DEPARTMENT OF THE ARMY TECHNICAL MANUAL

DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER

TM 11-6675-200-35
TO 49A8-2-12

FIELD AND DEPOT MAINTENANCE

THEODOLITES ML-47-C THROUGH ML-47-R, ML-247 AND ML-247-A AND DOUBLE CENTER THEODOLITE ML-474/GM

DEPARTMENTS OF THE ARMY AND THE AIR FORCE

DECEMBER 1958

CHANGE No. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 4 *February* 1966

DS,GS, and Depot Maintenance Manual

THEODOLITES ML-47-C THROUGH ML-47-R, ML-247, AND ML-247-A AND DOUBLE CENTER THEODOLITES ML-474-GM AND ML-474A/GM

TM 11-6675-200-35, 8 December 1958 is changed as follows:

The title is changed as shown above.

Page 2, paragraph 1. Delete subparagraph *d* and substitute:

d. The direct reporting of errors, omissions, and recommendations for improving this manual by the individual user, is authorized and encouraged. DA Form 2028 (Recommended Changes to DA Publications) will be used for reporting these improvements. This form will be completed using pencil, pen, or typewriter and forwarded direct to Commanding General, U.S. Army Electronics Command, ATTN: AMSEL-MR-(NMP)-MA, Fort Monmouth, N.J., 07703.

Page 23. Designate the appendix: I.

Add appendix II after appendix I.

APPENDIX II

DS, GS, AND DEPOT REPAIR PARTS LIST

Section I. INTRODUCTION

1. General

a. This appendix lists the quantities of repair parts for direct and general support and depot maintenance and is a basis for requisitioning authorized parts. It is also a guide for depot maintenance in establishing initial levels of spare parts.

b. Columns are as follows:

(1) *Source, maintenance, and recoverability code.* Source, maintenance, and recoverability codes indicate the commodity command responsible for supply, the maintenance category at which an item is stocked, categories at which an item is installed or repaired, and whether an item is repairable or salvageable. The source code column is divided into four parts.

(a) Column A. This column indicates the materiel code and designates the the area of responsibility for supply. AR 310-1 defines the basic numbers used to identify the materiel code. If the part is Signal materiel responsibility, the column is left blank.

(b) Column B. This column indicates the point within the maintenance system where the part is available. "P1" indicates that the repair part is a low mortality part; procured by commodity command, stocked only in and supplied from Army depot system, and authorized for installation at indicated maintenance categories.

(c) Column C. This column indicates the lowest maintenance category authorized to install the part.

"O" - Organizational maintenance (operator and organizational).
"F" - Direct support.
"D" - Depot maintenance.

(d) Column D. Not used.

(2) *Federal stock number.* This column lists the 11-digit Federal stock number.

(3) *Designation by model.* The dagger (†) indicates the model in which the part is

*This change supersedes TM 11–6675–200–35P, 12 October 1959.

used and further, by its position, designates the item number by which the item is identified and/or the quantity used in in each model where the quantity varies.

(4) *Description.* Nomenclature or the standard item name and brief identifying data for each item are listed in this column. When requisitioning, enter the nomenclature and description.

(5) *Unit of issue.* The unit of issue is each unless otherwise indicated and is the supply term by which the individual item is counted for procurement, storage, requisitioning, allowances, and issue purposes.

(6) *Expendability.* Nonexpendable items are indicated by NX. Expendable items are not annotated.

(7) *Quantity incorporated in unit.* This column lists the quantity of each part found in a given assembly, component, or equipment.

(8) *Direct support. This* column indicates quantities of repair parts authorized for initial stockage for use in direct support maintenance and in supply support to organization. The quantities are based on 100 equipments to be maintained for a 15-day period.

(9) *General support.* The numbers in this column indicate quantities of repair parts authorized for initial stockage for use in general support maintenance. The quantities are based on 100 equipments to be maintained for a 15-day period.

(10) *Depot.* The numbers in this column indicate quantities of repair parts authorized for depot maintenance and for initial stockage for maintenance, and for supply support to lower categories. The entries are based on the quantity required for rebuild of 100 equipments.

(11) *Illustration.* The "Item No." column lists the reference designations that appear on the part in the equipment. These same designations are also used on any illustrations of the equipment. The numbers in the "Figure No." column refer to the illustrations where the part is shown.

2. Parts for Maintenance

When this equipment is used by Signal service organizations organic to theater headquarters or communication zones to provide theater communications, those repair parts authorized up to and including general support are authorized for stockage by the organization operating this equipment.

3. Additional Repair Parts Authorization

An asterisk indicates that an item is not authorized for stockage but if required, may be requisitioned for immediate use only.

4. Requisitioning Information

a. The allowance factors are based on 100 equipments. In order to determine the number of parts authorized for initial stockage for the specific number of equipments supported, the following formula will be used and carried out to two decimal places.

Specific number of equipments supported

$$\sim \frac{\text{allowance factor}}{100}$$

= number of parts authorized for initial stockage.

b. Fractional values obtained from above computation will be rounded to whole numbers as follows:

(1) When the total number of parts authorized is less than 0.5, the quantity authorized will be zero.

(2) When the total number of parts authorized is between 0.5 and 1.0, the quantity authorized will be 1.

(3) For all values above one, fractional values below 0.5 will revert to the next lower whole number and fractional value 0.5 and above will advance to the next higher whole number.

c. The quantities determined in accordance with the above computation represent the initial stockage for a 15-day period.

SECTION II. FUNCTIONAL PARTS LIST

SOURCE CODE				FEDERAL STOCK NUMBER	DESIGNATION BY MODEL					DESCRIPTION	UNIT OF ISSUE	EXP	QTY IN UNIT	DIRECT SUPPORT	GENERAL SUPPORT	DEPOT	ILLUSTRATION	
A	B	C	D														FIGURE NO.	ITEM NO.
										THEODOLITE, DOUBLE CENTER ML-474/GM; ML-474A/GM; THEODOLITE ML-247, ML-247A NOTE: Model column 1 refers to ML-247, column 2 refers to ML-247-A; column 3 refers to ML-474/GM; column 4 refers to ML-474A/GM								
				6660-498-9773						THEODOLITE, DOUBLE CENTER ML-474/GM; ML-474A/GM; THEODOLITE ML-247-A; ML-247		NX						
	P1	F		1240-356-5230	†					SIGHT, TELESCOPE: ECOM Dwg SC-C-52416			1	*	*	6.0		MP2
	P1	O		6660-448-8396	†	†	†	†		GUARD, EYEPIECE: black rubber; Warren-Knight No. 6061-173; ECOM Dwg SC-B-52308 or SM-B-531509			1	*	*	4.0		MP5
	P1	O		6605-498-9649	†	†	†	†		COMPAS ML-197: ECOM Dwg SC-B-52185 or SM-C-531502			1	*	*	8.0		MP12
	P1	O		6675-219-7191		†	†	†		CALIPER, THEODOLITE ADJUSTMENT: micrometer type; oper on circle gear; Warren-Knight #6061-641; ECOM Dwg SC-B-52298 or SM-B-531504				*	*	4.0	4	MP15
	P1	O		5310-595-7083		†	†	†		WASHER FLAT: accom 4-48 screw; Warren-Knight #6061-28; ECOM Dwg SC-B-52209 or SM-B-531527			4	*	0.3	10.0		MP85, MP86, MP130, MP131
	P1	O		5310-208-3356		†	†	†		NUT, PLAIN, ROUND: 3/8-36 thd; p/o elevation control; ECOM Dwg SC-B-52213 or SM-B-531530			4	*	0.3	10.0		MP29, MP30, MP117, MP120
	P1	D		6660-392-9734		†	†	†		SPRING: top plate catch spring; Warren-Knight #6061-15; ECOM Dwg SC-B-52214 or SM-B-531531			2			6.0		MP76, MP126
	P1	D		6660-392-9732		†	†	†		SPRING: to hold worm; Warren-Knight #6061-27; ECOM Dwg SC-B-52215 or SM-B-531683			1			4.0		MP75

SOURCE CODE				FEDERAL STOCK NUMBER	DESIGNATION BY MODEL					DESCRIPTION	UNIT OF ISSUE	EXP	QTY IN UNIT	DIRECT SUPPORT	GENERAL SUPPORT	DEPOT	ILLUSTRATION	
A	B	C	D														FIGURE NO.	ITEM NO.
										ML-474/GM(continued)								
	P1			6675-373-3899	†	†	†			CALIPER, THEODOLITE ADJUSTMENT: azimuth measurement; Warren-Knight #6061-721; ECOM Dwg SC-B-52208 or SM-B-531526			1	*	*	4	4	MP16
	P1	0		6660-521-1443	†	†	†			LEVEL SPIRIT: transit type; Warren-Knight #6061-714; ECOM Dwg SC-B-52178 or SM-B-531519		NX	2	*	*	5.0		MP9, MP10
	P1	0		5305-297-9106	†	†	†			SCREW, SHOULDER: 4-48NF-2A thd; 33/64 in. lg; ECOM Dwg No. SC-B-52172 or SM-B-531513			2	*	0.2	5.0		MP91, MP117
	P1	0		6675-663-3388	†	†	†			SPRING, HELICAL, COMPRESSION: cylindrical shape; 8 coils; for level adjustment; Warren-Knight #7012-205 ECOM Dwg SC-B-52177 or SM-B-531515			2	*	*	6.0		MP99, MP109
	P1	0		6675-597-9843	†	†	†			SPRING, HELICAL, COMPRESSION: cylindrical; 8 coils; p/o level; Warren-Knight #7012-207			2	*	*	6.0		MP93, MP118
	P1	0		6660-911-2308	†	†	†			SCREW, ADJUSTMENT: for level adjustment; Warren-Knight No. 7012-204 ECOM Dwg SM-B-531516			2	*	0.2	5.0		MP92, MP100
	P1	0		5905-257-9476	†					RESISTOR, VARIABLE: ww; 100 ohm ±10% 3 w; Clarostat No. 58 w			1	1.0	0.2	6.0		R1
	P1	0		5905-642-5355	†	†				RESISTOR, VARIABLE: ww; 20 ohm ±10%, 2 w; Mallory No. C20R; ECOM Dwg SM-B-531583			1	1.0	0.2	6.0		R1
	P1	0		5905-174-1439	†					RESISTOR, VARIABLE: ww; 10 ohm ±10%, 4 w; Mallory No. B-117612 type M			1	1.0	0.2	6.0		R1
	P1	0		5355-667-9336	†	†	†			KNOB: pointer shaped; for rheostat; ECOM Dwg SC-B-52203-2			1	*	*	4		MP113

SOURCE CODE				FEDERAL STOCK NUMBER	DESIGNATION BY MODEL						DESCRIPTION	UNIT OF ISSUE	EXP	QTY IN UNIT	DIRECT SUPPORT	GENERAL SUPPORT	DEPOT	ILLUSTRATION	
																		FIGURE NO.	ITEM NO.
A	B	C	D								ML-474/GM (continued)								
	P1	0		5930-396-3467		†					SWITCH ASSEMBLY: for lamp; Warren-Knight #6061-776; ECOM Dwg			2	*	0.3	10.0		S1,S2
							†	†			SC-B-52260 or SM-B-531577			1	*	0.2	6.0		S2
	P1	0		6660-911-2307				†			LAMPHOLDER ASSEMBLY: illuminates azimuth indicator; ECOM Dwg SM-B-531503; Warren-Knight No. 6061-712			1	*	*	4.0		XDS3
	P1	0		6250-523-6032	†	†	†	†			LAMPHOLDER: illuminates crosshairs; Warren-Knight No. 6061-760; ECOM Dwg SC-B-52379 or SM-B-531507			1	*	*	4.0	3	XDS1
	P1	0		6210-319-0824	†	†	†				LAMPHOLDER ASSEMBLY: verticle circle illumination; ECOM Dwg			2	*	*	6.0		XDS2,3
								†			SC-B-52329 or SM-B-531506; Warren-Knight No. 6061-751			1	*	*	4.0		XDS2
	P	0		6240-797-2650	†	†	†	†			LAMP, INCANDESCENT LM-19: 2.5 v, 0.3 amp			3	3.4	0.6	25.0		DS1, DS2, DS3
	P1	0		6135-583-9461	†	†	†	†			BATTERY BOX: Warren-Knight #6061-728; ECOM Dwg SC-B-52237 or SM-B-531554			1	*	*	4		BT1,2
	P1	0		5305-637-6643		†	†	†			SCREW, MACHINE: 7-36NS-2 x 3/8 in. lg; p/o standard assys; Warren-Knight No. 6061-43: ECOM Dwg SC-B-52292 or SM-B-531598			4	*	0.1	4.0		MP672 THRU MP675
	P1	0		5340-356-5202		†	†	†			SPRING, HELICAL, COMPRESSION: 7 coils; cap block spring; Warren-Knight #6061-42; ECOM Dwg SC-B-52293 or SM-B-531599			2	*	0.2	6.0		MP71, MP127
	P1	0		5305-637-9770		†	†	†			SCREW, CAPTIVE: 4-40 thd; 31/64 in lg; for standard assy; Warren-Knight No. 6061-41; ECOM Dwg SC-B-52291 or SM-B-531600			2	*	0.2	5.0		MP62, MP63
	P1	0		5310-545-8305		†	†	†			NUT, ROUND: 10-40 thd; p/o adjustable standard; Warren-Knight No. 6061-47; ECOM Dwg SC-B-52287 or SM-B-531604			1	*	0.1	4.0	10	MP34

SOURCE CODE				FEDERAL STOCK NUMBER	DESIGNATION BY MODEL						DESCRIPTION	UNIT OF ISSUE	EXP	QTY IN UNIT	DIRECT SUPPORT	GENERAL SUPPORT	DEPOT	ILLUSTRATION	
A	B	C	D															FIGURE NO.	ITEM NO.
											ML-474/GM (continued)								
	P1	0		5310-208-3726	†	†	†	†			NUT, ROUND: 10-40 thid; p/o adjustable standard; Warren-Knight No. 6061-46; ECOM Dwg SC-B-52288 or SM-B-531606			1	*	0.1	4.0	10	MP35
	P1	0		5305-638-0986	†	†	†	†			THUMBSCREW: 8-32NC-2 thd; p/o azimuth calibrator assy; Warren-Knight No. 7014-10; ECOM Dwg SC-B-52161 or SM-B-531630			1	*	0.1	4.0	7	MP102
	P1	0		5305-322-4487		†	†	†			THUMBSCREW: .383 in - 36 thd; Warren-Knight No. 7012-25; ECOM Dwg SC-B-52160 or SM-B-531631			1	*	0.1	4.0	7	MP64
	P1	0		6675-663-3387		†	†	†			SPRING, HELICAL, COMPRESSION: 23 coils; Warren-Knight No. 7012-23; ECOM Dwg SC-B-52162 or SM-B-531632			1	*	0.1	4.0		MP70
	P1	0		5305-524-0228		†	†	†			SCREW, MACHINE: tension screw on azimuth calibration assy; 5-44 thd; 13/32 in lg; Warren-Knight No. 7012-92; ECOM Dwg SC-B-52163 or SM-B-531633			1	*	0.1	4.0	7	MP50
	P1	0		5305-639-3409		†	†	†			THUMBSCREW: 7/8 in. dia X 1/4 in thk; 1/4 in - 40NC2 thd; 1-25/64 in lg o/a; ECOM Dwg SC-B-52164 or SM-B-531634			1	*	0.1	4.0	7	MP33
	P1	0		5305-032-5517	†						THUMBSCREW: 4-40 thd; White D No. 7012-628			1	*	0.1	4.0	7	MP33
	P1	0		5305-396-3425		†	†	†			SCREW, ADJUSTMENT: leveling head adj screw; Warren-Knight No. 7012-744; ECOM Dwg SM-B-531639			4	*	0.3	10.0	8	MP36 THRU MP39
	P1	0		6675-219-7193			†	†			CAP: protects leveling screw; ECOM Dwg SC-B-52405 or SM-B-531643			4	*	*	10.0		MP17 THRU MP20
	P1	0		5305-206-2018		†	†				SCREW, MACHINE: for leveling assy 8-36 thd, 11/32 in lg; ECOM Dwg SC-B-52147			4	*	0.3	10.0	8	MP51 THRU MP54

SOURCE CODE				FEDERAL STOCK NUMBER	DESIGNATION BY MODEL						DESCRIPTION	UNIT OF ISSUE	EXP	QTY IN UNIT	DIRECT SUPPORT	GENERAL SUPPORT	DEPOT	ILLUSTRATION	
A	B	C	D															FIGURE NO.	ITEM NO.
											ML-474/GM (Continued)								
	P1	D		6675-396-3465		†					SLEEVE, CENTERING: brg for leveling screw; White D No. 701-9-2			4			4.0		
	P1	O		6675-219-7217		†	†	†			SHOE, FRICTION: brg surface for leveling screw; ECOM Dwg SC-B-52146 or SM-B-531644			4	*	0.3	10.0	8	MP66 THRU MP69
	P1	D		6660-013-3069		†	†	†			SPRING: flat type; for ctr cap; Warren-Knight No. 7012-14; ECOM Dwg SC-B-52133 or SM-B-531645			1			4.0		MP72
	P1	D		6675-219-7194		†	†	†			EYEPIECE, OPTICAL: to view image on crosshair pattern; Warren-Knight No. 6061-753 ECOM Dwg SC-C-52353 or SM-B-531690			1			4.0		MP3
	P1	D		6650-448-8290	†						RETICULE: crosshairs; White D No. 6061-13		NX	1			4.0		MP43
	P1	D		5310-595-7762		†	†	†			WASHER, SADDLE: 0.132 in dia ctr hole; White D No. 7012-76-1			4			10.0		MP81 THRU MP84
	P1	D		5305-448-8119	†	†	†	†			SCREW, MACHINE: 5-44 thd; 37/64 in lg; reticle screws ECOM Dwg SC-B-52310 or SM-B-531689			4			10.0	3	MP103 THRU MP106
	P1	O		6650-537-9222	†	†	†	†			TELESCOPE ML-146		NX	1	*	*	4.0	1 3	MP1
	P1	D		6640-664-6227		†	†	†			SPRING: p/o finder assy; Warren-Knight No. 6061-212 ECOM DWG SC-B-52391 or SM-B-531706			1			4.0		MP56
	P1	O		6675-219-7197		†	†	†			LENS, MAGNIFYING: 4 x magnifying power; ECOM dwg SC-B-52400; Warren-Knight No. 6061-765			1	*	*	4.0	1	MP25
	P1	O		6760-222-0178	†	†	†	†			CAP, LENS: used as dust cover; Warren-Knight No. 6061-20; ECOM Dwg SC-B-52304 or SM-B-531735			1	*	*	4.0		MP3

SOURCE CODE	FEDERAL STOCK NUMBER	DESIGNATION BY MODEL	DESCRIPTION	UNIT OF ISSUE	EXP	QTY IN UNIT	DIRECT SUPPORT	GENERAL SUPPORT	DEPOT	ILLUSTRATION	
										FIGURE NO.	ITEM NO.
A B C D			ML-474/GM (continued)								
P1 D	6660-521-1446	† † †	PRISM ASSEMBLY: 90° prism; Warren-Knight No. 6061-747; ECOM Dwg SC-B-52317 or SM-B-531742		NX	1			4.0	4	MP42
P1 D	6675-219-7196	† † †	LENS, CONDENSING: 3 in f/lg X 18 mm dia X 4.0 mm thk; clear; Warren-Knight No. 6061-192 ECOM Dwg SC-B-52378 or SM-B-531759			1			4.0	1	MP4
P1 O	6660-911-2306	†	LENS ASSEMBLY, OBJECTIVE: p/o Trunion assy; ECOM Dwg SM-B-531765; Warren-Knight No. 6061-787			1	*	*	4.0		MP80
P1 O	6675-219-7220	† † †	LENS, OBJECTIVE: p/o trunion assy; ECOM Dwg SC-B-52410 or SM-B-531765			1	*	*	4.0		MP80
P1 O	5340-322-4618	† †	CATCH, FASTENER: White D No. 6061-82; p/o case			1	*	*	4.0		MP21
P1 O	6675-356-5225	† † † †	COVER: dust, canvas; Warren-Knight No. 6061-775; ECOM Dwg SM-B-531785			1	*	*	4.0		MP671

By Order of the Secretary of the Army:

HAROLD K. JOHNSON,
General, United States Army,
Chief of Staff.

Official:

J. C. LAMBERT,
Major General, United States Army,
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Corps (2)
USAC (3)
11th Air Aslt Div (3)
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Br Svc Sch (2) except
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USATC Engr (2)
USATC Inf (2)
WRAMC (1)
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Ft Gordon (10)
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Ft Carson (21)
WSMR (5)
APG (5)
DPG (5)
YPG (5)
GENDEP (2)
Sig Sec GENDEP (5)
Sig Dep (12)
A Dep (2) except
LBAD (14)
SAAD (30)
TOAD (14)
FTWOAD (10)
LEAD (7)
SHAD (3)
NAAD (5)
SVAD (5)
CHAD (3)
ATAD (10)
Sig Fld Maint Shops (2)
AMS (1)
USADRDAA (2)
USAERDAW (13)
USABIOLABS (5)
CRRELL (2)
Units organized under following TOE's (2 copies each):
11-57
11-97
11-98
11-117
11-127
11-155
11-157
11-158
11-500 (AA-AC)
11-587
11-592
11-597

NG: None.

USAR: None.

For explanation of abbreviations used, see AR 320-50.

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DEPARTMENTS OF THE ARMY
AND THE AIR FORCE

WASHINGTON 25, D. C., 8 December 1958

THEODOLITES ML-47-C THROUGH ML-47-R, ML-247 AND ML-247-A AND DOUBLE CENTER THEODOLITE ML-474/GM

*This manual, together with TM 11-7665-200-10 4 September 1958 and TM 11-6675-200-20, 20 November 1958, supersedes TM 11-423, 7 October 1944, including C1, 4 January 1954; C2, 15 May 1954; and C3, 5 April 1956.

CHAPTER 1
INTRODUCTION

1. Scope

a. This manual covers field and depot maintenance for Theodolite ML-47-(*), ML-247-(*), and Double Center Theodolite ML-474/GM. It includes instructions appropriate to third, fourth, and fifth echelons for troubleshooting, testing, alining, and repairing specified maintenance parts. It also lists tools, materials, and test equipment for third, fourth, and fifth echelon maintenance. Detailed functions of the equipment are covered in the theory section.

b. The maintenance allocation chart for this equipment is published in TM 11-6675-200-20. The repair parts and special tools list will be published separately. For applicable forms and records, see paragraph 2, TM 11-6675-200-10.

c. The complete technical instructions for this equipment includes the following manuals:

TM 11-6675-200-10 Theodolites ML-47-C through ML-47-R, ML-247 and ML-247-A, and Double Center Theodolite ML-474/GM, Operator's Manual.

TM 11-6675-200-20 Theodolites ML-47-C through ML-47-R, ML-247 and ML-247-A, and Double Center Theodolite ML-474/GM, Organizational Maintenance, Second Echelon Maintenance.

d. Forward comments concerning this manual to the Commanding Officer, United States Army Signal Publications Agency, Fort Monmouth, N. J.

2. Differences in Models

Internal differences are listed in the chart below. For external differences and other internal differences, refer to TM 11-6675-200-10 and TM 11-6675-200-20.

Item	ML-47-(*) and ML-247	ML-247-A	ML-474 /GM
Cross hair brightness control variable resistor	10 ohms, 4 watts	100 ohms, 3 watts	20 ohms, 2 watts.
Leveling screw cap	Not used	Used	Used.

CHAPTER 2
THEORY

3. General

The theodolite is an optical instrument for tracking weather balloons. Cross hairs in the tracking telescope are used in sighting the instrument directly at a balloon. The height and lateral position of the balloon determine the angles of azimuth and elevation, which are shown on the scales of the theodolite. The information obtained is used to compute the wind direction and velocity (TM 11-6675-200-10).

4. Optical Systems

The theodolite has three optical systems; the tracking telescope (fig. 1) *(a* below), the finder telescope (fig. 1) *(b* below), and the sights (fig. 3) *(c* below).

a. Tracking Telescope (fig. 1). The tracking telescope provides a high power, narrow field of view (approx 2°) for accurate balloon tracking.

(1) *Tracking telescope object lens.* When the theodolite is used to follow a balloon, light rays from the balloon are collected by the plano-convex object lens (MP80). The lens causes the rays to converge. They then pass along the telescope tube to the prism (MP42) which bends the rays 90° into the eyepiece tube.

(2) *Internal focusing lens.* In the eyepiece tube, the rays pass through the internal plano-concave focusing lens (MP4). This lens causes the rays to converge less sharply and because of the decrease in the angle of the rays a larger image (approximately 22 power) is produced. The internal focusing tube containing the internal focusing lens can be moved back and forth within the eyepiece tube by a rack and pinion, controlled by the focusing knob.

(3) *Focusing eyepiece.* Adjustment of the position of the internal focusing lens (MP4) brings the image formed by the light rays passing through the lens exactly into the plane of the cross hairs. The focusing eyepiece (MP26) is a combination of convex lenses (essentially a microscope) that are focused on the cross hairs so that the image of the balloon is further magnified for the eye.

(4) *Cross hairs.* The cross hairs intersect at a point coincident with the optical axis to precisely center the telescope on any visible point.

b. Finder Telescope (fig. 1). The finder telescope provides a low power, wide field of view and may be adjusted so that an object centered in its field of view will be centered in the field of view of the tracking telescope. The finder telescope consists of the following parts:

(1) *Finder telescope object lens.* The finder telescope object lens (MP25) accepts light rays and bends and projects these light rays in accordance with the curvature of the lens surfaces to form a slightly enlarged image (approx four power) with a wide field of view (approx 10°) at the eyepiece end of the telescope.

(2) *Mirror.* The light rays from the finder telescope object lens are reflected 90° by the mirror, making the finder telescope function as a right-angle telescope. The light rays converge to a point of sharp focus at the plane of the cross hairs.

(3) *Focusing eyepiece.* The focusing eyepiece functions as described in a(4) above, except that when the finder telescope is used, the focusing eyepiece controls the light rays that come from the mirror.

(4) *Cross hairs.* The cross hairs function the same as those described in a(4) above.

c. Sights (fig. 3). The sights provide a means for direct viewing and are useful for quickly orienting the theodolite to a newly re-

leased or to an erratic balloon. The sights may be used in the folded down position (short sights) or raised (extension sights) for near vertical objects.

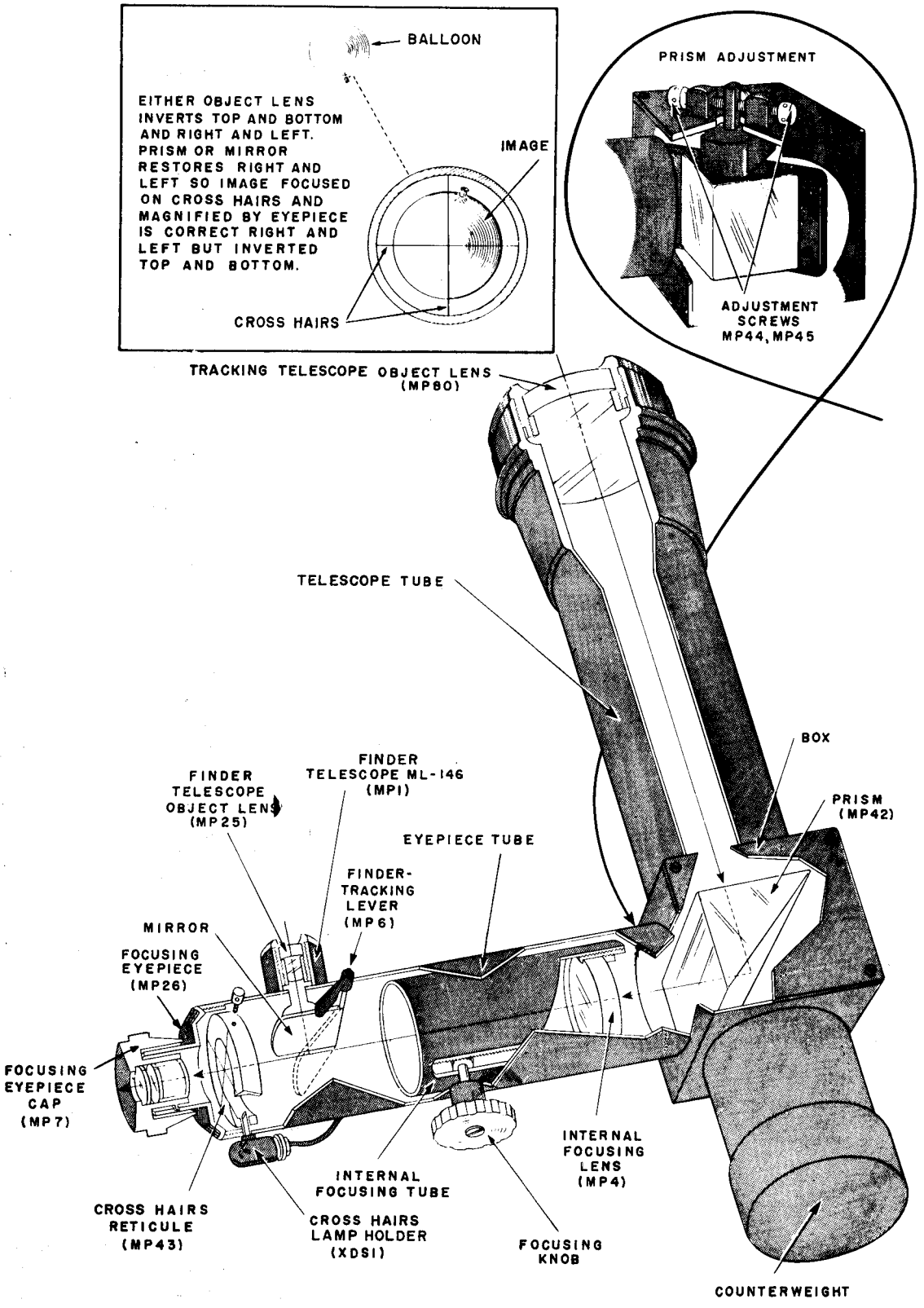

Figure 1. Optical systems of theodolite.

5. Electrical System (fig. 2)

The 3-volt, direct current (dc) power to operate the scale lamps (DS2 and DS3) and the cross hairs lamp (DS1) is furnished by two Batteries BA-30. The scale lamps and the cross hairs lamp are used during night operation of the theodolite (TM 11-6675-200-10).

a. ML-474/GM (A, fig. 2).

(1) With switch S2 in the ON position, the circuit that provides the dc power to the scale lamps (DS2 and DS3) is completed.

(2) The brightness of the cross hairs lamp (DS1) is controlled by the rheostat (R1). In the OFF position, the high resistance of the rheostat extinguishes the cross hairs lamp.

b. ML-47-(*) and ML-247-(") (B, fig. 2).

(1) With switch S1 in the ON position, the circuit that provides dc power to the cross hairs lamp (DS1) is completed. The rheostat (R1) controls the brightness of the cross hairs lamp.

(2) With switch S2 in the ON position, the circuit that provides the dc power to the scale lamps (DS2 and DS3) is completed.

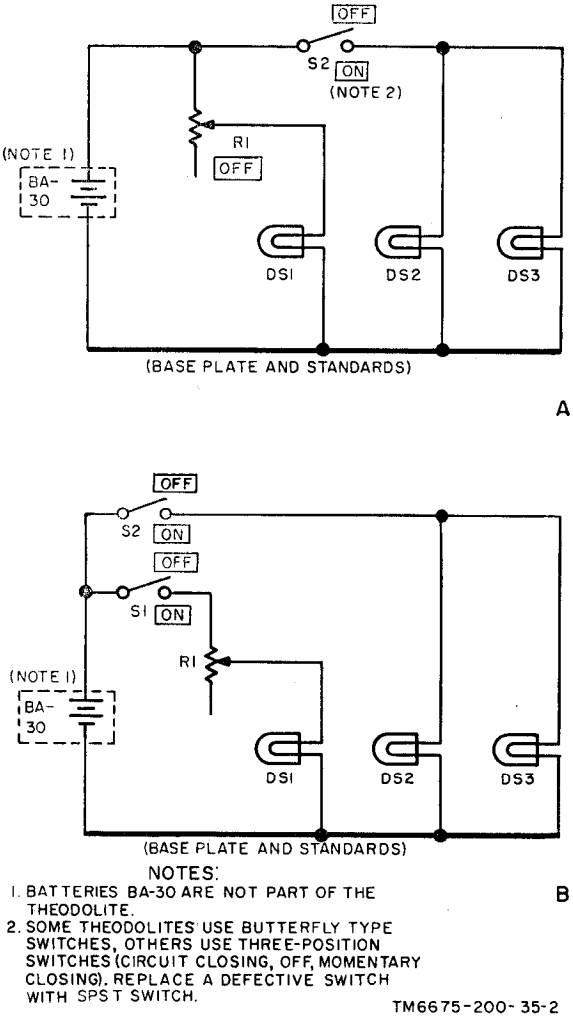

Figure 2. Theodolite schematic diagram.

CHAPTER 3

TROUBLESHOOTING

6. General Troubleshooting Information

Troubleshooting at field and depot maintenance level includes all the techniques outlined for organizational maintenance and any special or additional techniques required to isolate a defective part. The field and depot maintenance procedures are not complete in themselves but supplement the procedures described in operator's and organizational maintenance. The systematic troubleshooting procedure, which begins with the operational and sectionalization checks performed at an organizational level, must be completed by means of further localizing and isolating techniques.

7. Troubleshooting Procedures

a. Sectionalization. Sectionalization means tracing the fault to the major component responsible for abnormal operation.

b. Localization and Isolation. Localization means tracing the fault to the defective section of the equipment. Isolation means tracing the fault to the defective part by sight, touch, hearing, or detailed equipment checks.

8. Tools and Materials Required

Tools and materials required for field and depot maintenance of the theodolite set are listed below.

Tool Equipment TK-17/FMQ-1
Tool Equipment TE-113
Tool set (FSN 6660-353-5236)
Magnifying lens (FSN 6760-356-5585)
Wrench strap (SigC SN 6R59349)
Dividers (Oral SN 41-D-1365)
Camel's-hair Brush TL-72 (½ inch flat)
Cleaning Compound (FSN 7930-395-9542)
Acetone (FSN 6810-281-1863)
Wiping cloth (FSN 8305-170-5063)
Cement (SigC SN 6G199.1)
Lubricating oil, general purpose, preservative (PL special) 4 oz can/spout (FSN 9150-273-2389)
Lubricating oil, watch (OCW), 5cc bottle/dropper (FSN 9150-252-6382)

9. Localizing Troubles

a. Use of Troubleshooting Chart. Use the troubleshooting chart (b below) to supplement the equipment performance checklist in TM 11-6675-200-10 and the troubleshooting chart in TM 11-6675-200-20. If operational symptoms are not known, begin at item 1 of the equipment performance checklist (TM 11-6675-200-10) and proceed as directed.

b. Theodolite Set Troubleshooting Chart. The chart below is supplied as an aid in locating trouble in the theodolite set. In performing the checks outlined below, refer to the appropriate illustrations in TM 11-6675-200-10 and TM 11-6675-200-20.

Symptom	Probable trouble	Correction
Cross hairs cannot be focused sharply by turning the focusing eyepiece.	Misalined or damaged focusing eyepiece.	Replace focusing eyepiece (par. 11).
	Broken cross hairs	Replace cross hairs (par. 12).
Tracking telescope cannot be focused sharply by turning the focusing knob.	Damaged prism assembly	Replace prism assembly (par. 13).
	Damaged internal focusing lens	Replace internal focusing lens (par. 14).
	Damaged focusing assembly	Repair focusing assembly (par. 14).
Finder-tracking lever binds	Bent shaft or lever	Repair or replace (par. 15).
Azimuth calibration adjustment binds	Bent or damaged parts	Repair or replace (par. 17).
Azimuth calibration clamp will not operate properly.	Bent or damaged parts	Repair or replace (par. 17).
Azimuth mounting binds when telescope is rotated horizontally.	Dirt or no lubrication on internal bearing surfaces.	Clean and lubricated internal bearing surfaces (par. 16).
	Bent or damaged parts	Repair or replace damaged parts (par. 16).
Elevation mounting binds when telescope is rotated vertically.	Trunnion end thrust screw too tight	Repair or adjust trunnion end thrust screw (par. 18).
	Elevation scale rubbing on guard	Repair or adjust guard (par. 18).
Cross hairs not centered on same point as sights when using tracking telescope.	Cross hairs not centered in telescope tube.	Adjust cross hairs reticule (par. 21).
	Prism needs adjustment	Adjust prism (par. 22).
	Sights are damaged or need adjustment.	Repair, replace, or adjust sights (par. 24).
Cross hairs do not remain on identical target point when finder-tracking lever is operated.	Finder telescope mirror needs adjustment.	Adjust finder telescope mirror (par. 23).

CHAPTER 4
REPAIRS, ADJUSTMENTS, AND OPTICAL ALINEMENTS

Section I. REPAIRS

10. General Parts Replacement Techniques

a. This section describes the preferred sequence of disassembly, inspection, and reassembly of the theodolite set. The order of disassembly may be varied, if necessary. Certain parts may remain in place while other parts are repaired or replaced.

b. During disassembly, group the parts of each unit to avoid confusion during reassembly. To facilitate reassembly, loosely replace the screws, washers, nuts, knobs, and minor parts on or in the unit to which they belong.

c. Whenever the theodolite set is disassembled, examine each part to see that it is not bent, broken, worn, or dirty. Clean and replace all parts as necessary. Be sure to align and test the theodolite set after reassembly.

11. Replacement of Focusing Eyepiece (fig. 3)

The focusing eyepiece and lens is replaced as an assembly.

a. Clean and check the replacement assembly before removing the defective focusing eyepiece (MP26).

b. Unscrew the focusing eyepiece cap (MP7) from the focusing eyepiece (MP26) by turning the focusing eyepiece cap counterclockwise.

c. Unscrew the focusing eyepiece (MP26) by turning the knurled flange counterclockwise.

d. Replace the focusing eyepiece by turning the knurled flange clockwise until it is hand-tight.

e. Screw the focusing eyepiece cap (MP7) to the focusing eyepiece until the focusing eyepiece cap is hand-tight.

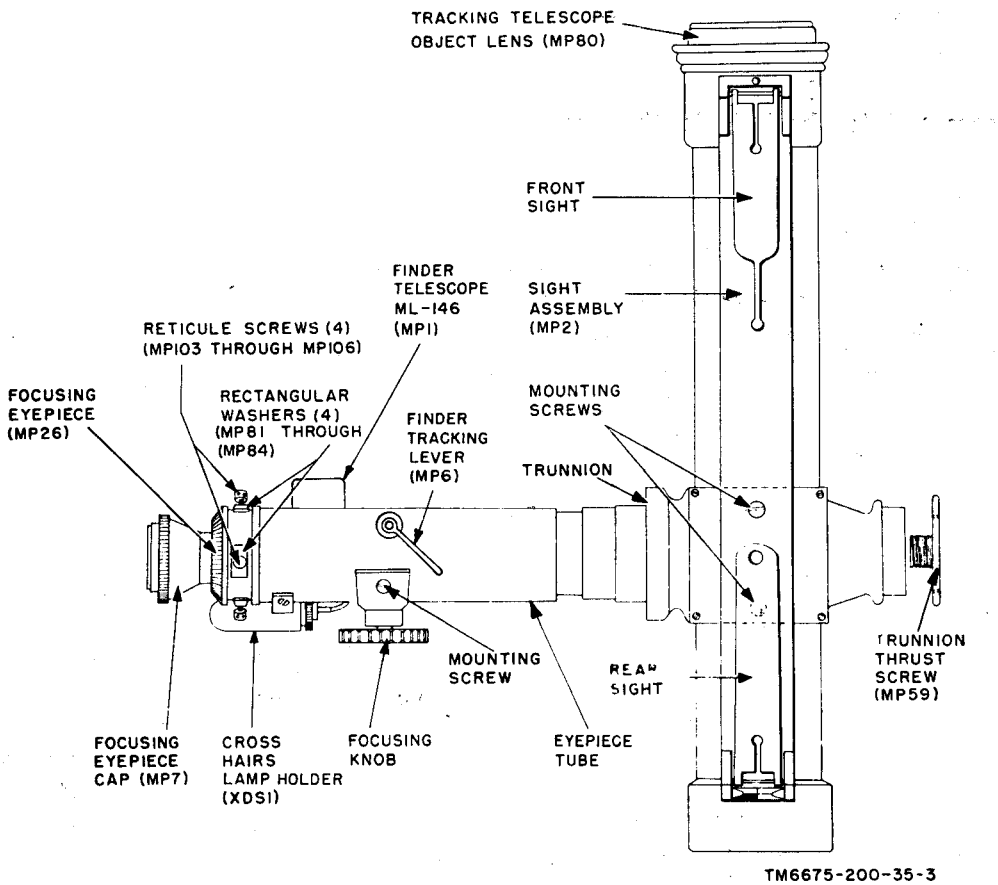

Figure 3. Theodolite telescope, top view.

12. Replacement of Cross Hairs

The cross hairs (fig. 1) of the theodolite are very fragile and break easily. Broken cross hairs must be replaced before the theodolite can be used for accurate observations.

Note. The thread used for cross hairs must be fine, smooth and opaque. The best cross hair thread is a 'thread from a spider cocoon. If a spider thread is not obtainable, a suitable thread can be made by unwinding a nylon thread and using one of the single strands.

a. Remove the focusing eyepiece cap (MP7) and the focusing eyepiece (MP26) (par. 11).

b. To remove the cross hairs lampholder (XDS1) (fig. 3), unscrew the bracket screws and slide the lampholder out of the cross hairs lamp hole in the reticule (fig. 1).

c. Remove the cross hairs reticule (MP43) as follows:

(1) Use the adjusting pin to remove the top and bottom reticule screws (MP103-MP106) (fig. 3). Be careful not to lose the rectangular washers (MP81 through MP 84).

(2) Loosen the remaining two screws and pivot the reticule 90° to expose its edge.

(3) Screw one of the removed reticule screws into the hole in the exposed edge of the reticule to act as a handle.

(4) Remove the remaining screws and lift out the reticule.

d. Remove the cross hairs and traces of cement from the reticule grooves by dipping the reticule in acetone; wipe clean and dry thoroughly.

Warning: Acetone is flammable and its fumes are toxic. Do not use near a flame and provide adequate ventilation.

e. Place the reticule, with the cross hair notches facing up, on a sheet of clean white paper and install the new cross hairs as follows:

(1) Adjust the dividers to the outside dimensions of the reticule.

(2) Attach one end of a very fine thread to one tip of the dividers. Do not use cement.

(3) Gently pull the thread across the dividers and secure it to the other tip.

(4) Dip the tips of the dividers into clear, fresh water. Be sure that the thread is completely submerged.

Note. The water will cause the thread to stretch slightly. After the thread is secured to the reticule ((9) below) the drying action will cause it to become taut.

(5) Remove the thread from the water and shake the thread gently to dislodge drops of water.

(6) Use the screw adjustment and gradually widen the dividers to slightly stretch the thread.

(7) Place the thread in one of the cross hair notches in the reticule. Do not remove the dividers.

(8) Using a toothpick, apply a drop of cement to each of the ends of the notch containing the thread.

(9) Hold the divider still; allow a few minutes for the cement to set.

(lo) To remove the dividers push them down and away from the reticule. Do not pull up on the dividers.

(11) To insert the second cross hair, follow the procedures in (1) through (10) above.

f. Replace the cross hair reticule as follows:

(1) Using the reticule screw (fig. 3) as a handle (c(3) above), insert the cross hairs reticule (MP43, fig. 1) into the eyepiece tube. Aline the holes for the cross hair lamp tube and the top and bottom screw holes.

(2) Replace the top and bottom reticule screws and rectangular washers, but do not tighten. Remove the screw that was used as a handle.

(3) Pivot the reticule 90° to aline the side screw holes and the cross hair lamp hole. The cross hair side of the reticle should face the open end of the eyepiece tube.

(4) Replace, but do not tighten, the side reticle screws and rectangular washers.

(5) Adjust and tighten the four reticule screws so that the reticule is centered in the eyepiece tube.

(6) Replace the focusing eyepiece and focusing eyepiece cap (par. 11).

(7) Adjust the reticule and cross hairs (par. 21).

13. Replacement of Prism Assembly (fig. 4)

a. Invert the theodolite telescope so that the sights are on the bottom.

b. Remove the prism cover retaining screws (not shown).

c. Lift the prism cover and the prism assembly (MP42) from the telescope tube (fig. 1).

d. Remove the prism assembly retaining screw (fig. 4).

e. Loosen the adjustment screws (MP44 and MP45) and pass the adjustment stud through the prism cover to free the prism assembly.

f. 'Replace the prism assembly (MP42) by reversing the procedures given in a through e above.

g. Adjust the prism (par. 22).

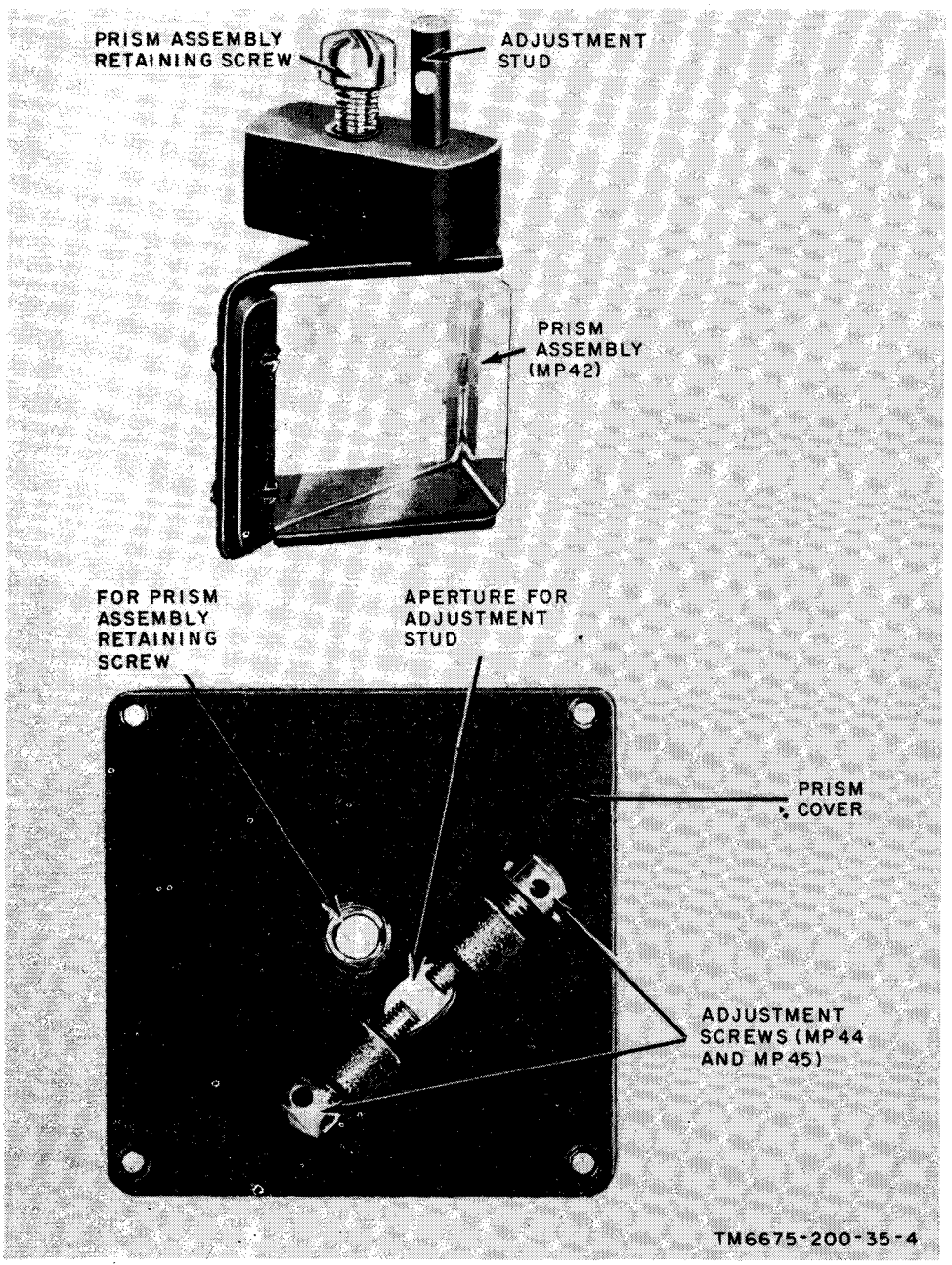

Figure 4. Prism assembly MP42 and cover.

14. Repair of Tracking Telescope Focusing Assembly

The tracking telescope focusing assembly consists of a focusing knob and pinion assembly (a below) and an internal focusing tube and lens (b below).

a. Focusing Knob and Pinion Assembly,

(1) Remove the mounting screws.

(2) Disengage the pionion gear (MP13) (fig. 5) and draw the assembly from the eyepiece tube (fig. 3).

(3) Disassemble the focusing knob and pinion assembly as follows:

(a) Remove the machine screw (MP55) (fig. 5).

(b) Remove the focusing knob. Be careful not to lose the key or the thrust washer (MP87).

(c) Draw the pinion gear (MP13) and shaft from the assembly.

(d) Remove the bushing retaining screw

(e) Remove the pinion bushing.

(4) Clean and inspect the parts as follows:

(a) Clean the parts with cleaning compound; dry thoroughly.

Warning: **Cleaning Compound is flammable and its fumes are toxic. Do not use near a flame and provide adequate ventilation.**

(b) Inspect the parts and replace as necessary.

(c) Dip the parts to be reassembled in oil (OCW); remove excess oil.

(5) Reassemble the focusing knob and pinion assembly by reversing the procedures in (3) above.

(6) Replace the focusing knob and pinion assembly by reversing the procedures in (1) and (2) above.

b. *Internal Focusing Tube and Lens* (fig. 1).

(1) Remove the focusing knob and pinion assembly (a(1) and (2) above).

(2) Remove the focusing eyepiece cap and and the focusing eyepiece (par. 11).

(3) Remove the cross hairs lamp holder (XDS1) and the cross hairs reticule (par. 12).

(4) Remove the finder telescope (par. 15).

(5) Slide the internal focusing tube (fig. 1) out of the eyepiece tube,

(6) Unscrew the internal focusing lens (MP4) from the internal focusing tube,

(7) Clean the parts as follows:

(a) Use a camel's-hair brush and lens tissue to clean the lens.

(b) Clean the internal focusing tube and rack gear with cleaning compound.

(8) Inspect the parts and repair or replace as necessary.

(9) Lubricate the focusing tube and rack gear as follows:

(a) Dip the internal focusing tube in oil (PL special); Remove excess oil with a clean, dry cloth.

(b) Place a few drops of oil (PL special) on the rack gear.

(10) Screw the internal focusing lens (MP4) into the internal focusing tube.

(11) Slide the internal focusing tube into the eyepiece tube so that the rack gear is aligned with the pinion gear hole (not shown).

(12) Insert the pinion gear through the pinion gear hole; the pinion gear (fig. 5) must mesh with the rack gear.

(13) Replace the mounting screws.

(14) Check the focusing assembly for satisfactory operation.

(15) Replace the cross hairs reticule and cross hairs lampholder (par. 12), and the focusing eyepiece and focusing eyepiece cap (par. 11).

15. Repair Finder Telescope

a. Remove the focusing eyepiece cap and the focusing eyepiece (par. 11).

b. Remove the cross hairs lampholder (XDS1) and the cross hairs reticule (par. 12).

c. Disassemble the finder telescope as follows :

(1) Remove the screws (not shown) that hold the mirror to the finder-tracking lever shaft (MP6); remove the mirror.

(2) Loosen the setscrew (not shown) and remove the finder-tracking lever (MP6) from its shaft.

(3) Unscrew the collar (not shown) and remove the finder-tracking lever shaft.

(4) Loosen the finder telescope clamping screws (not shown) and slide the finder telescope housing off the eyepiece tube.

(5) Unscrew and remove the finder telescope object lens (MP25).

d. Clean the parts as follows:

(1) Use a camel's-hair brush and lens tissue to clean the lens and the mirror.

(2) Clean the metal parts in cleaning compound; dry thoroughly.

(3) Dip the metal parts in oil (PL special); wipe dry with a clean cloth.

e. Inspect the parts and repair or replace as necessary.

f. Reassemble the finder telescope by reversing the procedures in c above.

h. Replace the cross hairs lampholder and the cross hairs reticule (par. 12).

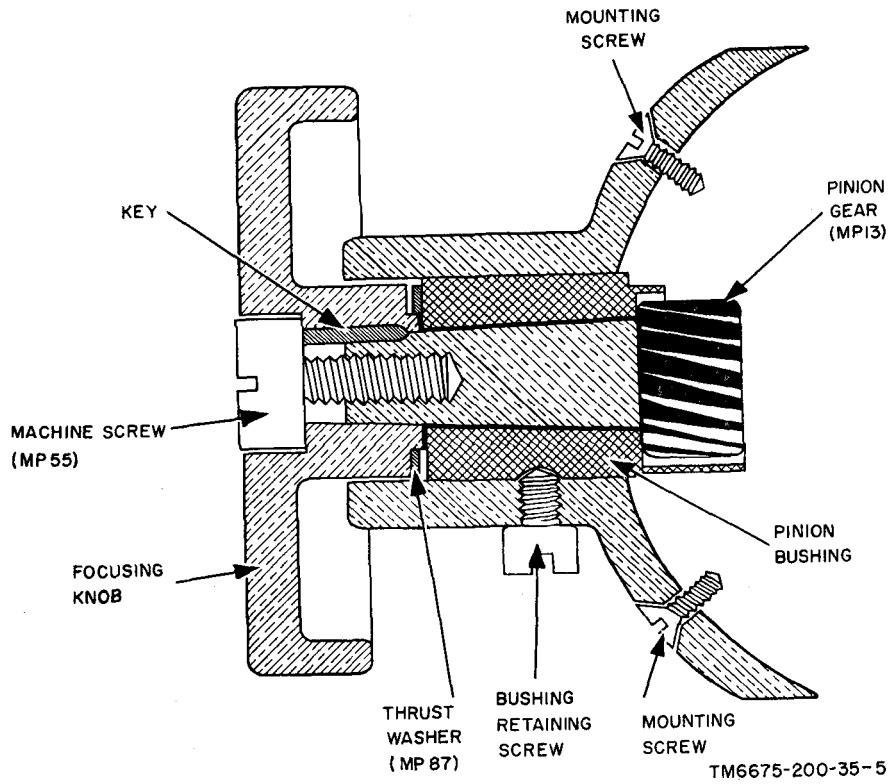

Figure 5. Focusing knob and pinion assembly.

16. Cleaning, Lubrication, and Inspection of Internal Bearing Surfaces (fig. 6)

The procedures described below should be performed only in a clean dust-free area. Be sure to keep dirt or grit from the internal bearing surfaces.

a. Disassembly.

(1) Unscrew the theodolite from the theodolite mount.

(2) Carefully place the theodolite on its side and unscrew the center cap. Be careful not to lose the center spring (MP72).

(3) Use the spanner wrench to remove the center nut (MP32).

(4) Hold the upper portion of the theodolite and the leveling head together and place the instrument right-side-up on a firm surface.

(5) Release the azimuth calibration assembly by loosening the azimuth calibration clamp.

(6) Lift the upper portion of the theodolite from the leveling head.

(7) Remove the azimuth calibration assembly from the leveling head.

(8) Disengage the azimuth tracking control and separate the intermediate center from the inner center.

b. Cleaning. Use a clean cloth moistened with oil (PL special) and carefully remove all traces of dirt, grit, and old lubrication. Clean all parts, particularly the bearing surfaces and the recessed portion that houses the azimuth scale.

c. Inspection. Inspect all parts for wear or improper functioning and replace as necessary.

d. Lubrication. Coat all bearing surfaces with a thin film of oil (OCW). Do not oil excessively. Lubrication should be performed immediately before reassembly.

e. Reassembly.

(1) Put the azimuth calibration assembly in place on the leveling head (MP11) so that the head of the tension screw (MP50) (fig. 7) is up and the vertical lug (fig. 6) of the leveling head is between the calibration adjustment screw (MP33) (fig. 7) and the piston.

(2) Carefully slide the intermediate center (fig. 6) onto the inner center spindle. Engage the azimuth tracking control.

(3) Carefully insert the intermediate center into the leveling head (MP11).

(4) Lower the upper portion of the unit until the shoulder of the intermediate center is seated in the azimuth calibration assembly.

(5) Tighten the azimuth calibration clamp.

(6) Place the theodolite on its side and replace the center nut (MP32). Use the spanner wrench to tighten the nut.

(7) Place the center spring (MP72) in the center cap so that its raised side will press against the inner center spindle tip when the cap is in place. Screw the cap on hand-tight.

17. Repair Azimuth Calibration Assembly

The azimuth calibration assembly includes an azimuth calibration clamp (MP102) and a calibration adjustment screw (MP33). The azimuth calibration clamp (MP102) may be replaced by unscrewing the original and inserting the replacement. If more extensive repairs are required proceed as follows:

a. Perform the procedures given in paragraph 16a(1) through (7).

b. Disassemble the azimuth calibration assembly as follows:

(1) Remove the screwcap (MP64).

(2) Remove the piston spring (MP70) and the piston.

(3) Remove the tension screw (MP50).

(4) Remove the calibration adjustment screw (MP33).

(5) Remove the wing screw (MP102).

c. Clean and inspect the parts.

(1) Clean the parts with cleaning compound; dry thoroughly.

(2) Inspect the parts and replace as necessary.

(3) Dip the parts in oil (PL special); wipe with a clean cloth.

d. Reassemble the azimuth calibration assembly by reversing the procedures in b above.

e. Reassemble the theodolite components by reversing the procedures given in paragraph 16a(1) through (7).

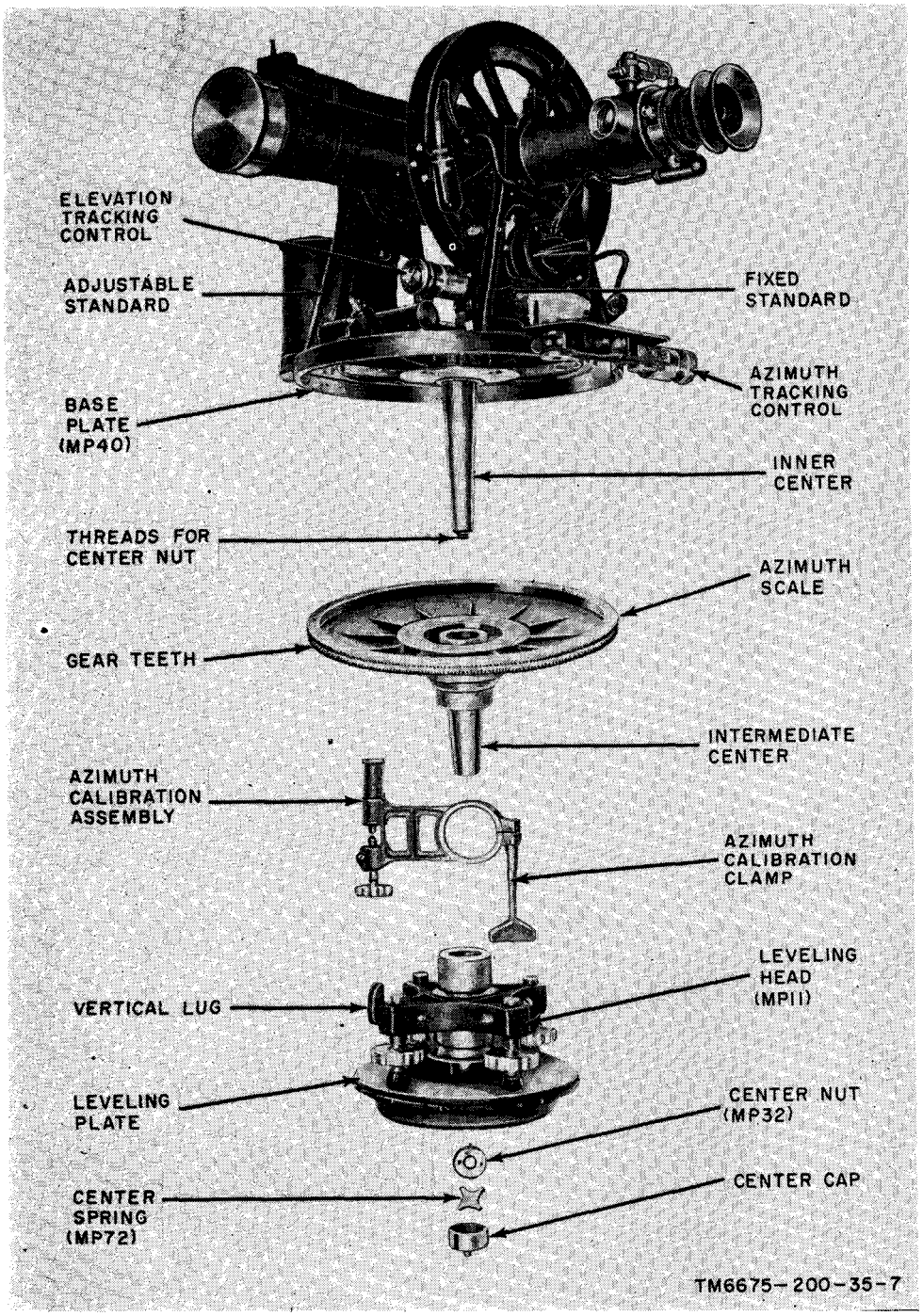

Figure 6. Partial disassembly of theodolite to reveal internal bearing surfaces.

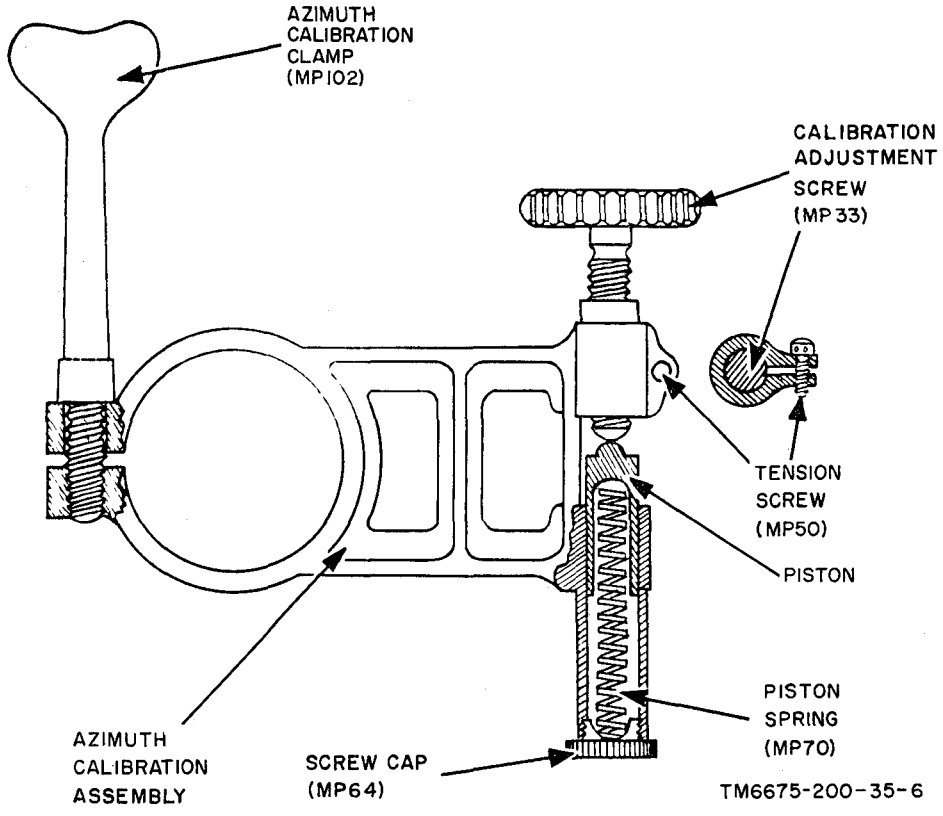

Figure 7. Azimuth calibration assembly.

18. Repair of Leveling Assembly
(fig. 8)

The leveling assembly consists of the leveling head and screws, the leveling plate, the shifting plate and the half-ball nut.

a. Perform the procedures given in paragraph 16a(1) through (7).

b. Disassemble the leveling assembly as follows :

(1) Remove the half-ball nut (MP114) from the underside of the leveling assembly.

(2) Lift the leveling head (MP11) from the leveling plate and the shifting plate.

(3) Remove the tension screws (MP51-MP54).

(4) Remove the leveling screws (MP36-MP39).

(5) Remove the friction shoes (MP66-MP69) from the leveling screws by pressing sideways until the shoe snaps off.

c. Clean and inspect the parts.

(1) Clean the parts with cleaning compound; dry thoroughly.

(2) Inspect the parts and replace as necessary.

(3) Dip the parts in oil (PL special); wipe with a clean cloth.

d. Reassemble the leveling assembly by reversing the procedures in b above.

e. Reassemble the theodolite components by following the procedures in paragraph 16e (1) through (7).

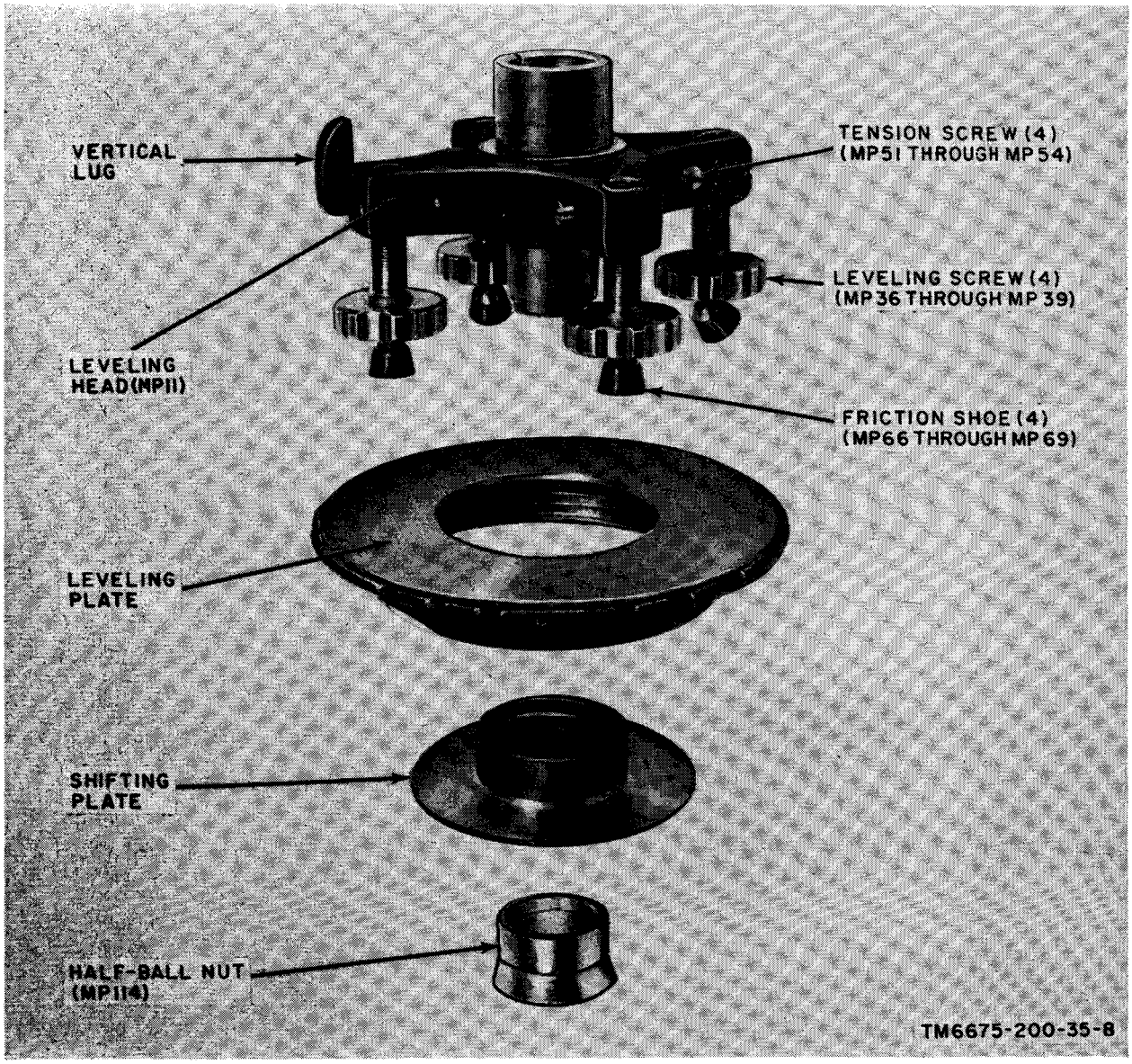

Figure 8. Theodolite leveling assembly.

Section II. ADJUSTMENTS

19. Preparation for Adjustments

The final adjustments should not be performed until the theodolite is prepared as follows:

a. Mount the theodolite on its tripod (TM11-6675-200-10).

b. Level the theodolite (TM 11-6675-200-10).

c. Adjust the levels (TM 11-6675-200-20).

Note. The theodolite should remain set up and level for the adjustment and alinement procedures in paragraphs 20 through 26. Perform the procedures in the sequence given. Do not begin a new procedure until the previous procedure has been satisfactorily completed.

20. Adjustments of Elevation Mounting (fig. 6)

The theodolite elevation mounting is made up of two standards (fixed and adjustable) which are supported by the base plate (MP40). The upper end of the standards are shaped to form a trunnion support for the telescope assembly. The fixed standard supports the elevation scale and scale guard. The adjustable standard is used during alinement of the horizontal axis (par. 25).

a. Elevation Mounting Check.

(1) Disengage the elevation tracking control.

(2) Rotate the telescope vertically and note the smoothness of operation. If binding occurs, perform the procedures in b below.

b. Adjusting.

(1) Inspect the elevation scale and guard (fig. 4, TM 11-6675-200-10). If the elevation scale is rubbing on the scale guard, check the mounting of each and retighten or readjust the one that is misalined.

(2) Check the trunnion thrust screw (MP59, fig. 3). If excessive friction exists between the trunnion thrust screw and the trunnion, place a thin paper washer under the screw head to correct the trouble.

Note. Do not change the position of nuts MP34 and MP35 (fig. 10). These nuts are used during optical alinement (par. 25).

21. Adjustment of Cross Hairs Reticule

The cross hairs reticule is correctly adjusted when the cross hairs are centered in the eyepiece tube with one cross hair exactly vertical.

a. Centering Reticule.

(1) Remove the focusing eyepiece cap and the focusing eyepiece (par. 11a-c).

(2) Use the adjusting pin to loosen the reticule screws (MP103-MP106, fig. 3).

(3) Visually center the cross hairs reticule horizontally by turning the two side reticule screws (fig. 3) simultaneously in the same direction.

(4) Visually center the cross hairs reticule vertically by turning the top and bottom reticule screws simultaneously in the same direction.

(5) Tighten the four reticule screws an equal amount by turning the opposite screws the same amount at the same time.

(6) Replace the focusing eyepiece and cap assembly (par. 11d and e).

b. Adjusting 'Cross Hairs.

(1) Disengage both tracking controls (fig. 6).

(2) Tighten the azimuth calibration clamp.

(3) Sight the vertical cross hair on some well-defined point.

(4) Engage the azimuth tracking control.

(5) Swing the telescope up and down slowly while sighting on the point.

(6) The point should appear to travel exactly along the length of the vertical cross hair.

(7) If the point does not travel exactly along the length of the vertical cross hair, loosen the four reticule screws (fig. 3). Lightly tap the top and bottom reticule screws, simultaneously, in opposite directions to rotate the reticule slightly on its axis.

(8) Repeat (5) through (7) above until the point travels exactly along the length of the vertical cross hair when the telescope is swung up and down. Tighten the reticule screws.

22. Adjustment of Prism
(fig. 9)

The line of sight through the telescope will coincide with the line of collimation of the prism when the prism is correctly adjusted.

a. Checking Prism Adjustment.

(1) Disengage both tracking controls (fig. 6). Operate the finder-tracking lever (MP6, fig. 1) toward the focusing eyepiece (MP26).
(2) Select a well-defined target point, 200 to 300 feet away, to which the line of sight is approximately horizontal.
(3) Set the azimuth scale to 0° (1, fig. 9) and engage the azimuth tracking control (fig. 6).
(4) Loosen the azimuth calibration clamp.
(5) Turn the focusing eyepiece (fig. 1) to focus the cross hairs; turn the focusing knob to focus the telescope.
(6) Center the tracking telescope cross hairs on the target point selected ((21) above); tighten the azimuth calibration clamp (fig. 6).
(7) Turn the azimuth calibration adjustment (fig. 4, TM 11-6675-200-10) to center the cross hairs exactly on the target point.
(8) Disengage the azimuth tracking control (fig. 6) and set the azimuth scale at exactly 180° (2, fig. 9); engage the azimuth tracking control (fig. 6).
(9) Swing (transit) the telescope vertically until the target point is again visible in the telescope field (3, fig. 9).
(10) If the target point falls on the vertical cross hair, the telescope line of sight is correctly adjusted. If it does not, adjust the prism as outlined in b below.

b. Adjusting Prism. With the theodolite still set as in a(9) above, proceed as follows:

(1) Turn the azimuth tracking control (fig. 6) to center the cross hairs on the target point.
(2) Read the azimuth scale (4, fig. 9); note the number of degrees the reading deviates from 1800.
(3) Turn the azimuth tracking control to set the azimuth scale halfway between the reading ((2) above) and 180° (5, fig. 9).
(4) Loosen the prism assembly retaining screw (fig. 4).
(5) Engage the capstan pins in the prism holder adjustment screws (MP44 and MP45).
(6) Look through the telescope. Turn the screws simultaneously, in the same direction, to bring the target point (a(10) above) laterally to the cross hair intersection (6, fig. 9).
(7) Tighten the prism assembly retaining screw (fig. 4).
(8) Do not change the setting of the theodolite controls.

23. Adjustment of Finder Telescope Mirror
(fig. 1)

The following adjustment should not be performed until the tracking telescope prism is adjusted (par. 22). The cross hair intersection should be on the same target point with the finder telescope as with the tracking telescope.

a. Checking Mirror Adjustment. Look through the eyepiece and shift the finder-tracking lever back and forth. If the cross hairs are centered on the same point with both telescopes, the mirror is correctly adjusted. If the cross hairs are not centered on the same point with both telescopes adjust the mirror (b below).

b. Adjustment of Mirror.

(1) Loosen the lock nut on the finder-tracking lever stop (not shown).
(2) Turn the finder-tracking lever (MP6) toward the focusing eyepiece (MP26).
(3) Note the point of the tracking telescope image upon which the cross hairs are centered.
(4) Turn the finder-tracking lever (MP6) away from the focusing eyepiece (MP26) .
(5) Turn the capstan screw (not shown) in or out to shift the finder telescope image and bring the point described in (3) above laterally to the cross hair intersection.
(6) Tighten the locknut (not shown) on the finder-tracking lever stop.
(7) Do not change the setting of the theodolite controls.

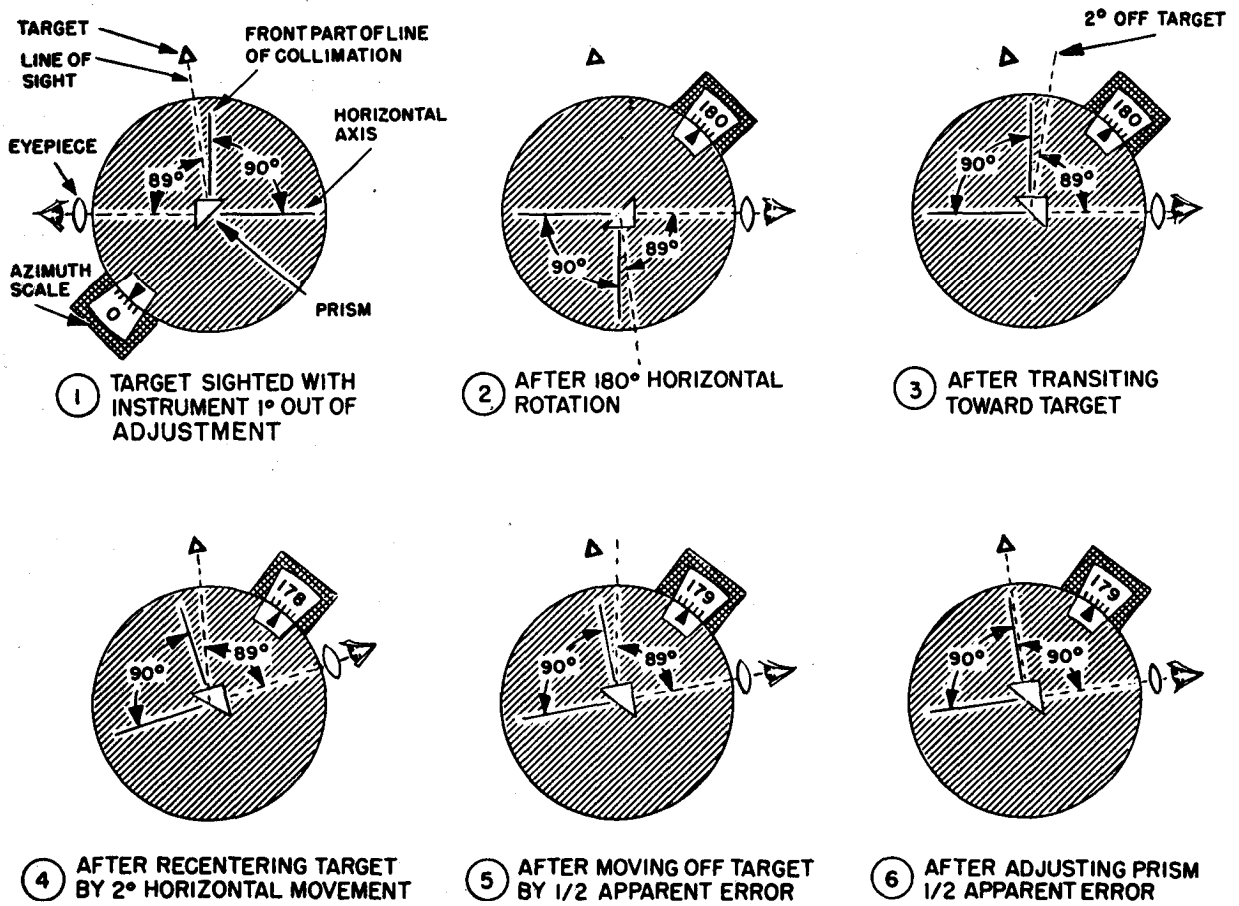

Figure 9. Adjustment of prism.

24. Adjustment of Sights
(fig. 3)

The sights should be centered on the same point as the telescope cross hairs (par. 23b (5)).

a. Checking Sight Adjustment.

(1) Look through the telescope and note the point on which the cross hairs are centered.

(2) Look down the sights and note the point on which the sights are centered.

(3) If the points noted in (1) and (2) above are the same, the sights are correctly adjusted. If the points are not the same, perform the procedures in b below.

b. Adjusting Sights.

(1) Loosen the mounting screws.

(2) Look down the sights, and shift the sight assembly (MP2) to center the sights on the point noted in a(1) above.

(3) Tighten the mounting screws.

(4) If the procedure in (2) above does not permit satisfactory adjustment, the sights may be bent or otherwise damaged and should be replaced (c below).

c. Replacing Sights.

(1) Remove the sight assembly (MP2) by removing the mounting screws.

(2) Substitute a new sight assembly (MP2) and mount it loosely in place with the mounting screws.

(3) Perform the procedures in b(2) and (3) above.

Section III. OPTICAL ALINEMENTS

25. Alinement of Horizontal Axis (fig. 10)

The horizontal axis of the theodolite is correctly alined when the eyepiece tube is in a plane parallel to the plane of the levels.

a. Check Horizontal Axis A linement.

(1) Set the azimuth scale at 0°; engage the azimuth tracking control.

(2) Disengage the elevation tracking control (fig. 6).

(3) Select a high target point on a wall or building about 20 feet away.

(4) Loosen the azimuth calibration clamp and center the cross hairs on high point P (1, fig. 10). Tighten the azimuth calibration clamp.

(5) Use the azimuth calibration adjustment (fig. 4, TM 11-6675-200-10) to exactly center the vertical cross hair on point P (1, fig. 10).

(6) Gently press down on the end of the telescope until the cross hair intersection falls on point A (2, fig. 10) at the base of the building.

(7) Disengage the azimuth tracking control (fig. 6). Set the azimuth scale at 180°. Engage the azimuth tracking control.

(8) Swing the telescope over vertically and again sight on point P. Use the azimuth calibration adjustment (fig. 4, TM 11-6675-200-10) to center the vertical cross hair on point P (3, fig. 10).

(9) Lower the telescope to the level of point A. If the cross hair intersection falls on point A, no adjustment is needed. If it does not, mark the point at which the cross hairs intersect as point B (4, fig. 10) and proceed with the steps in b below.

b. Aline Horizontal Axis. If the check in a(9) above indicates an adjustment is needed, proceed as follows:

(1) Turn the azimuth tracking control to center the vertical cross hair on point A (5, fig. 10).

(2) Read the azimuth scale; note the number of degrees the reading deviates from 180°.

(3) Turn the azimuth tracking control to set the azimuth scale halfway between the reading ((2) above) and 180°.

(4) Raise the telescope to the level of point P (6, fig. 10).

(5) Adjust the nuts (MP34 and MP35) on the adjustable standard to center the cross hairs on point P as follows:

(a) Loosen the top nut (MP34).

(b) Turn both nuts (MP34 and MP35) simultaneously in the same direction to center the cross hairs on point P (7, fig. 10).

(c) Tighten the top nut (MP35).

(6) Check the adjustment by repeating the procedures in a(1) through (9) above.

26. Alinement of Elevation Scale Fiducial Marker and Final Test (fig. 11)

The fiducial marker should indicate 0° or 180° when the telescope line of sight is in a horizontal plane. The procedures given in this paragraph are used to aline the elevation scale fiducial marker and, in addition, will serve as a final test of over-all theodolite alinement.

a. Checking Fiducial Marker Adjustment.

(1) Set the azimuth scale (1, fig. 11) and the elevation scale at 0°. Engage both tracking controls (fig. 6).

(2) Loosen the azimuth calibration clamp and center the cross hairs on a target point 200 to 300 feet away (1, fig. 11). Tighten the azimuth calibration assembly.

(3) Disengage the elevation tracking control and set the elevation scale at 180° (2, fig. 11). Engage the elevation tracking control (fig. 6).

(4) Disengage the azimuth tracking control and set the azimuth scale at 180° (3, fig. 11). Engage the azimuth tracking control (fig. 6).

(5) Look through the telescope. If the cross hairs intersection again falls on the target point, the elevation scale fiducial marker is correctly adjusted. If it does not, perform the procedures in b below.

b. Adjusting Fiducial Marker.

(1) Turn the elevation tracking control (fig. 6) to bring the cross hair intersection vertically on the target (4, fig. 11).

Note. Vertical motion alone should bring the cross hairs on the target. If horizontal motion is needed, repeat the adjustment procedures in paragraphs 21, 22, and 25.

(2) Read the elevation scale. Note the number of degrees the reading deviates from 180°.

(3) Turn the elevation tracking control (fig. 6) to set the elevation scale halfway between the reading ((2) above) and 180° (5, fig. 11).

(4) Loosen the adjustment screws (MP96 and MP97) and move the fiducial plate until the fiducial marker is even with the 180° line (6, fig. 11).

(5) Check to see that the fiducial plate is very close to, but not touching, the elevation scale. If the two are touching, insert a piece of paper between the fiducial plate and the elevation scale and repeat the adjustment ((4) above).

(6) Tighten' the adjusting screws (MP96 and MP97).

(7) Realign the elevation tracking control graduated drum (TM 11-6675-200-20) .

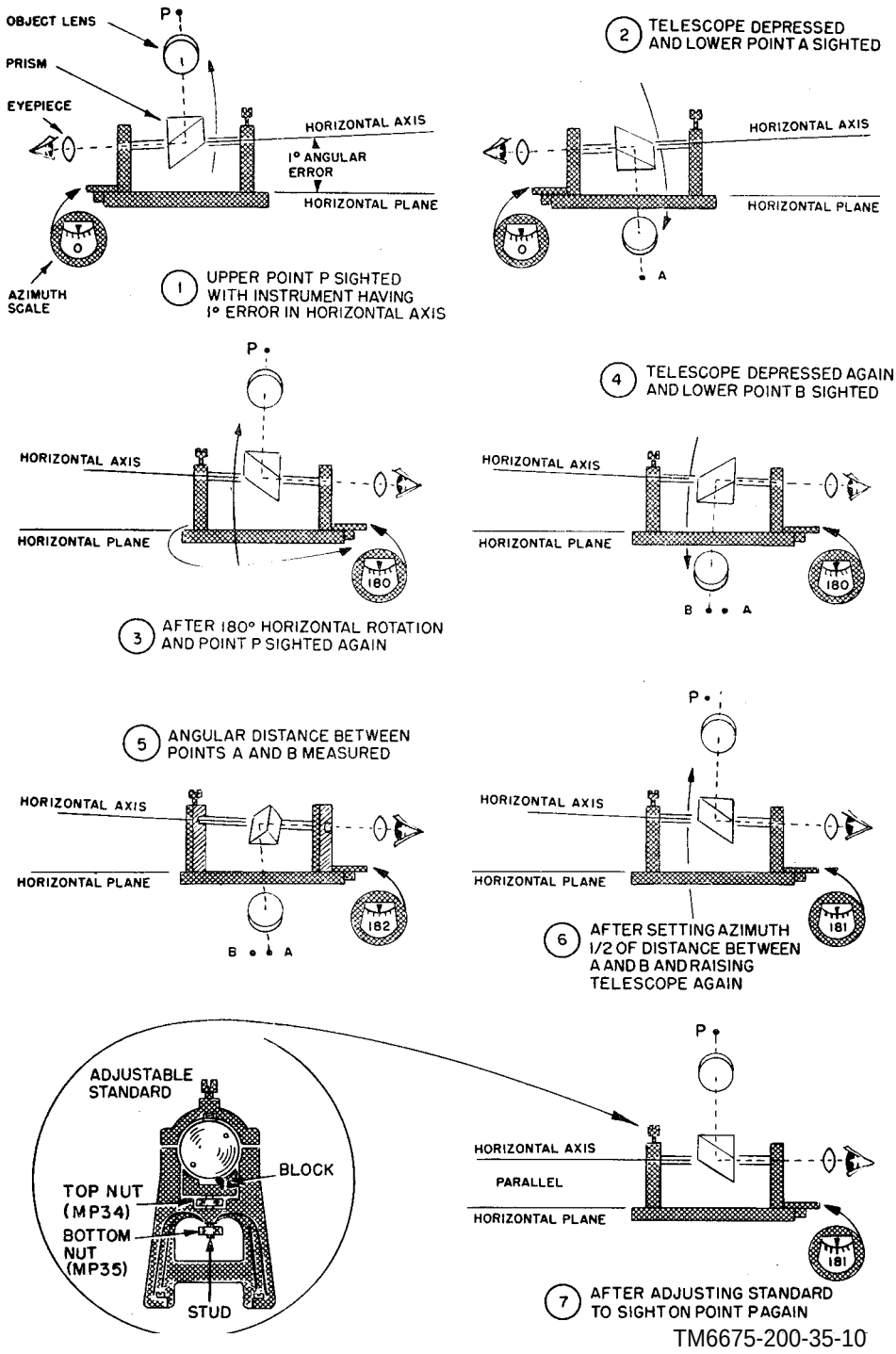

Figure 10. Adjustment of horizontal axis.

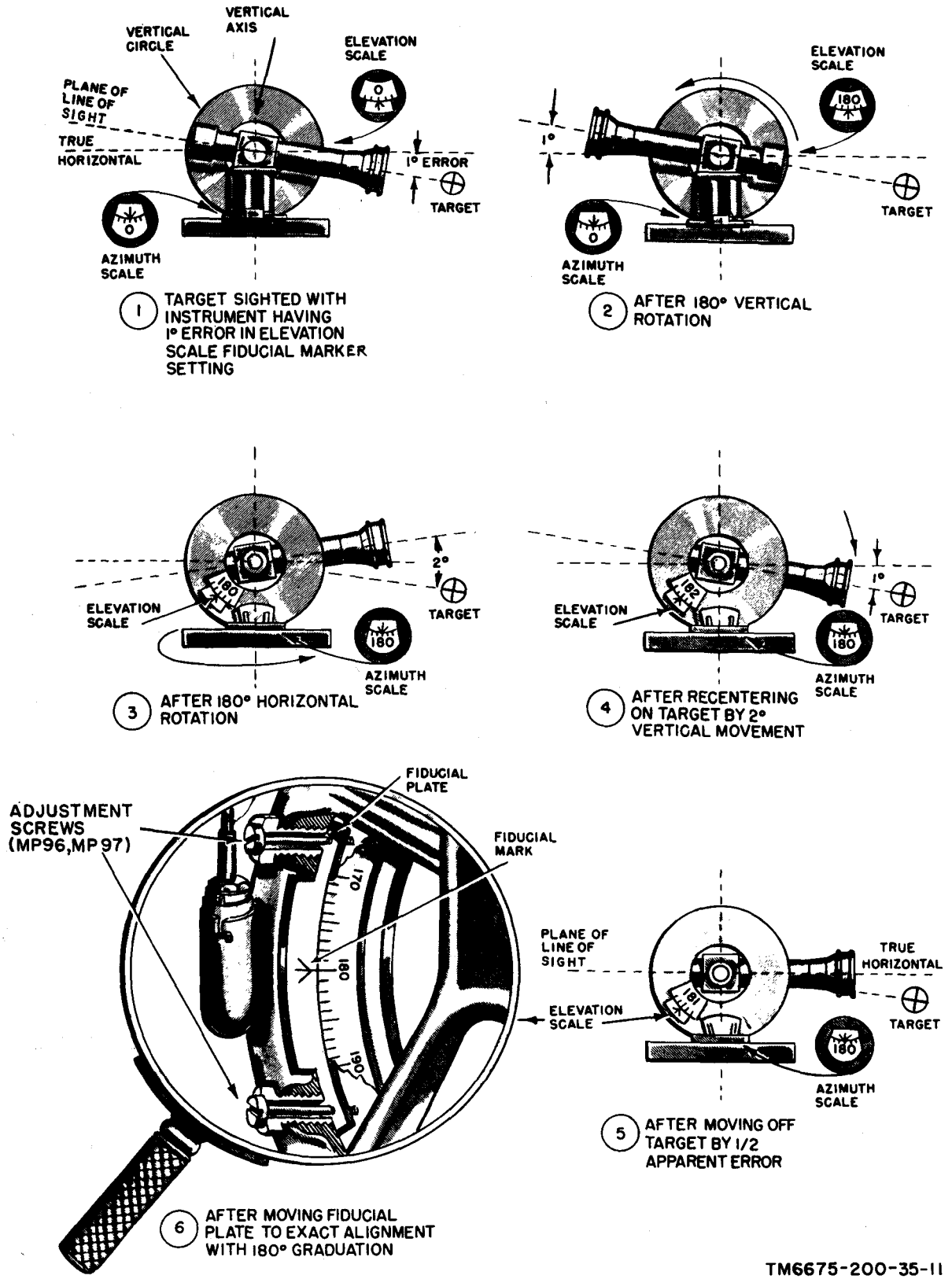

Figure 11. Adjustment of elevation scale fiducial marker.

APPENDIX
REFERENCES

Following is a list of references applicable and available to the field and depot maintenance personnel of the theodolite set:

TM 11-6675–200-10	Theodolites ML-47-C through ML-47-R, Theodolites ML-247 and ML-247-A, and Double Center Theodolite ML-474/GM, Operator's Manual
TM 11-6675-200-20	Theodolites ML47-C through ML-47-R, Theodolites ML-247 and ML-247-A, and Double Center Theodolite ML-474/GM, Organizational Maintenance, Second Echelon

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Units org under fol TOE:
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11-16 (2)
11-57 (2)
11-500 (AA-AE) (2)
11-557 (2) ,
11-587 (2)
11-592 (2)
11-597 (2)

NG: State AG (3); units-same as Active Army except allowance is one copy to each unit.

USAR: None.

For explanation of abbreviations used, see AR 320-50.

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