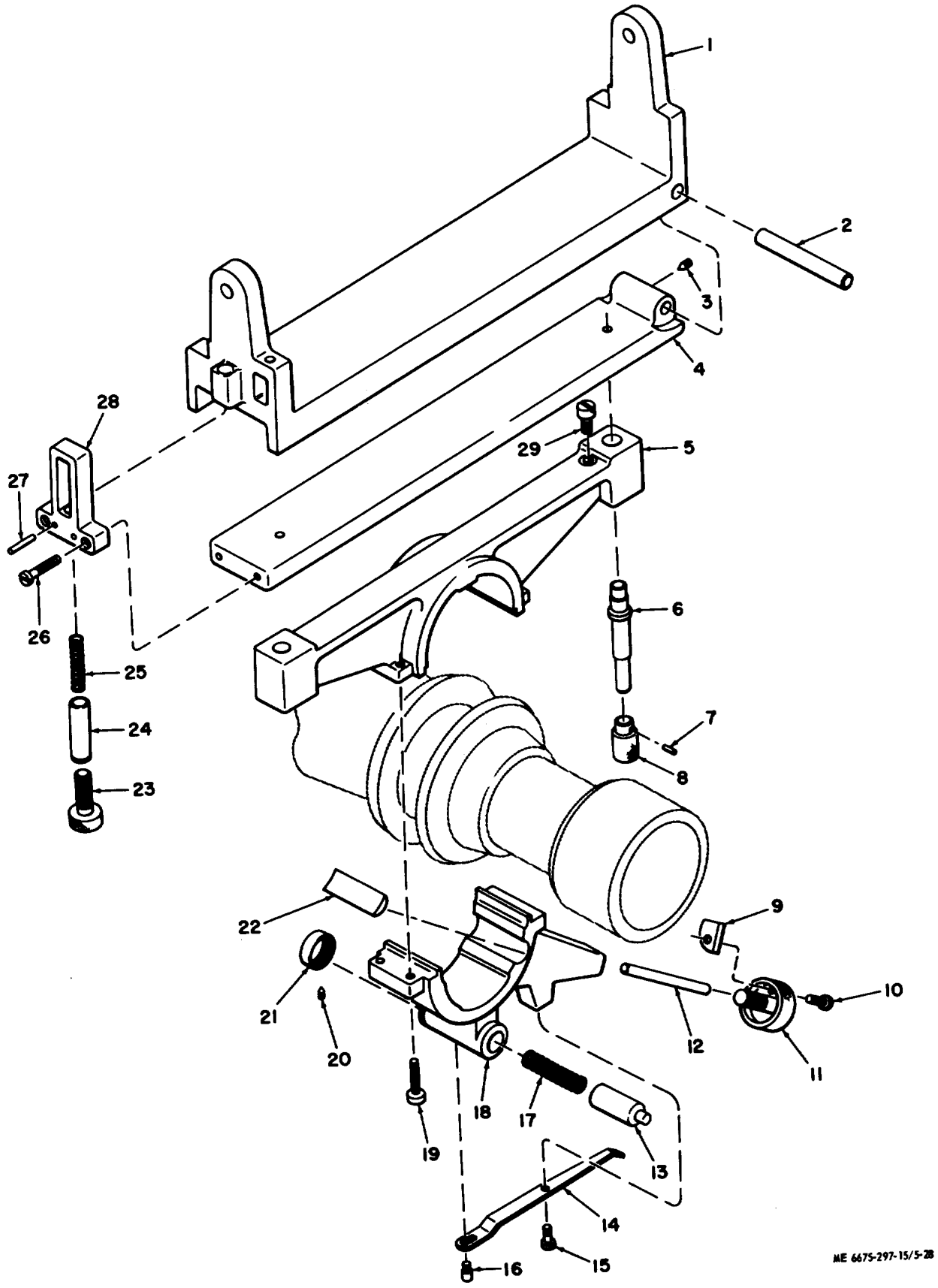


Figure 5-28. Horrebow-Talcott level carrier, disassembly and reassembly.

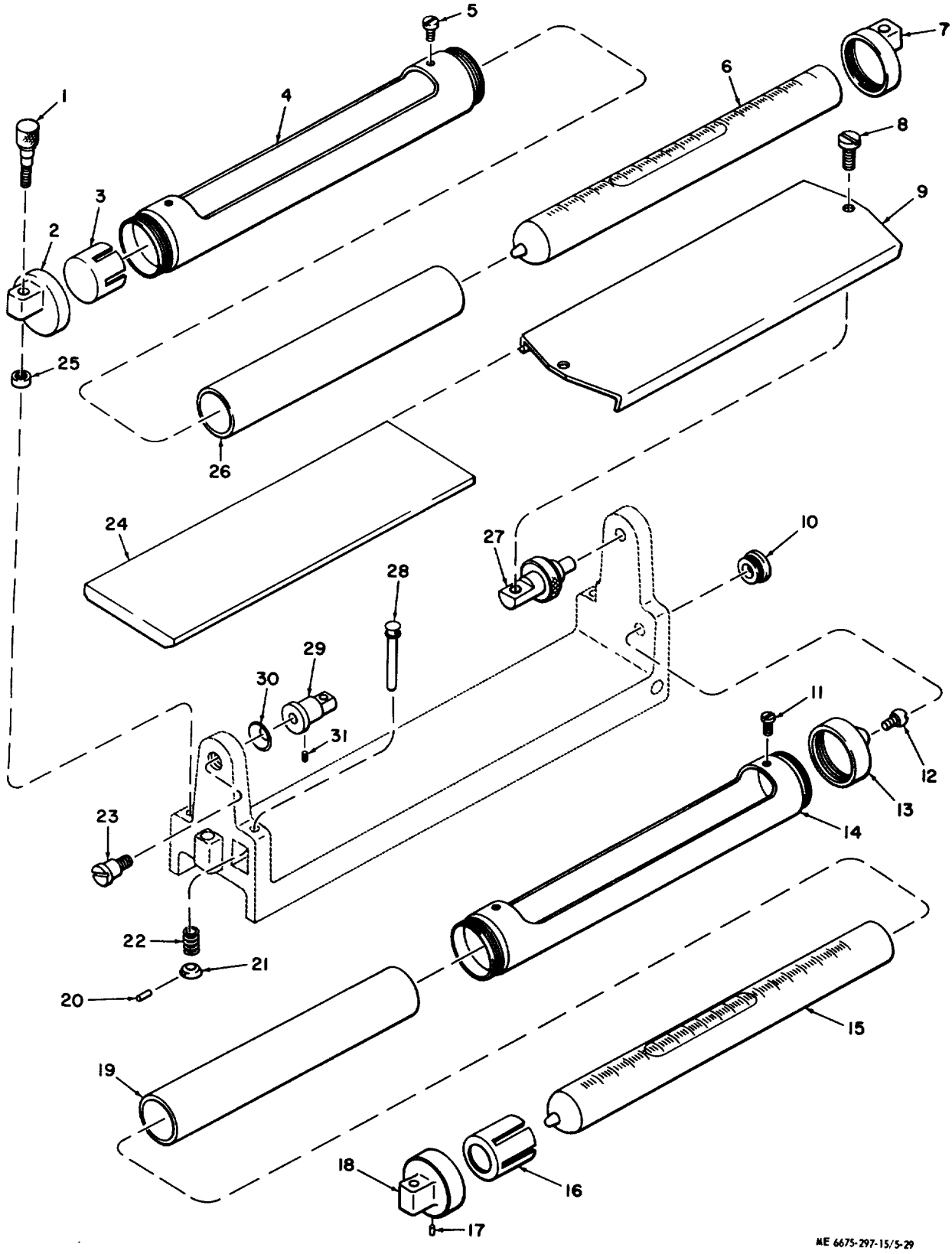


Figure 5-29. Horrebow-Talcott level assembly, disassembly and reassembly.

1 Screw (2)	7 Fitting	13 Bearing	19 Cover	25 Nut	31 Setscrew (2)
2 Fitting	8 Screw (2)	14 Housing	20 Pin	26 Cover	
3 Cap (2)	9 Housing	15 Vial	21 Nut	27 Axis	
4 Housing	10 Cap	16 Cap (2)	22 Spring	28 Screw	
5 Screw (6)	11 Screw (6)	17 Setscrew (2)	23 Screw	29 Axis	
6 Vial	12 Screw	18 Cap	24 Mirror	30 Washer	

scope assembly magnifies the image of the vertical circle to facilitate accurate readings.

b. Removal. Refer to figure 5-30 and remove the vertical illumination and microscope assemblies.

c. Disassembly. Refer to figure 5-31 and disassemble the vertical illumination and microscope assemblies.

d. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent. Polish all lenses and prisms with a soft, clean, line-free cloth or lens tissue.

(2) Inspect all parts for burrs, dents, or deformation.

(3) Remove all burrs and minor dents.

(4) Replace defective parts which cannot be repaired.

e. Reassembly. Refer to figure 5-31 and reassemble the vertical illumination and microscope assemblies.

f. Installation. Refer to figure 5-30 and install the vertical illumination and microscope assemblies.

5-61. Vertical Collimation Level Assembly

a. General. The vertical collimation level assembly mounts on the top of the collimation lever housing. It provides for determining the accurate alignment of the collimation housing prior to reading the vertical angle of the telescope.

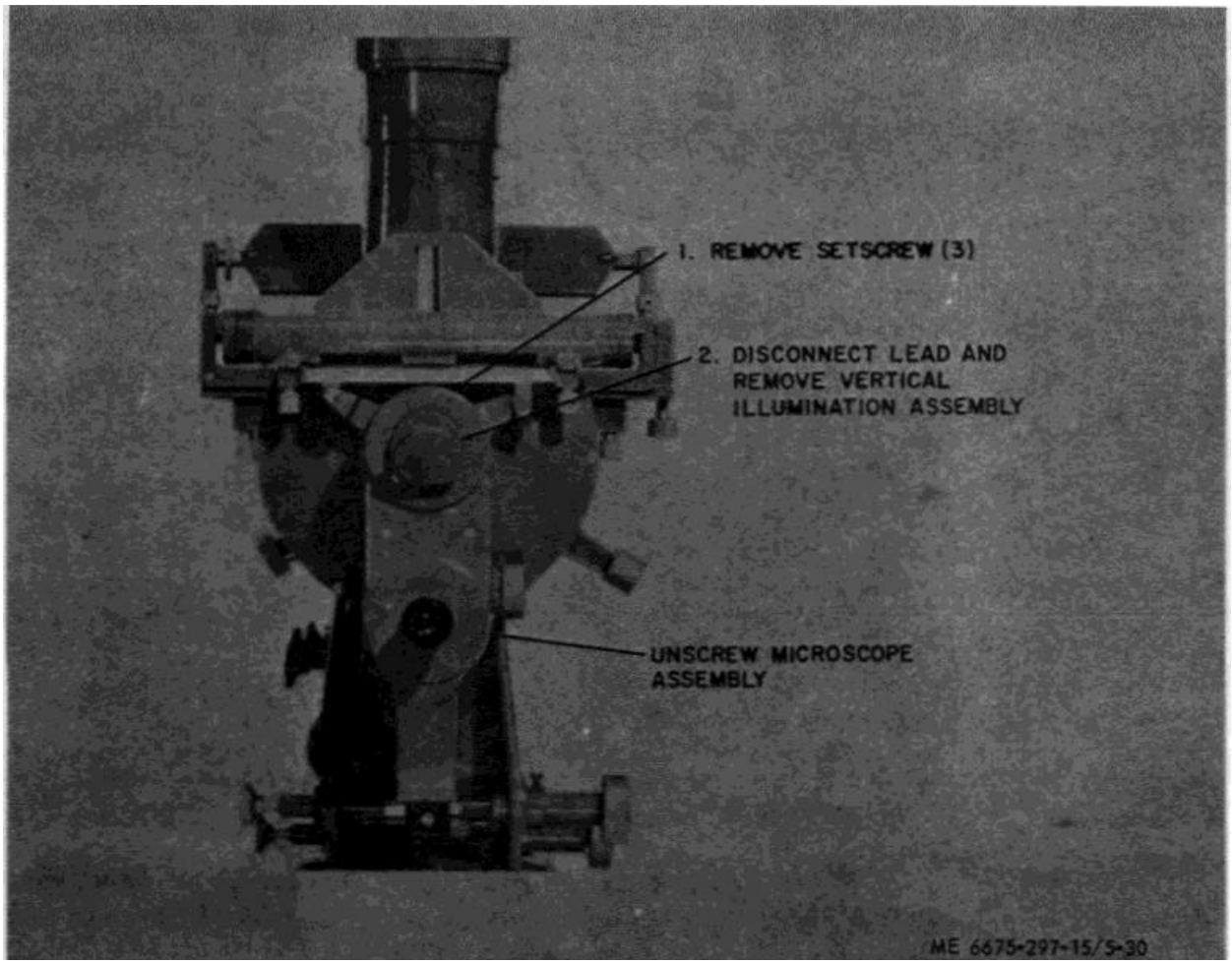


Figure 5-30. Vertical illumination and microscope assemblies, removal and installation

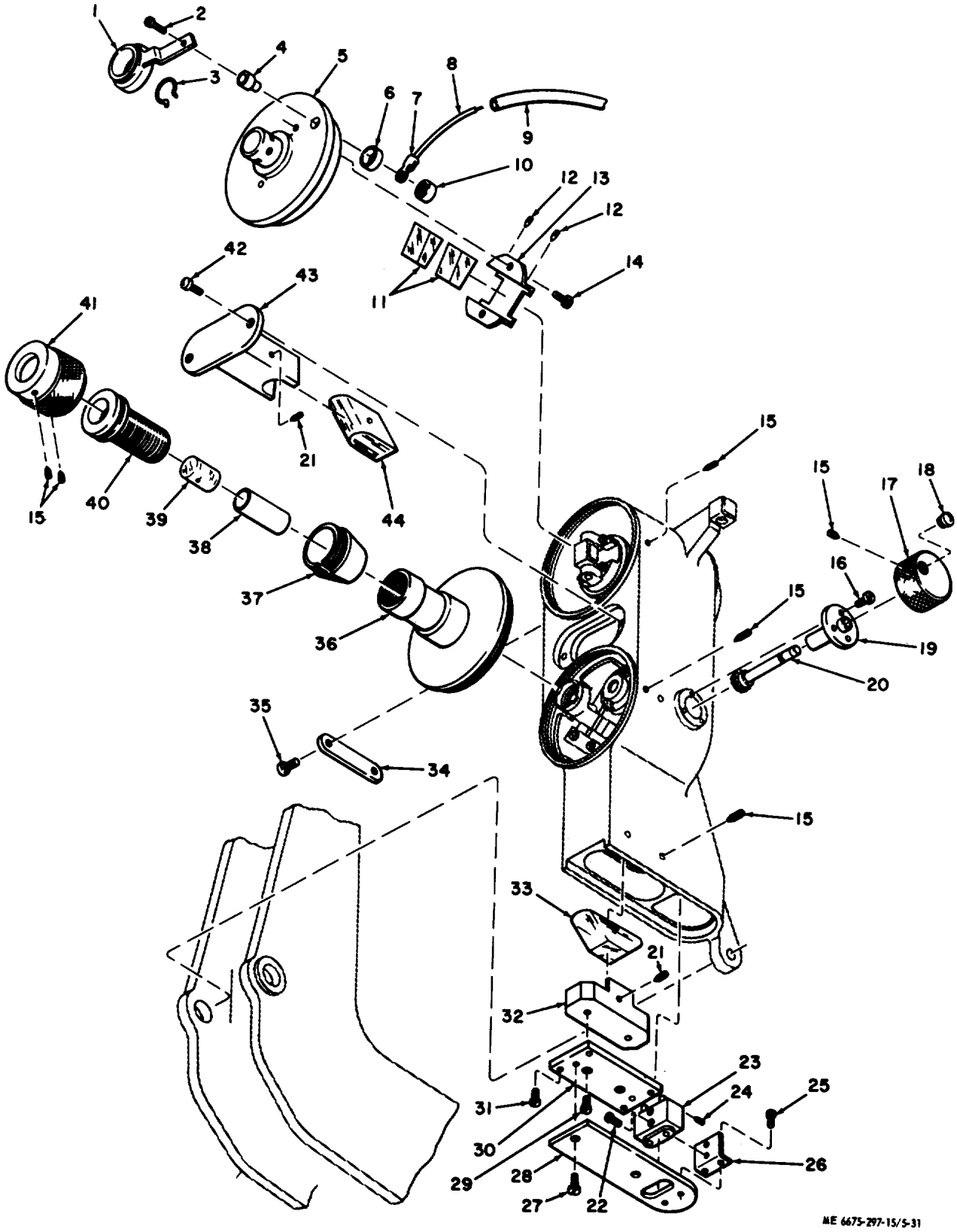


Figure 5-31. Vertical illumination and microscope assemblies, disassembly and reassembly.

1 Contact
2 Screw
3 Clip
4 Insulator
5 Sleeve
6 Insulator
7 Terminal
8 Cable
9 Insulation
10 Nut
11 Prism (2)
12 Setscrew (2)
13 Housing
14 Screw (2)
15 Setscrew (8)
16 Screw
17 Knob
18 Screw
19 Bushing
20 Axis
21 Setscrew (2)
22 Screw (2)
23 Connector
24 Setscrew (2)
25 Screw (2)
26 Bracket
27 Screw (2)
28 Plate
29 Screw (2)
30 Plate
31 Screw (4)
32 Housing
33 Prism
34 Plate
35 Screw (2)
36 Sleeve
87 Ring
88 Spacer
89 Lens Assembly
40 Mount
41 Knob
42 Screw (2)
43 Housing
44 Prism

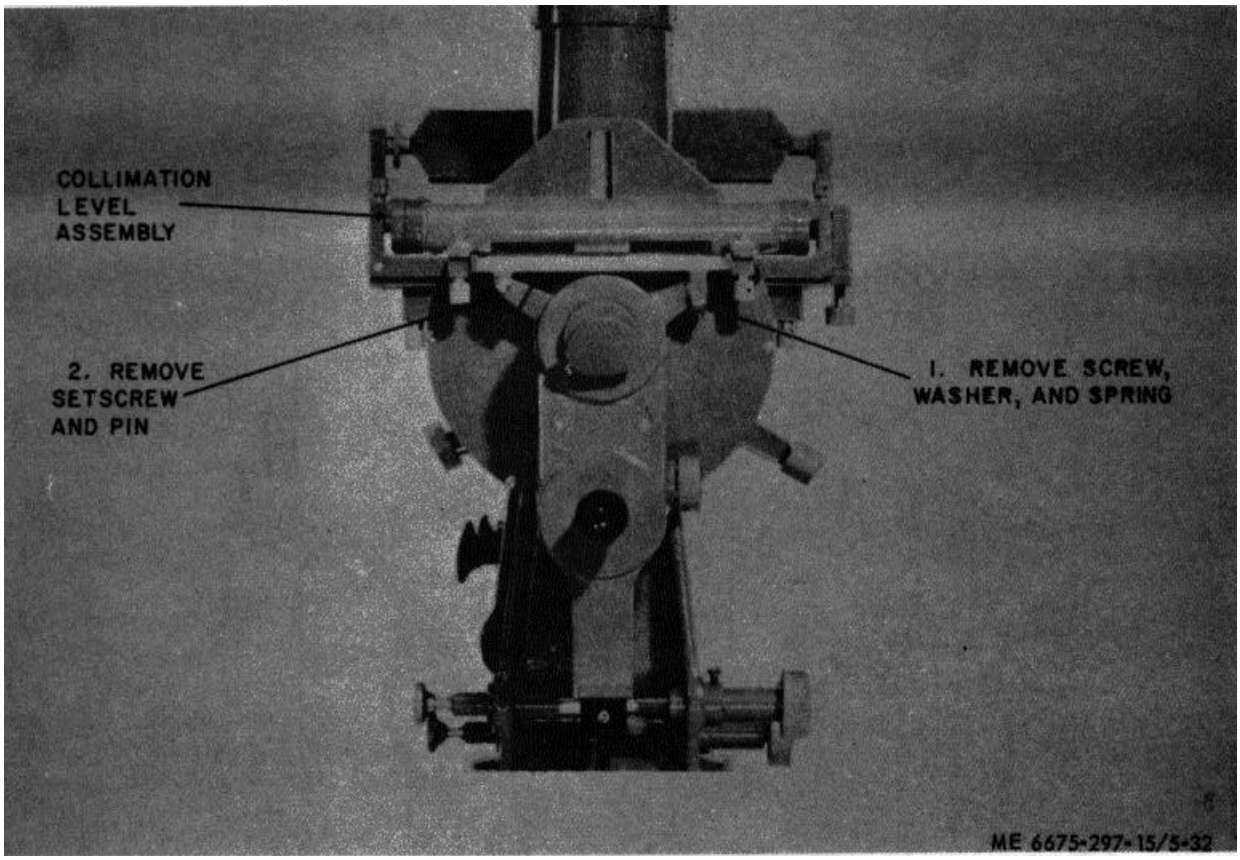


Figure 5-32. Vertical collimation level assembly, removal and installation.

b. Removal. Refer to figure 5-32 and remove the vertical collimation level assembly.

c. Disassembly. Refer to figure .5-33 and disassemble the vertical collimation level assembly.

d. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent. Polish level vial and prisms with a soft, clean, lint-free cloth or lens tissue.

(2) Inspect all parts for burrs, dents, or deformation. Inspect all threaded parts for worn or damaged threads. Inspect all prisms and the level vial for scratches and etching.

(3) Remove all burrs and minor dents.

(4) Replace defective parts which cannot be repaired.

e. Reassembly. Refer to figure 5-33 and reassemble the vertical collimation level assembly.

f. Installation. Refer to figure 5-32 and install the vertical collimation level assembly.

5-62. Vertical Micrometer

a. General. The vertical micrometer mounts within the collimation lever housing behind the vertical illumination and microscope assemblies. It consists of adjustable prisms which move one image of the vertical circle with respect to the other to provide a vernier measurement. A graduated glass circle indicates the relative positions of the images.

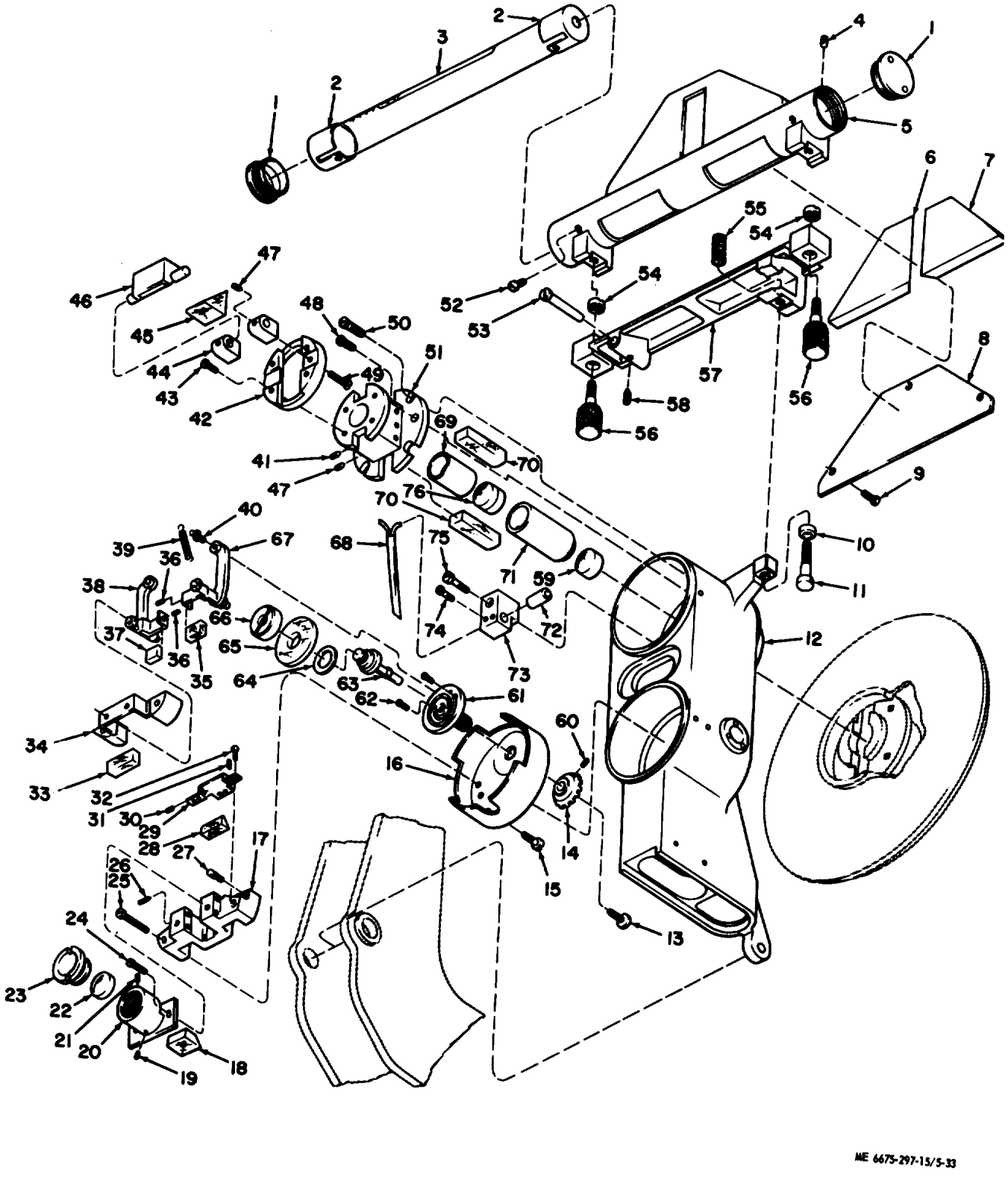


Figure 5-33. Vertical micrometer, collimation level assembly, and collimation lever housing; removal, disassembly, reassembly, and installation.

1 Cap (2)
2 Cap (2)
3 Vial
4 Setscrew
5 Housing
6 Prism
7 Prism
8 Cover
9 Screw (3)
10 Bushing
11 Screw
12 Housing
13 Screw
14 Bevel gear
15 Screw (2)
16 Housing
17 Mount
18 Prism
19 Setscrew (5)
20 Mount
21 Setscrew (3)
22 Lens
23 Retainer
24 Screw (2)
25 Screw (2)
26 Setscrew (4)
27 Screw (2)
28 Prism
29 Mount
30 Setscrew (2)
31 Setscrew (3)
32 Screw (3)
33 Prism
34 Bearing
35 Plate glass
36 Setscrew (2)
37 Plate glass
38 Lever
39 Spring (2)
40 Pin (2)
41 Setscrew (4)
42 Ring
43 Screw (4)
44 Bearing (2)
45 Prism
46 Mount
47 Setscrew (3)
48 Screw (2)
49 Screw (2)
50 Screw (4)
51 Carrier
52 Screw (6)
53 Pin
54 Nut (2)
55 Spring
56 Screw (2)
57 Bracket
58 Setscrew (2)
59 Lens
60 Setscrew
61 Wheel
62 Screw (2)
63 Axis
64 Spacer
65 Circle
66 Nut
67 Lever
68 Cable assembly
69 Mount
70 Lens (2)
71 Mount
72 Connector
7,3 Insulator
74 Screw (2)
75 Screw
76 Lens assembly

b. Removal and Disassembly. Refer to figure 5-33 and remove and disassemble the vertical micrometer.

e. Cleaning, Inspection, and Repair.

(1) Clean all, metal parts with an approved cleaning solvent. Polish all lenses and prisms with a soft, clean, lint-free cloth or lens tissue.

(2) Inspect all parts for burrs, dents, and deformation. Inspect all threaded parts for worn or damaged threads. Inspect all lenses, prisms, and the graduated glass circle for scratches and etching.

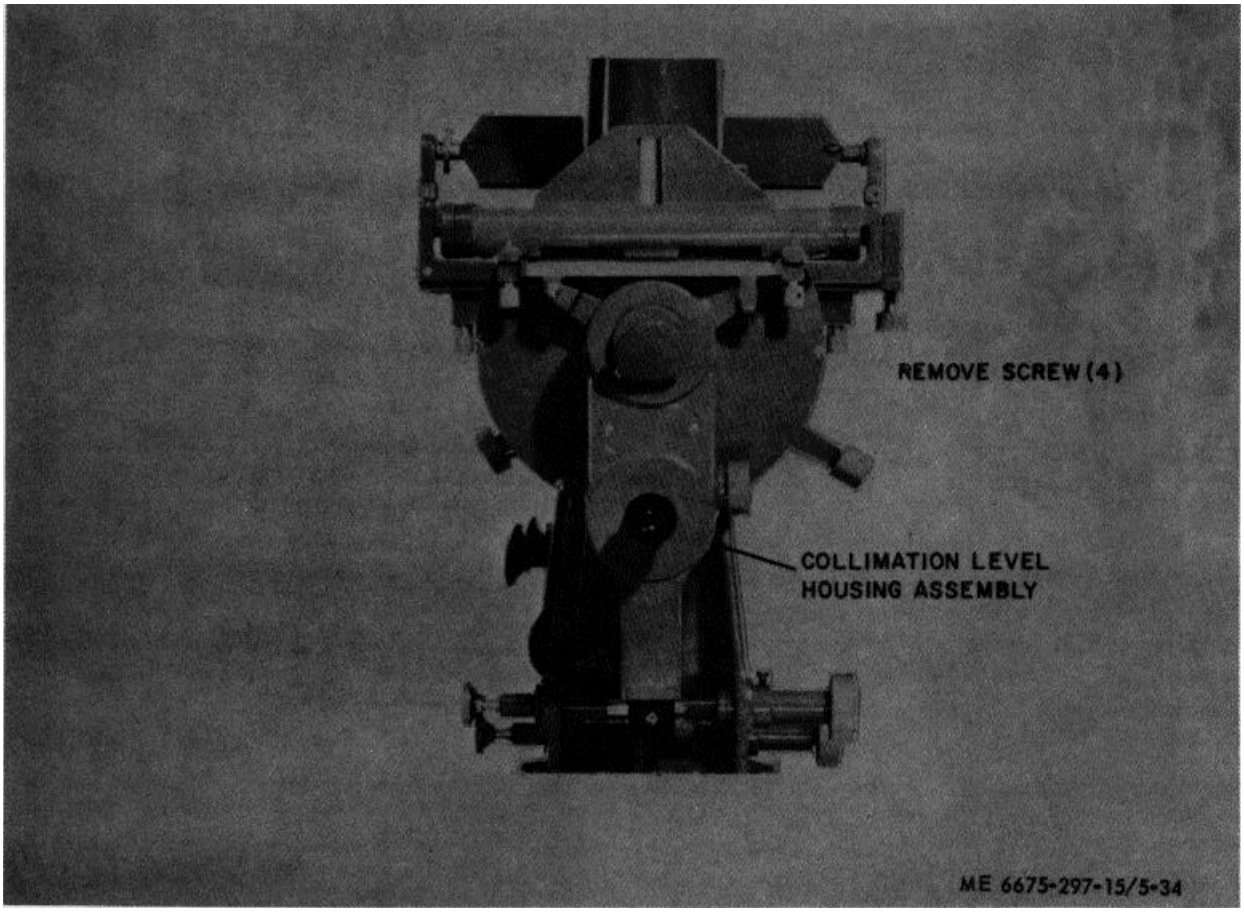


Figure 5-34. Collimation lever housing assembly, removal and installation.

(3) Remove all burrs and minor dents.

(4) Replace defective parts which cannot be repaired.

d. Reassembly and Installation. Refer to figure 5-33 and reassemble and install the vertical micrometer.

5-63. Collimation Lever Housing Assembly

a. General. The collimation lever housing assembly mounts on the vertical circle drive housing at the end of the horizontal axis. It houses the vertical micrometer and associated optical parts together with the electrical connector for tile vertical circle and telescope illumination lamps.

b. Removal. Refer to figure 5-34 and remove the collimation lever housing assembly.

c. Disassembly. Refer to figure 5-33 and disassemble the collimation lever housing assembly.

d. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent. Polish all prisms with a soft, clean, lint-free cloth or lens tissue.

(2) Inspect all parts for burrs, dents, or deformation. Inspect all threaded parts for worn or damaged threads. Inspect prisms for scratches or etching.

(3) Remove all burrs and minor dents.

(4) Replace defective parts which cannot be repaired.

e. Reassembly. Refer to figure 5-33 and reassemble the collimation lever housing assembly.

f. Installation. Refer to figure 5-34 and install the collimation lever housing assembly.

5-64. Vertical Circle Drive, Axis, and Prism Carrier

a. General. The vertical circle drive, axis, and prism carrier mount within a housing secured to the end of the horizontal axis. They provide for positioning the vertical circle with respect to the line of sight of the telescope and for optically positioning images of opposite sides of the vertical circle in the field of view of the vertical microscope.

b. Removal and Disassembly.

(1) Remove collimation lever housing assembly (para 5-63).

(2) Refer to figure 5-35 and remove and disassemble the vertical circle drive, axis, and prism carrier.

c. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent. Polish vertical circle and prisms with a soft, clean, lint-free cloth or lens tissue.

(2) Inspect all parts for burrs, dents, or deformation. Inspect all threaded parts for worn or damaged threads. Inspect vertical circle and prisms for scratches or etching.

(3) Remove all burrs and minor dents.

(4) Replace defective parts which cannot be repaired.

d. Reassembly and Installation.

(1) Refer to figure 5-35 and reassemble and install the vertical circle drive, axis, and prism carrier.

(2) Install collimation lever housing assembly (para 5-63).

5-65. Vertical Clamp Arm

a. General. The vertical clamp arm mounts over the horizontal axis at one side of the telescope. It provides for fine adjustment of the position of the horizontal axis and for locking the horizontal axis in position.

b. Removal. Refer to figure 5-36 and remove the vertical clamp arm.

c. Disassembly. Refer to figure 5-37 and disassemble the vertical clamp arm.

d. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent.

(2) Inspect all parts for burrs, dents, or deformation. Inspect all threaded parts for worn or damaged threads.

1 Cover
2 Plate (4)
3 Prism (2)
4 Carrier
5 Setscrew (5)
6 Setscrew (8)
7 Ball bearing (2)
8 Spacer
9 Ring
10 Setscrew (2)
11 Insulator
12 Cable
13 Setscrew
14 Contact
15 Screw
16 Cover
17 Knob
18 Sleeve
19 Bushing
20 Stop
21 Screw
22 Housing
23 Screw (4)
24 Bushing
25 Vertical circle
26 Plate
27 Screw (4)
28 Spring washer
29 Disk
30 Screw (6)
81 Screw (8)
32 Screw (8)
33 Axis
34 Hinge
35 Screw (2)
36 Setscrew (4)
87 Screw (4)
38 Pin

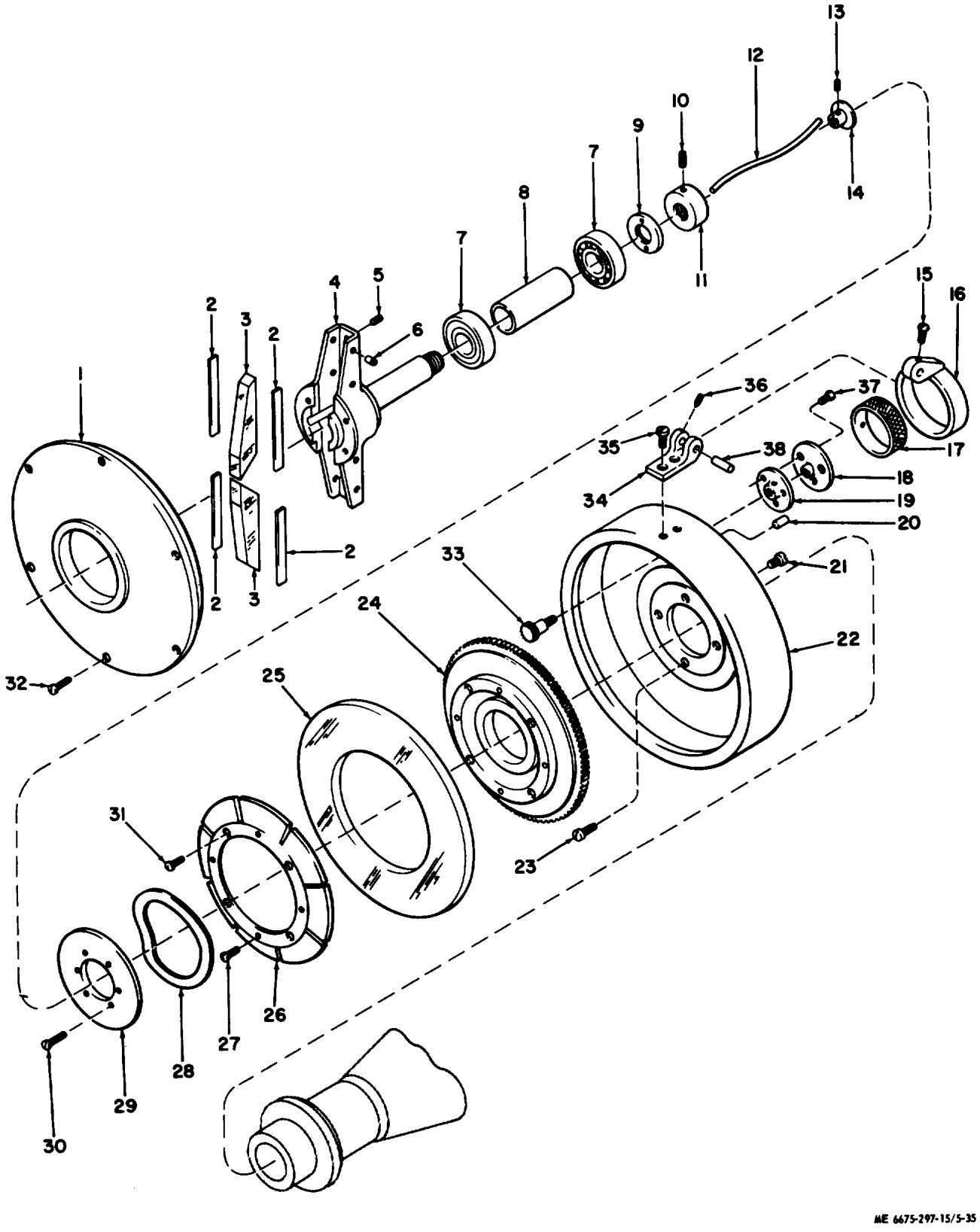


Figure 5-35. Vertical circle drive, axis and prism carrier: removal, disassembly, reassembly, and installation.

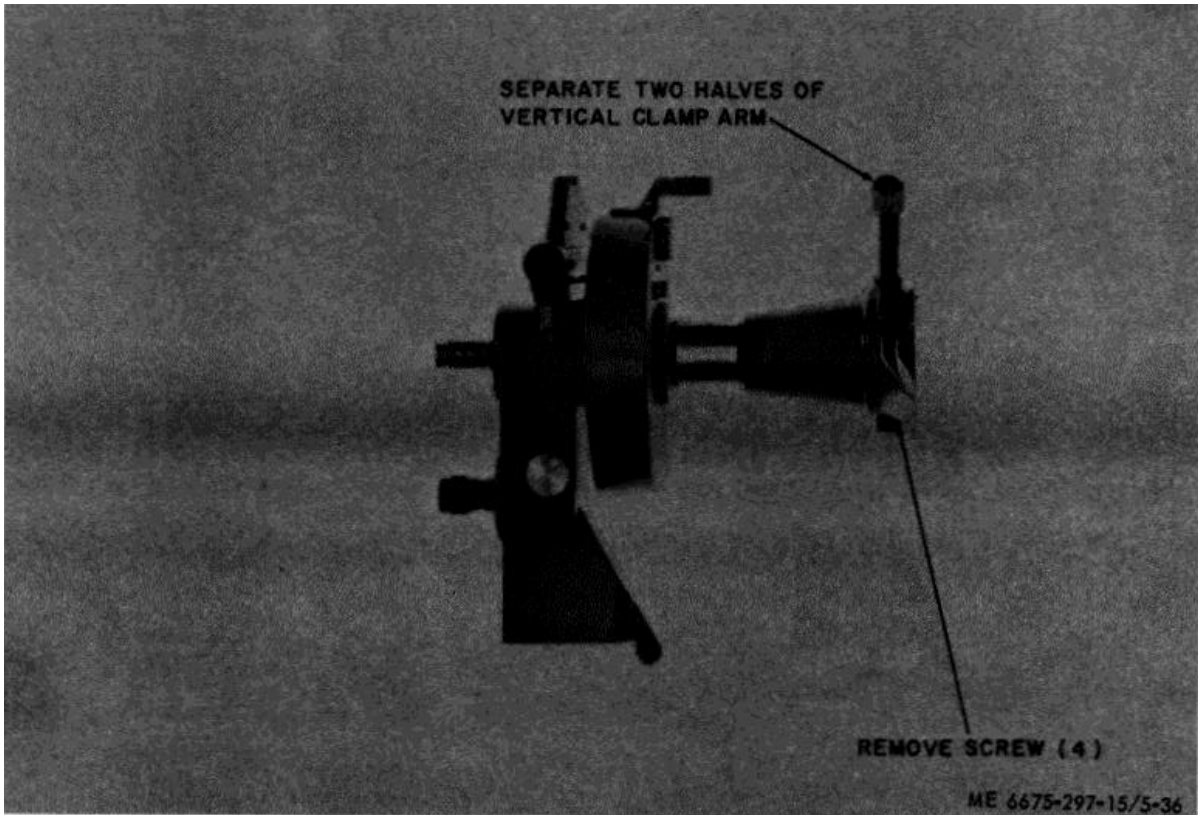


Figure 5-36. Vertical clamp arm, removal and installation.

(3) Remove all burrs and minor dents.

(4) Replace defective Parts which cannot be repaired.

e. Reassembly. Refer to figure 5-37 and reassemble the vertical clamp arm.

f. Installation. Refer to figure 5-36 and install the vertical clamp arm.

5-66. Counterweight and Telescope Mirror Assembly

a. General. The counterweight and telescope mirror assembly are installed in the horizontal axis. The weight of the telescope to facilitate positioning of the horizontal axis. The telescope mirror assembly reflects the telescope image to the eyepiece.

b. Removal. Refer to figure 5-38 and remove the counterweight and telescope)e mirror assembly.

c. Disassembly. Refer to figure 5-37 and disassemble the telescope mirror assembly.

d. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent. Polish telescope mirror with a soft, clean, lint-free cloth.

(2) Inspect all parts for burrs, dents, or deformation. Inspect all threaded parts for worn or damaged threads. Inspect telescope mirror for scratches or etching.

1 Insulator
2 Ring
3 Axis
4 Screw (4)
5 Clamp half
6 Rivet (8)
7 Pin
8 Insulator
9 Spring
10 Screw
11 Bushing
12 Cable
13 Shoe
14 Screw (2)
15 Plate
10 Pin
17 Knob
18 Screw
19 Clamp half
20 Nut
21 Screw (2)
22 Bracket
23 Counterweight
24 Cover
25 Screw (4)
26 Spacer
27 Setscrew (4)
28 Setscrew (2)
29 Screw
30 Screw
31 Screw
32 Bracket
33 Screw (2)
34 Sight
35 Thumbscrew (2)
36 Bushing (2)
37 Screw
38 Setscrew
39 Plate
40 Adjusting screw (2)
41 Screw (2)
42 Mirror
43 Rivet (3)
44 Plate
45 Rivet (3)
46 Setscrew
47 Housing

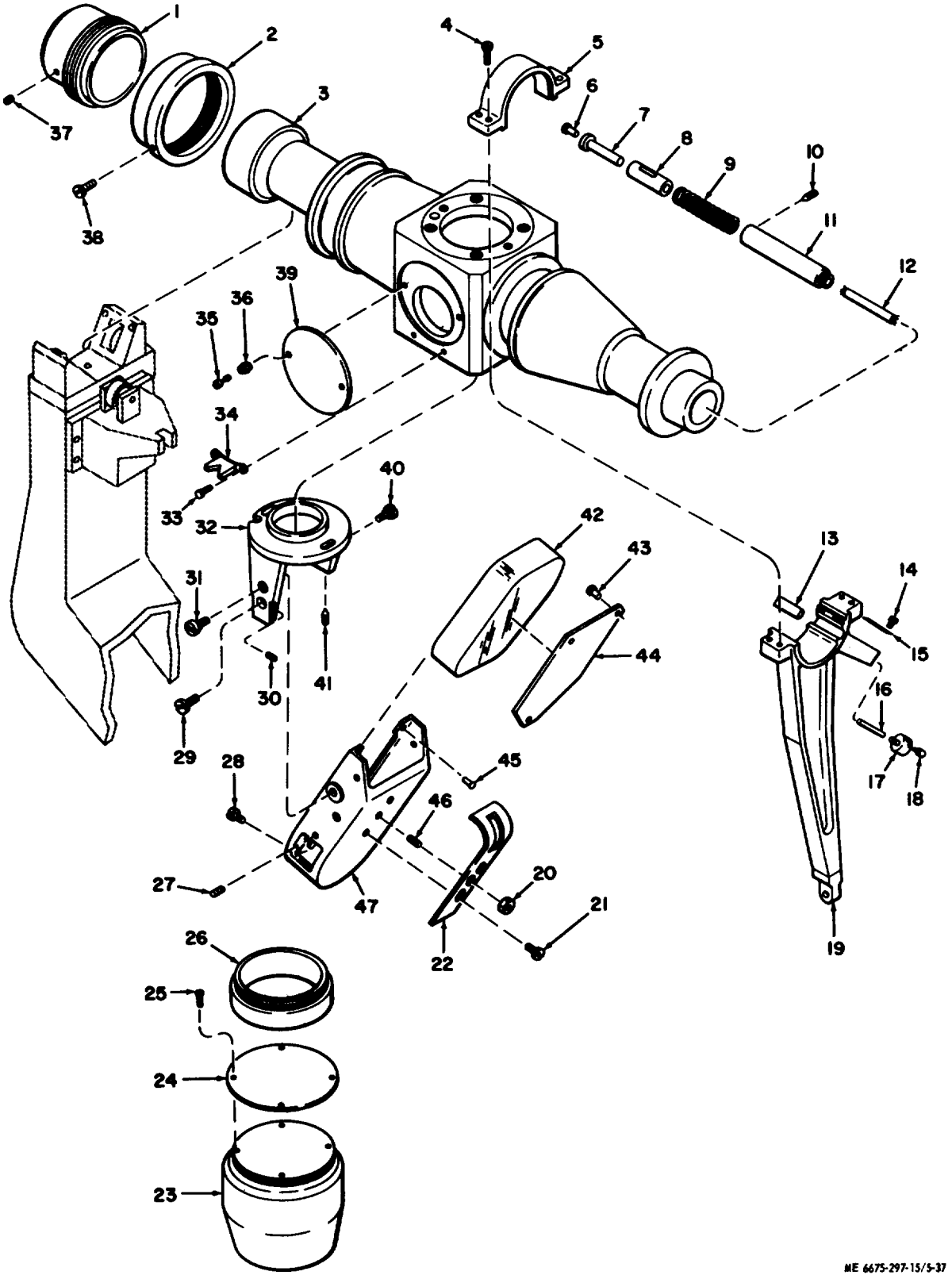


Figure 5-37. Counterweight, telescope mirror assembly, and vertical clamp arm; disassembly and reassembly.

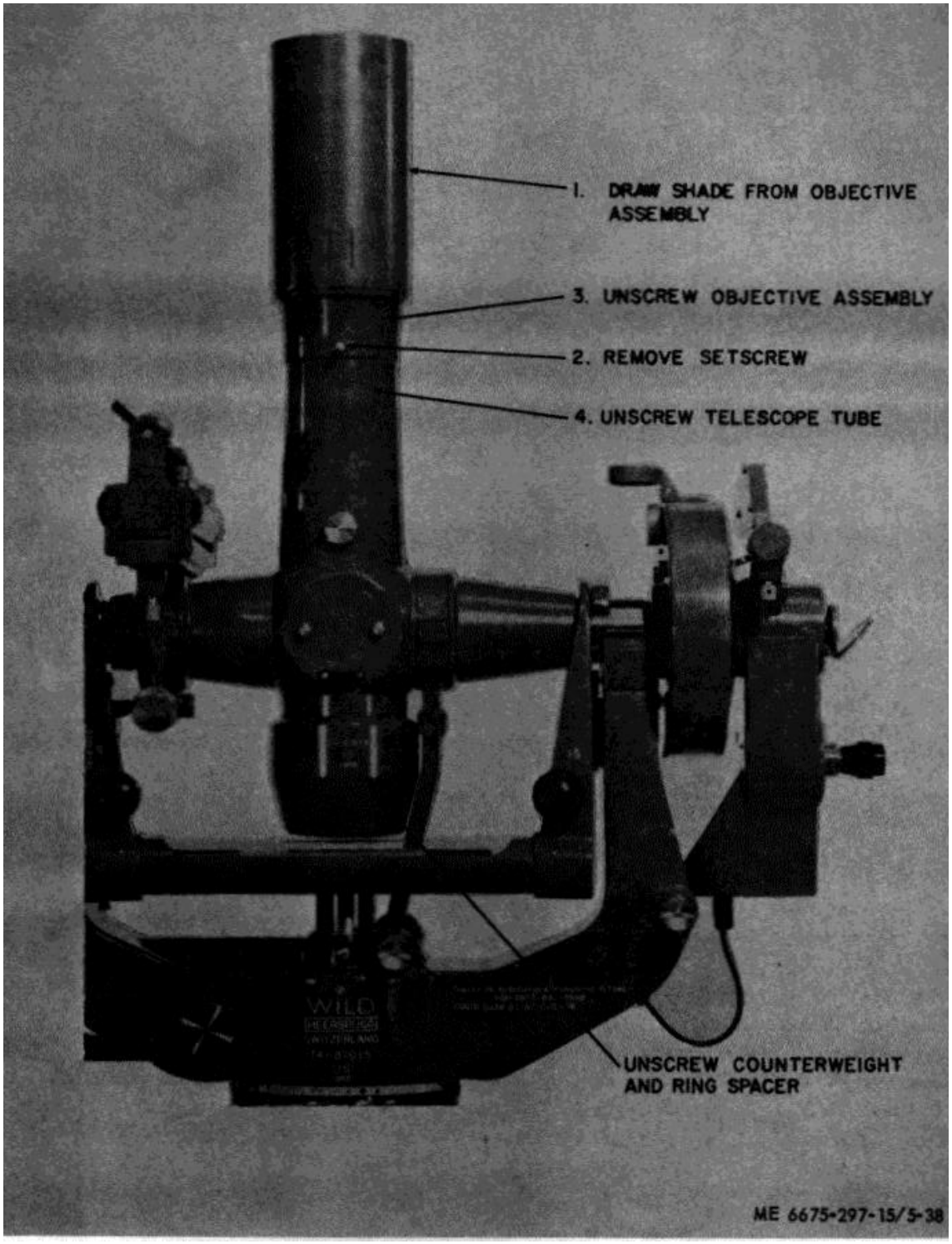


Figure 5-38. Telescope shade, tube, objective assembly, counterweight, and ring spacer; removal and installation.

(3) Remove all burrs and minor dents.

(4) Replace defective parts which cannot be repaired.

e. Reassembly. Refer to figure 5-37 and reassemble the telescope mirror assembly.

f. Installation. Refer to figure 5-38 and install the telescope mirror assembly and counterweight.

5-67. Electrical Contact

a. General. The electrical contact is a spring-loaded contact and cable for passing power to the telescope illumination lamp. It is mounted within one arm of the horizontal axis.

b. Removal and disassembly.

(1) Remove collimation lever housing assembly (para 5-63).

(2) Remove vertical circle drive housing (para 5-64).

(3) Refer to figure 5-37 and remove and disassemble the electrical contact.

c. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent. Wipe electrical leads clean with a clean cloth moistened with the cleaning solvent.

(2) Inspect all parts for burrs, dents, or deformation. Inspect all threaded parts for worn or damaged threads.

(3) Remove all burrs and minor dents.

(4) Replace defective parts which cannot be repaired.

d. Reassembly and Installation.

(1) Refer to figure 5-37 and reassemble and install the electrical contact.

(2) Install vertical circle drive housing (para 5-64).

(3) Install collimation lever housing assembly (para 5-63).

5-68. Telescope Shade, Objective Assembly, and Tube

a. The telescope shade, objective assembly, and tube form the objective section of the telescope. They are mounted on the horizontal axis opposite the counterweight and telescope mirror assembly.

b. Removal. Refer to figure 5-38 and remove the telescope shade, objective assembly, and tube.

c. Disassembly. Refer to figure 5-39 and disassemble the telescope shade, objective assembly and tube.

d. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent. Polish all lenses with a soft, clean, lint-free cloth or lens tissue.

(2) Inspect all parts for burrs, dents, or deformation. Inspect all threaded parts for worn or damaged threads. Inspect all lenses for scratches or etching.

(3) Remove all burrs and minor dents.

(4) Replace defective parts which cannot be repaired.

e. Reassembly. Refer to figure 5-39 and reassemble the telescope shade, objective assembly, and tube.

f. Refer to figure 5-38 and install the telescope shade, objective assembly and tube.

5-69. Telescope Diaphragm and Minor

a. General. The telescope diaphragm and mirror are installed in the telescope tube. The diaphragm provides for adjusting the intensity of illumination on the telescope reticles. The mirror directs illumination from the diaphragm onto the telescope reticles.

b. Removal and Disassembly. Refer to figure 5-39 and remove and disassemble the telescope diaphragm and mirror.

c. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent. Polish the mirror with a soft, clean, lint-free cloth or lens tissue.

(2) Inspect all metal parts for burrs, dents, or deformation. Inspect all threaded parts for worn or damaged threads. Inspect the mirror for scratches or etching.

(3) Remove all burrs and minor dents.

(4) Replace defective parts which cannot be repaired.

d. Reassembly and Installation. Refer to figure 5-39 and reassemble and install the telescope diaphragm and mirror.

5-70. Suspension Level

a. General. The suspension level is a separate assembly of the theodolite. In use it is hung on the horizontal axis by means of two integral brackets.

b. Disassembly. Refer to figure 5-40 and disassemble the suspension level.

c. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent. Polish the level vial with a soft, clean, lint-free cloth or lens tissue.

(2) Inspect all parts for burrs, dents, or deformation. Inspect all threaded parts for worn or damaged threads. Inspect level vial for cracks, scratches, or etching.

1 Shade
2 Lens
3 Spacer
4 Lens assembly
5 Setscrew
6 Housing
7 Setscrew
8 Sight
9 Screw (2)
10 Pin
11 Knob
12 Setscrew (2)
13 Bearing
14 Axis
15 Mirror
16 Tube
17 Screw (3)
18 Terminal
19 Screw (2)
20 Insulator
21 Contact
22 Insulator
23 Housing
24 Lampholder
25 Lamp
26 Spacer
27 Lens
28 Spacer
29 Lens
30 Ring
31 Diaphragm
32 Spring
33 Screw
34 Sleeve
35 Pin
36 Knob

(3) Remove all burrs and minor dents.

(4) Replace defective parts which cannot be repaired.

d. Reassembly. Refer to figure 5-40 and reassemble the suspension level.

Section VIII. TRIPOD ASSEMBLY

5-71. General

The tripod assembly is used to support the theodolite when a permanent pedestal is not available.

a. Disassembly. Refer to figure 5-41 and disassemble the tripod assembly.

b. Cleaning. Inspection. and Repair.

(1) Clean all metal parts with an approved cleaning solvent. Clean all wooden parts with a soft cloth moistened with water and dry thoroughly. Clean belt with a suitable leather cleaner.

(2) Inspect all metal parts for burrs, dents, or deformation. Inspect all wooden parts for cracks, splits, warping, and wear. Inspect all threaded parts for worn or damaged threads. Inspect belt for cuts, wear, and ripped seams.

(3) Replace defective parts which cannot be repaired.

c. Reassembly. Refer to figure 5-41 and reassemble the tripod assembly.

Section IX. HAND LAMP RHEOSTAT AND CABLE ASSEMBLIES

5-72. Hand Lamp

a. Disassembly. Refer to figure 5-42 and disassemble the hand lamp.

b. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent. Wipe the cable clean with a soft cloth. Clean corrosion from terminals and contacts with crocus cloth. Brush all threaded parts clean, removing all dirt and foreign matter.

(2) Inspect all metal parts for dents, cracks, and breaks. Inspect insulation for wear and damage. Inspect all terminals and contacts for corrosive damage, burrs, bends, and breaks.

(3) Repair minor damage to cable insulation with electrical tape. Remove all burrs and minor dents.

(4) Replace defective parts which cannot be repaired.

c. Reassembly. Refer to figure 5-42 and reassemble the hand lamp.

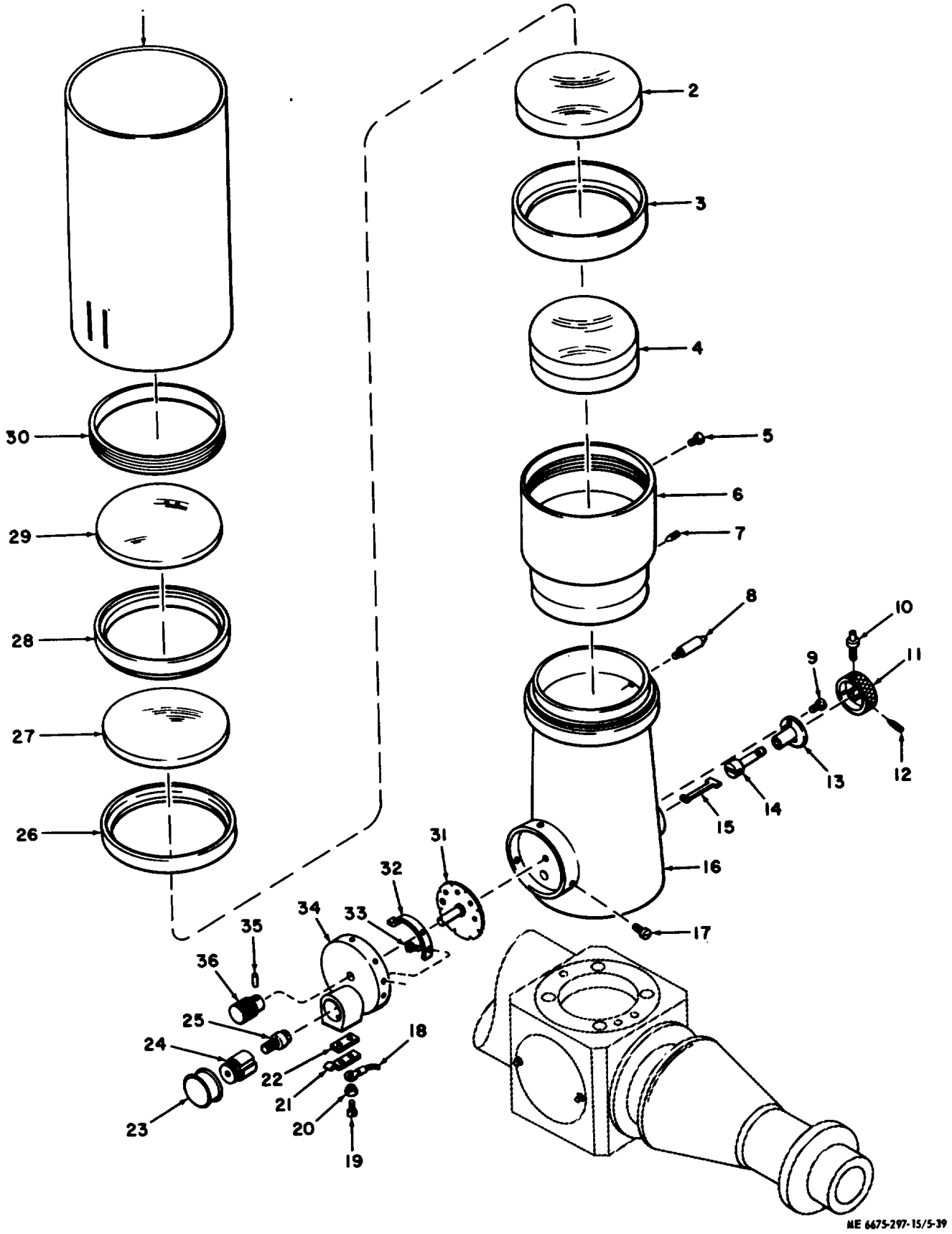
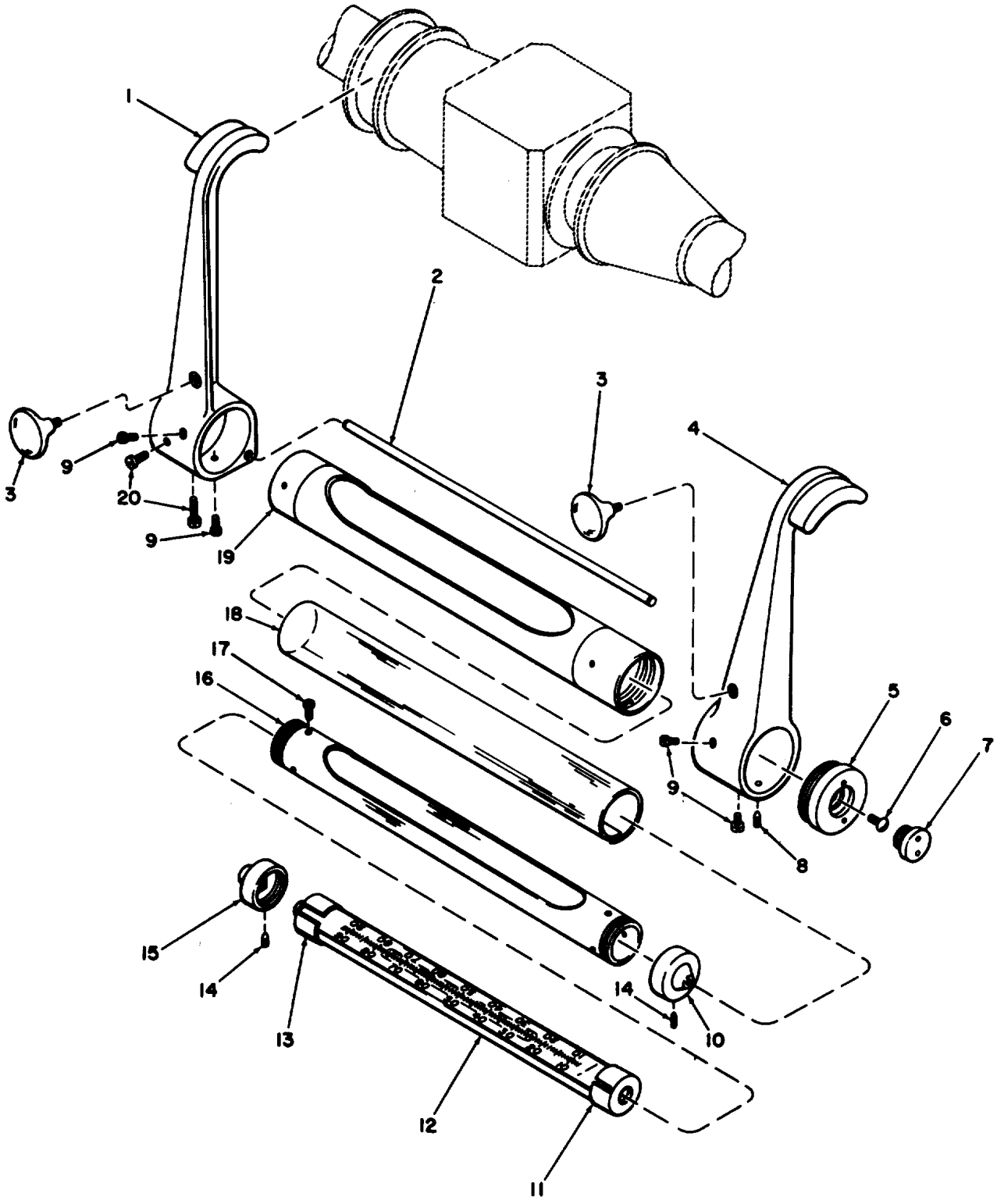
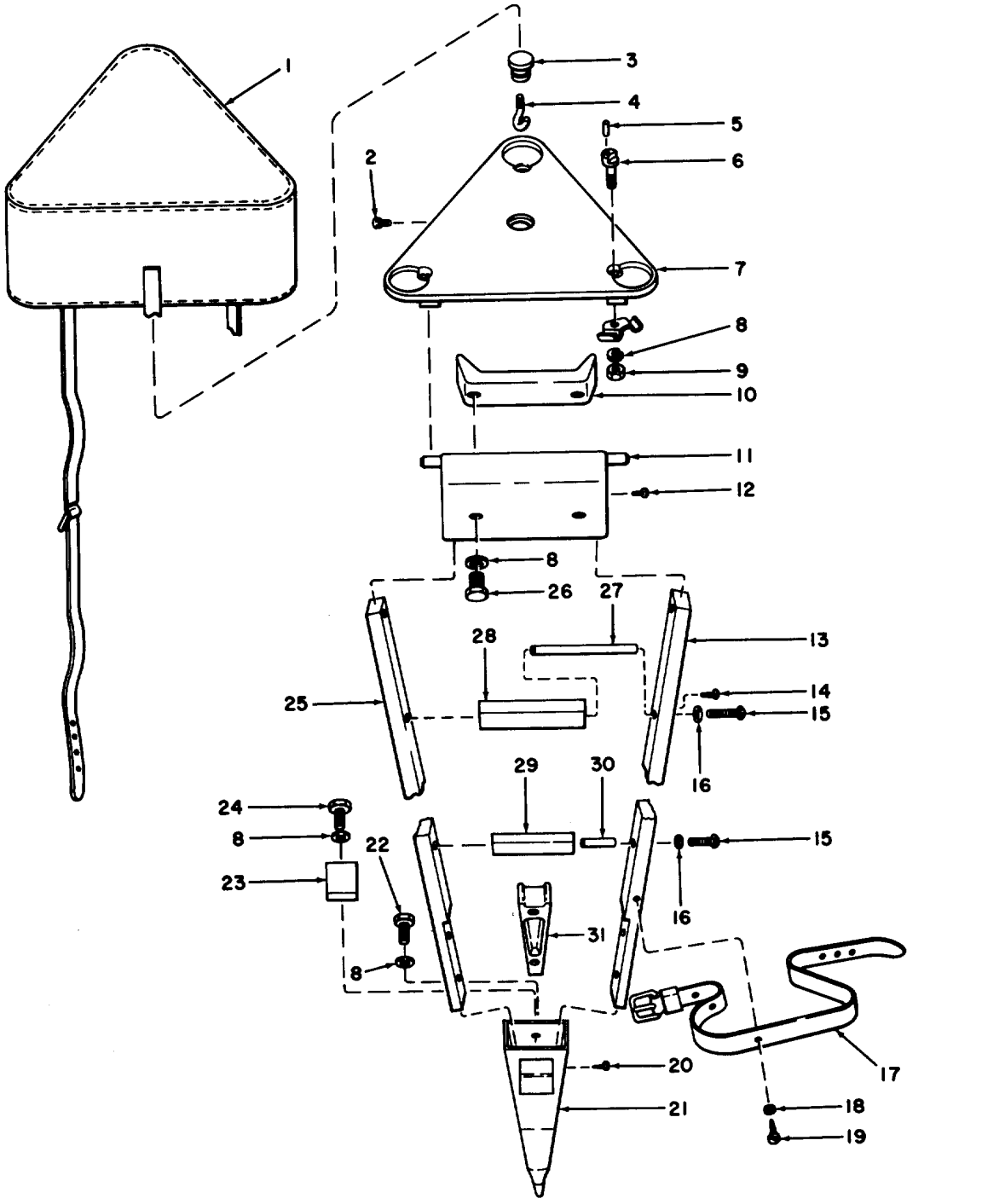


Figure 5-39. Telescope shade, objective assembly, tube, diaphragm and mirror; disassembly and reassembly.



1 Bracket	6 Screw	11 Cap	16 Tube
2 Rod	7 Cap	12 Vial	17 Screw (5)
3 Knob (2)	8 Setscrew	13 Cap	18 Cover
4 Bracket	9 Screw (6)	14 Setscrew (2)	19 Sleeve
5 Bushing	10 Sleeve	15 Sleeve	20 Adjusting screw (4)

Figure 5-40. Suspension level, disassembly and reassembly.



1 Cover	8 Washer (15)	15 Screw (6)	22 Screw (3)	29 Spacer (3)
2 Screw	9 Nut (3)	16 Washer (12)	23 Cover (3)	30 Bushing (3)
3 Insert	10 Plate (3)	17 Belt	24 Screw (3)	31 Spacer (3)
4 Eye bolt	11 Hinge (3)	18 Washer (2)	25 Leg half (3)	
5 Pin (3)	12 Screw (3)	19 Screw (2)	26 Screw (12)	
6 Screw (6)	13 Leg half (3)	20 Screw (12)	27 Bushing (3)	
7 Head assembly	14 Screw (12)	21 Shoe (3)	28 Spacer (3)	

Figure 5-41. Tripod assembly, disassembly and reassembly.

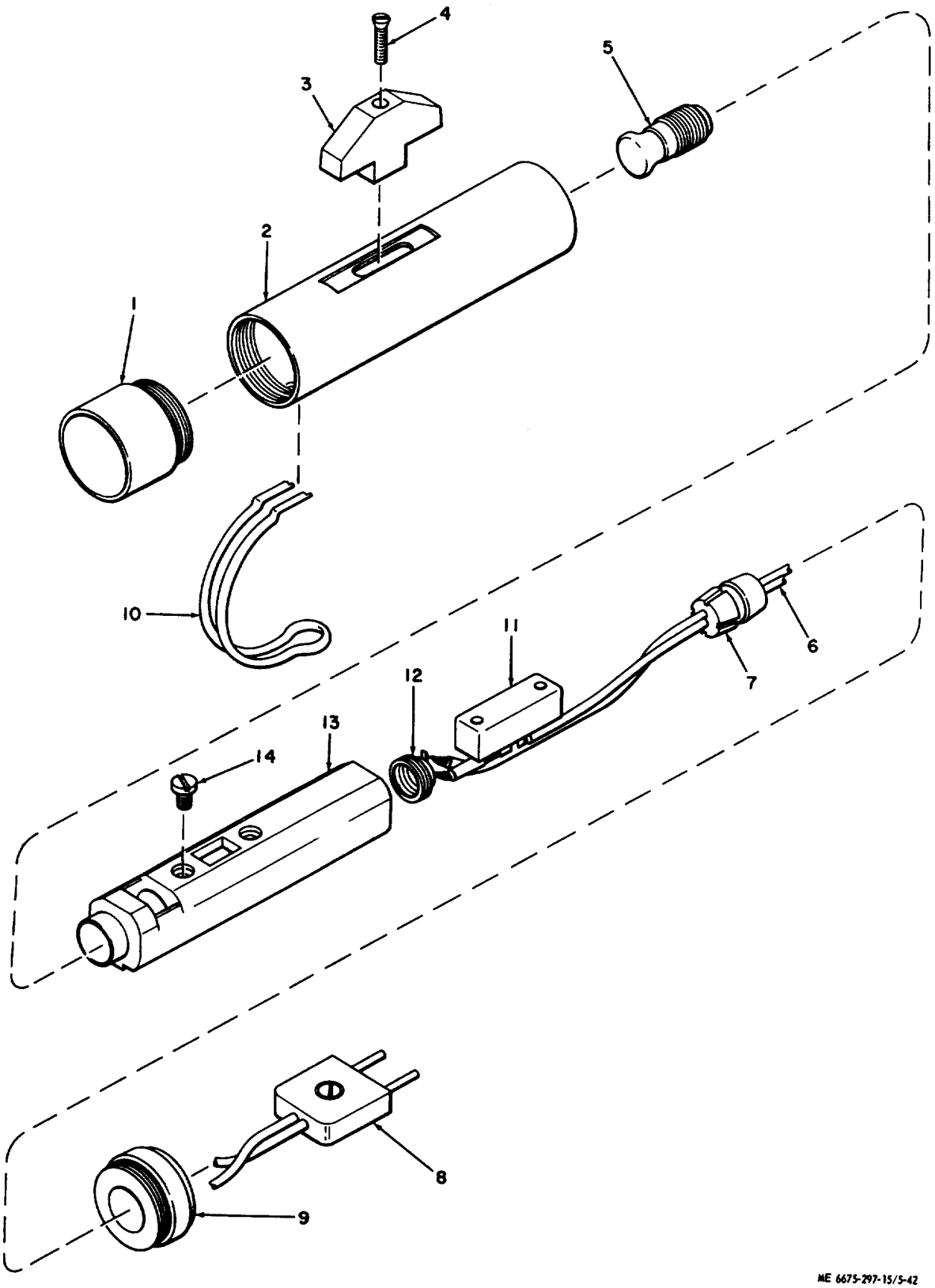


Figure 5-42. Hand lamp, disassembly and reassembly.

1 Cover	4 Screw	7 Insulator	10 Hook	13 Insulator
2 Housing	5 Lamp	8 Connector	11 Switch	14 Screw (2)
3 Slide	6 Cable	9 Cover	12 Lampholder	

5-73. Rheostat and Cables

a. Disassembly. Refer to figure 5-43 and disassemble tile rheostat and cables.

b. Cleaning, Inspection, and Repair.

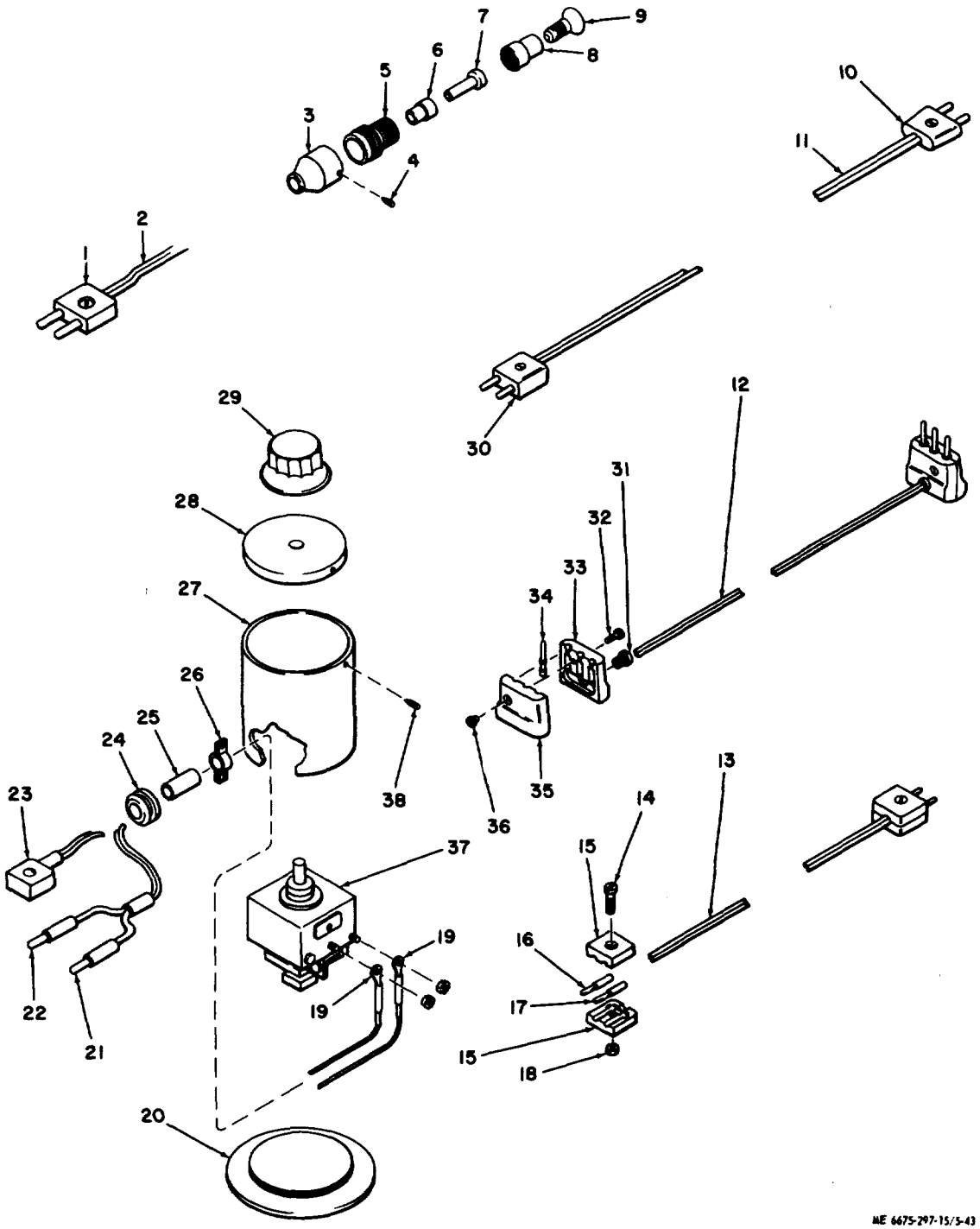
(1) Clean all metal parts with an approved cleaning solvent. Wipe all cables clean with a soft cloth. Clean corrosion from terminals and contacts with crocus cloth.

(2) Inspect all metal parts for dents, cracks, and breaks. Inspect insulation for wear or damage. Inspect all terminals and contacts for corrosive damage, burrs, bends, and breaks.

(3) Repair minor damage to cable insulation with electrical tape. Remove all burrs and minor dents.

(4) Replace defective parts which cannot be repaired.

c. Reassembly. Refer to figure 5-43 and reassemble the rheostat and cables.



1 Connector	9 Lamp	17 Pin (2)	25 Insulator	33 Plug half (2)
2 Cable	10 Connector	18 Nut (2)	26 Clamp	34 Pin (6)
3 Housing	11 Cable	19 Terminal (2)	27 Housing	35 Plug half (2)
4 Setscrew (3)	12 Cable	20 Bottom cover	28 Top cover	36 Nut (2)
5 Housing	13 Cable	21 Pin	29 Knob	37 Rheostat
6 Insulator	14 Screw (2)	22 Pin	30 Connector	38 Screw (6)
7 Pin	15 Plug half (4)	23 Connector	31 Bushing (2)	
8 Insulator	16 Pin (2)	24 Grommet	32 Screw (2)	

Figure 5-43. Rheostat and cables, disassembly and reassembly.

APPENDIX A

REFERENCES

A-1. Astronomical Publications

TM 5-236-67	The American Ephemeris and Nautical Almanac For The Year 1967
TM 5-238	60-Degree Star Graphs

A-2. Painting

TM 9-213	Painting Instructions for Field Use

A-3. Maintenance

TM 5-6675-297-25P	Organizational, Direct Support, General Support and Depot Maintenance Manual Repair Parts and Special Tools List

A-4. Shipment and Limited Storage

TB 740-93-2	Preservation of USAMEC Mechanical Equipment for Shipment and Storage

APPENDIX B

BASIC ISSUE ITEMS LIST

Section I. INTRODUCTION

B-1. Scope

This appendix lists items which accompany the Wild Heerbrugg model T4 directional theodolite or are required for installation, operation, or operator's maintenance.

B-2. General

This Basic Issue Items List is divided into the following sections:

a. Basic Issue Items-Section II. A list of items which accompany the theodolite or are required for the installation, operation, or operator's maintenance.

b. Maintenance and Operating Supplies -- Section III. Not Applicable.

B-3. Explanation of Columns

The following provides an explanation of columns in the tabular list of basic issue items, section II.

a. Source, Maintenance, and Recoverability Codes: (SMR), column (1):

NOTE

Common hardware items known to be readily available in Army supply will be assigned maintenance codes only. Source Codes, Recoverability Codes, and Quantity Authorized will not be assigned to this category of items.

(1) Source Code, indicates the selection status and source for the listed item. Source code is:

Code	*Explanation*
P	Applied to repair parts which are stocked in or supplied from GSA/DSA or Army supply system, and authorized for use at indicated maintenance categories.

(2) Maintenance Code, indicates the lowest category of maintenance authorized to install the listed item. The maintenance level code is:

Code	*Explanation*
C	Operator/crew

(3) Recoverability Code, indicates whether unserviceable items should be returned for recovery or salvage. Items not coded are expendable.
Recoverability codes are:

Code	*Explanation*
R	Applied to repair parts and assemblies which are economically repairable at DSU and GSU activities and are normally furnished by supply on an exchange basis.
T	Applied to high dollar value recoverable repair parts which are subject to special handling and are issued on an exchange basis. Such repair parts are normally repaired or overhauled at depot maintenance activities.
U	Applied to repair parts specifically selected for salvage by reclamation units because of precious metal content, critical materials, high dollar value reusable casings and castings.

b. Federal Stock Number, Column (2). This column indicates the Federal stock number for the item.

c. Description. Column (3). This column indicates the Federal item name and any additional description of the item required. A part number or other reference number is followed by the applicable five-digit Federal supply code for manufacturers in parentheses. Repair parts quantities included in kits, sets, and assemblies are shown in front of the repair part name.

d. Unit of Issue, Column (4). This column indicates the unit used as a basis for issue, e.g., ea, pr, ft, yd, etc.

e. Quantity Incorporated in Unit Pack, Column, (5). This column indicates the actual quantity contained in the unit pack.

f. Quantity Incorporated in Unit, Column (6). This column indicates the quantity of the item used in the functional group.

g. Quantity Furnished With Equipment, Column (7). This column indicates the quantity of an item furnished with the equipment.

h. Quantity Authorized, Column (8). This column indicates the quantity of an item authorized the operator/crew to have on hand or to obtain as required. As required items are indicated with an asterisk.

i. Illustration, Column (9). This column is divided as follows:

(1) Figure Number, column (9) (a). Indicates the figure number of the illustration in which the item is shown.

(2) Item Number, column (9)(b). Indicates the callout number used to reference the item in the illustration.

B-4. Federal Supply Code for Manufacturers

Code	*Manufacturer*
89906	Wild Heerbrugg, Instruments Inc.

Section II. BASIC ISSUE ITEMS

(1) SMR Code	(2) Federal Stock Number	(3) Description Ref No & Mfr Code / Usable on Code	(4) Unit of issue	(5) Qty inc in unit pack	(6) Qty inc in unit	(7) Qty furn with equip	(8) Qty auth	(9) Illustration (a) Fig No.	(9) Illustration (b) Item No.
		GROUP 31-BASIC ISSUE ITEMS MANUFACTURER INSTALLED 3100-Basic Issue Items, Manufacturer or Depot Installed							
PC	6675-715-3085	Adapter: Elec, Lamp (89905) T21-4	ea			2	2		
PC	6675-739-9877	Applicator, Oil (89905) 12299-5A	ea			1	1		
PC	6675-789-9866	Box, Battery T4A-1020	ea			1	1		
PC	7920-746-6273	Brush, Dust (89905) HDP1-1	ea			2	2		
PC	6675-739-9874	Cable Assembly: Vertical Circle Illumination (89905) XT4-17	ea			1	1		
PC	6675-894-6305	Cable Assembly: Microscope Eyepiece (89905) XT4-18	ea			1	1		
PC		Cable Switch Rheostat Assembly (89905) T4A-1040	ea			1	1		
PC	6675-739-9876	Cable Assembly Cronograph (89905) XT4-20	ea			1	1		
PC		Case, Accessory (89905) T4A-970A	ea			1	1		
PC		Case, Assembly Telescope (89905) GB-VP-32	ea			1	1		
PC	8830-965-1722	Chamois, Leather	ea			1	1		
PC	6675-739-9864	Container, Grease (89905) HDF3-12-7403	ea			1	1		
PC	6240-797-3750	Lamp, 4V (89905) HEG3-2	ea			2	8	10	
PC		Light, Extension Hand Lamp (89905) GEB12-00-000	ea			1	1		
PC	6230-739-9862	Light: Extension (89905) EB-75	ea			1	1		

Section II. BASIC ISSUE ITEMS-Continued

(1) SMR Code	(2) Federal Stock Number	(3) Description Ref No & Mfr Code Usable on Code	(4) Unit of issue	(5) Qty inc in unit pack	(6) Qty inc in unit	(7) Qty furn with equip	(8) Qty auth	(9) Illustration (a) Fig No.	(9) Illustration (b) Item No.
PC		Department of the Army Operator Organizational Direct and General Support, and Depot Maintenance Manual TM 5-6675-297-15							
PC		Mirror, Illumination (89905) T1A29001	ea		2		2		
PC	6675-739-9872	Pin, Adjusting (89905) T4A-963	ea			2	2		
PC	6675-353-4103	Pin, Adjusting (89905) 3A-55				4	4		
PC	5120-227-7319	Screwdriver (89905) 13369-9	ea			1	1		
PC	5120-236-2127	Screwdriver (89905) 13369-10	ea			1	1		
PC	5120-222-8852	Screwdriver (89905) 13369-11	ea			1	1		
PC	5120-746-2175	Screwdriver, Jewelers (89905) HDW1-1	ea			1	1		
PC	5120-961-2761	Screwdriver, Jewelers (89905) HDW1-2	ea			1	1		
PC	5120-746-6276	Screwdriver, Jewelers (89905) HDW1-4	ea			1	1		
PC	5120-408-4036	Orangewood Stock	ea			3	3		
PC	5120-247-0868	Tweezers (89905) HDW1-6	ea			1	1		
PC	5120-746-6277	Wrench, Allen (89905) T4A-247	ea			1	1		
PC	5120-746-6279	Wrench, Spanner (89905) T4A-942A	ea			1	1		
		GROUP 32-BASIC ISSUE ITEMS, TROOP INSTALLED							
		3200(-Basic Issue Items, Troop Installed or Authorized							
PC	6135-050-0915	Battery, Dry (80063) BA23	ea			6	*		

APPENDIX C

MAINTENANCE ALLOCATION CHART

Section I. INTRODUCTION

C-1. General

a. This section provides a general explanation of all maintenance and repair functions authorized at various maintenance levels.

b. Section II designates overall responsibility for the performance of maintenance operations on the identified end item or component. The implementation of the maintenance tasks upon the end item or component will be consistent with the assigned maintenance operations.

c. Section III lists the special tools and test equipment required for each maintenance operation as referenced from section II.

d. Section IV contains supplemental instructions, explanatory notes and/or illustrations required for a particular maintenance function.

C-2. Explanation of Columns in Section II

a. Functional Group Number. The functional group is a numerical group set up on a functional basis. The applicable functional grouping indexes (obtained from TB 750-93-1, Functional Grouping Codes) are listed on the MAC (Maintenance Allocation Chart) in the appropriate numerical sequence. These indexes are normally set up in accordance with their function and proximity to each other.

b. Component Assembly Nomenclature. This column contains a brief description of the components of each functional group.

c. Maintenance Functions and Maintenance Categories. This column lists the various maintenance functions (A through K) and indicates the lowest maintenance category authorized to perform these operations. The symbol designations for the various maintenance categories are as follows:

C-Operator or crew
O-Organizational maintenance
F-Direct support maintenance
H-General support maintenance
D-Depot maintenance

The maintenance functions are defined as follows:

A-Inspect: Verify serviceability and detect incipient electrical or mechanical failure by close visual examination.

B-Test: Verify serviceability and detect incipient electrical or mechanical failure by measuring the mechanical or electrical characteristics of the item and comparing those characteristics with authorized standards. Tests will be made commensurate with test procedures and with calibrated tools and/or test equipment referenced in the MAC.

C-Service: Operations required periodically to keep the item in proper operating condition, i.e., to clean, preserve, drain, paint, and replenish fuel, lubricants, hydraulic, and deicing fluids, or compressed air supplies.

D-Adjust: Regulate periodically to prevent malfunction. Adjustments will be made commensurate with adjustment procedures and associated equipment adjustment specifications.

E-Aline: Adjust two or more components of an electrical or mechanical system so that their functions are properly synchronized or adjusted.

F-calibrate: Determine, check, or rectify the graduation of an instrument, weapon, or weapons system or components of a weapons system.

G-Install: Remove and Install the same item for service or when required for the performance of other maintenance operations.

H-Replace: Substitute serviceable components, assemblies and subassemblies for unserviceable counterparts.

I-Repair: Restore to a serviceable condition by replacing unserviceable parts or by any other action required using available tools, equipment and skills, including welding, grinding, riveting, straightening, adjusting, and facing.

J-Overhaul: Restore an item to a completely serviceable condition (as prescribed by serviceability standards developed and published by the commodity commands) by employing techniques of "Inspect and Repair Only As Necessary" (IROAN). Maximum use of diagnostic and test equipment is combined with minimum disassembly

during overhaul. "Overhaul" may be assigned to any level of maintenance except organizational, provided the time, tools, equipment, repair parts authorization, and technical skills are available at that level. Normally, overhaul as applied to end items, is limited to depot maintenance level.

K-Rebuild: Restore to a condition comparable to new by disassembling to determine the condition of each component part and reassembling using serviceable, rebuilt, or new assemblies, subassemblies, and parts.

d. Reference Note. This column, subdivided into columns L and M, is provided for referencing the Special Tool and Test Equipment Requirements (sec. III) and Remarks (sec. IV) that may be associated with maintenance functions (sec. II).

C-3. Explanation of Columns in Section III

a. Reference Code. This column consists of a number and a letter separated by a dash. The number references the T&TE (Tool and Equipment) requirements column on the MAC. The letter represents the specific maintenance function the item is to be used with. The letter is representative of columns A through K on the MAC.

b. Maintenance Category. This column shows the lowest level of maintenance authorized to use the special tool or test equipment.

c. Nomenclature. This column lists the name or identification of the tool or test equipment.

d. Tool Number. This column lists the manufacturer's code and part number, or Federal stock number of tools and test equipment.

C-4. Explanation of Columns in Section IV

a. Reference code. This column consists of two letters separated by a dash, both of which are references to section II. The first letter references column M and the second letter references a maintenance operation, columns A through K.

b. Remarks. This column lists information pertinent to the maintenance operation being performed, as indicated on the MAC section II.

Section II. MAINTENANCE ASSIGNMENT

FUNCTIONAL GROUP NUMBER	COMPONENT ASSEMBLY NOMENCLATURE	MAINTENANCE FUNCTIONS											NOTE REFERENCE	
		A	B	C	D	E	F	G	H	I	J	K	L	M
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	REBUILD	TOOLS AND EQUIPMENT	REMARKS
18	BODY, CAB, HOOD AND HULL													
1808	Carrying Cases:													
	Case, base and alidade assembly								O	O				
	Case, telescope assembly								O	O				
	Case, suspension level								O	O				
	Case, accessory								O	O				
67	PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL													
6700	Surveying Instrument:													
	Theodolite	C		O	C				O	F	D			A
6701	Telescope Assembly:													
	Telescope assembly			C						D				B
	Axis assembly, telescope									D				
6702	Optics:													
	Objective assembly, telescope			C							D			C
	Eyepiece assembly telescope			C	C					O	D			D, E
	Eyepiece assembly, setting circle			C	D					O	D			F, G
	Eyepiece assembly, vertical circle			C	C					O	D			H, I
	Eyepiece assembly, horizontal circle			C	C					O	D			J, K
	Mirror illumination			C	C					O	F			
	Circle assembly, vertical									D	D			
	Circle assembly, setting									D	D			

Section II. MAINTENANCE ASSIGNMENT-Continued

FUNCTIONAL GROUP NUMBER	COMPONENT ASSEMBLY NOMENCLATURE	MAINTENANCE FUNCTIONS											NOTE REFERENCE	
		A	B	C	D	E	F	G	H	I	J	K	L	M
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	REBUILD	TOOLS AND EQUIPMENT	REMARKS
6708	Structural and Precision Parts:													
	Base assembly, horizontal								D	D				
	U-standard assembly								D	D				
	Drive assembly, horizontal circle			C					D	D				
	Clamp, vertical, horizontal									D				
	Footscrew assembly				C				F	H				
	Screw assemblies, vertical and horizontal, collimation				C				F	H				
	Axis assembly, horizontal and vertical									D				
	Level assembly, collimation									D				
6704	Batteries								C					
6705	Fuses and Lamps:													
	Housing lamp								O	F				
	Light, emergency			C					O	F				
6711	Controls and Special Components:													
	Rheostat assembly									F				
	Switch, lamp									F				
6712	Mounting Connecting Devices:													
	Contact rings									D				
	Receptacles									D				
	Housing, illumination									D				
6713	Miscellaneous Wiring and Fittings:													
	Leads, electrical, external								O	F				
	Wiring internal									D				
6717	Power Supply (self-contained)													
	Box, battery			C					O	F				
6718	Compass and Level:													
	Level assembly, circular			C	D					D				
	Level assembly, horrebow			C	D					D				1
	Level assembly, vertical circle			C	C					D				2
	Level suspension			C	C					D				
	Level assembly, setting circle			C	C					D				3
6719	Tripods:													
	Tripod assembly			C	C					O				4

Section III. SPECIAL TOOL AND SPECIAL TEST EQUIPMENT REQUIREMENTS

Reference Code	Maintenance Level	Nomenclature	Tool No.
1-D	C	Screwdriver, Jewelers	
2-D	C	Screwdriver, Jewelers	
3-D	C	Wrench: Fork Pin	
4-D	C	Wrench Key, 4mm Square.	

Section IV. REMARKS

Reference Code	Remarks
A-D	External
B-C	External
C-C	External
D-C	External
E-D	External
F-C	External
G-D	External
H-C	External
I-D	External
J-C	External
K-D	External

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The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 decagram = 10 grams = .35 ounce
1 hectogram = 10 decagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 33.81 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	*To*	*Multiply by*	*To change*	*To*	*Multiply by*
inches	centimeters	2.540	ounce-inches	Newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29,573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	Newton-meters	1.356	metric tons	short tons	1.102
pound-inches	Newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C