DEPARTMENT OF THE ARMY TECHNICAL MANUAL

TECHNICAL MANUAL

OPERATOR, ORGANIZATIONAL, DIRECT SUPPORT AND

GENERAL SUPPORT MAINTENANCE MANUAL

THEODOLITE, SURVEYING,

DIRECTIONAL

1-MINUTE GRADUATION, W/ COMPASS AND

EXTENSION LEG TRIPOD

KEUFFEL & ESSER MODEL K E / G6-730075

NSN 6675-00-353-4488

This copy is a reprint which includes current pages from Changes 1 through 3.

HEADQUARTERS, DEPARTMENT OF THE ARMY
JANUARY 1976

WARNING

Dry cleaning solvent, P-D-680, used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 1000 F. (380 C.) -138° F. (590 C.).

WARNING

During operation in subfreezing temperatures, avoid touching any portion of the instrument with bare hands, except the controls. Bare skin will stick to extremely cold metal parts.

WARNING

Severe eye damage can result from performing observations against direct sun light without utilizing the sun filters.

CHANGE
No. 3

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 24 June 1988

Operator, Organizational, Direct Support and
General Support Maintenance Manual

THEODOLITE, SURVEYING, DIRECTIONAL
1-MINUTE GRADUATION, W/COMPASS AND
EXTENSION LEG TRIPOD
KEUFFEL & ESSER MODEL K E/G6-730075
NSN 6675-00-353-4488

TM 5-6675-307-14, 19 January 1976, is changed as follows:

1. Remove and insert pages as indicated below. New or changed text material is indicated by a vertical bar in the margin. An illustration change is indicated by a miniature pointing hand.

Remove pages	Insert pages
1-1 and 1-2	1-1 and 1-2
4-1 and 4-2	4-1 and 4-2
A-1	A-1/A-2

2. Retain this sheet in front of manual for reference purposes.

By Order of the Secretary of the Army:

CARL E. VUONO
General, United States Army
Chief of Staff

Official:

R. L. DILWORTH
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-25A, Operator, Unit, Direct Support and General Support Maintenance requirements for Theodolite, Directional, Surveying, 1 min Grad (KE/G6-730075).

CHANGE
NO. 2

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC *7January 1977*

Operator, Organizational, Direct Support and General Support Maintenance Manual THEODOLITE, SURVEYING, DIRECTIONAL 1-MINUTE GRADUATION, WICOMPASS AND EXTENSION LEG TRIPOD KEUFFEL & ESSER MODEL KEIG6-730075 (NSN 6675-00-353-4488)

TM 5-6675-307-14, 19 January 1976, is changed as follows:

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Remove pages	*Insert pages*
B-1 through B-5	B-1 through B-2
C-1	C-1 and C2 (blank)
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None	E-1 and E-2 (blank)

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Major General, United States Army
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Distribution:

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

CHANGE
NO. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, *27 September 1976*

Operator's, Organizational, Direct Support and General Support Maintenance Manual

**THEODOLITE, SURVEYING,
DIRECTIONAL,
1-MINUTE GRADUATION, WICOMPASS AND
EXTENSION LEG TRIPOD
KEUFFEL and ESSER MODEL KEIG6-730075
NSN 6675-00.353-4488**

TM 5-6675-307-14, 19 January 1976, is changed as follows:

1. Remove old pages and insert new pages as indicated below.
2. New or changed material is indicated by a vertical bar in the margin of the page.
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Remove Pages	*Insert Pages*
7-1 and 7-2	7-1 and 7-2

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By Order of the Secretary of the Army:

FRED C. WEYAND
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TECHNICAL MANUAL
No. 5-6675-307-14

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *19January 1976*

OPERATOR, ORGANIZATIONAL, DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL

THEODOLITE, SURVEYING, DIRECTIONAL, 1-MINUTE GRADUATION, W/ COMPASS AND EXTENSION LEG TRIPOD

KEUFFEL & ESSER MODEL K E/G6-730075
NSN 6675-00-353-4488

LIST OF ILLUSTRATIONS

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. Scope

This manual contains instructions for operator, organizational, direct support and general support maintenance personnel responsible for the Theodolite. It provides information for the operation and maintenance of the equipment and its accessories as directed by the Maintenance Allocation Chart, Appendix B. Also included are instructions for shipment and storage. TM 6-6675-307-24P lists the repair parts authorized for maintenance.

1-2. Maintenance Forms and Records

The maintenance forms and records you are required to use with the Theodolite are DA Forms 2402 and 2801 (see DA Pam 738-750.

1-3. Reporting of Errors

You can help to improve this manual by calling attention to errors and by recommending improvements. Your letter, DA Form 202; (Recommended Changes to Publications and Blank Forms) and/or DA Form 2028-2 (Recommended Changes to Equipment Technical Manuals), may be used. Copies of DA Form 2028. 2 are attached in the back of the manual for your use. Please mail your recommended changes directly to Commander, U.S. Army Troop Support Command, ATTN: AMSTR-MCTS, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. A reply will be furnished directly to you.

1-4. Equipment Serviceability Criteria (ESC)

This equipment is not covered by an ESC.

1-5. Destruction of Army Material to Prevent Enemy Use

Methods of destruction should achieve such damage to equipment and repair parts that will not be possible to restore the equipment to a usable condition in the combat zone either by repair or cannibalization.

a. Demolition of Theodolites.

(1) *Fire.* Use fire to destroy equipment when quantities of fuel and flammable materials are at hand. Proper concentration of equipment to be burned will produce a hotter, more destructive fire. Fires should be lit after mechanical destruction has been accomplished. Fires can be built to produce more heat or smoke. For destruction, heat is desired but smoke may be useful.

(2) *Mechanical destruction.* Using an axe pick, mattock, sledge, or any other heavy implement, damage all vital elements.

b. Destruction. For additional data on procedures for destruction of equipment to prevent enemy use, refer to TM 750-244-3.

Section II. DESCRIPTION AND DATA

1-6. Administrative Storage

a. Before equipment is placed in administrative storage, current maintenance services should be completed, shortcomings and deficiencies should be corrected, and all modification work orders (MWO's) should be applied.

b. Place each instrument and its accessories in the carrying case and cushion with cushioning material, PPP-C-843.

c. Further information regarding administrative storage are given in TM 740-90-1.

1-7. Description

a. Theodolite. The Theodolite (figs. 1-1 thru 3) is a precision, directional type surveying instrument. It has both vertical (elevation) and horizontal (azimuth) circle scales, calibrated in degrees reading the value of angles. Such readings are observed through the microscope eyepiece (fig. 1-1). A microscope pattern provides for interpolation of angle value readings to 1minute resolution. A detachable tribrach (fig. 1-1) containing three leveling screws, a circular level, and base plate serves as the mount for the theodolite base. The tribrach base plate has a threaded center to accommodate the locking screw for securing the theodolite on the tripod head.

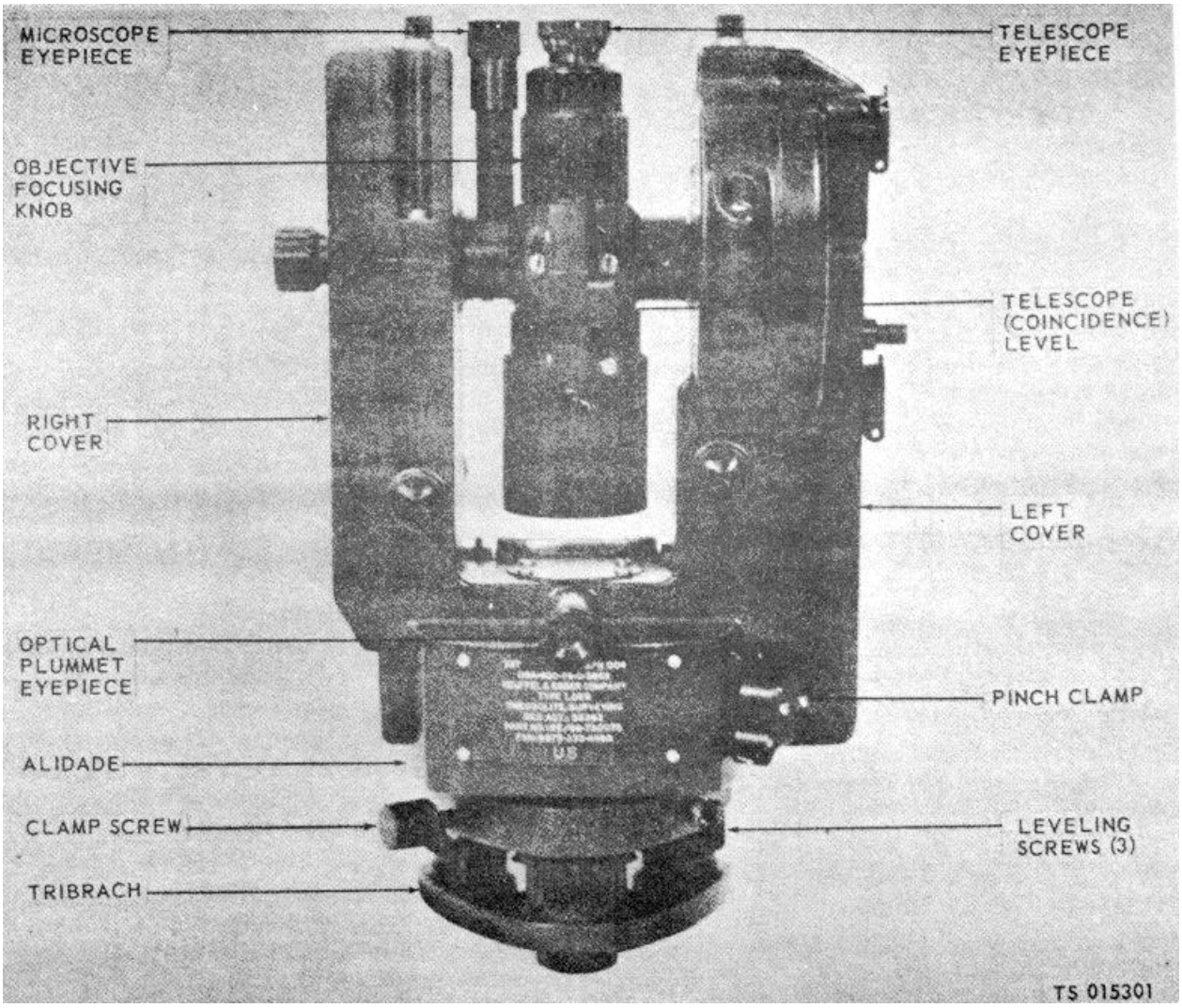


Figure 1-1. Theodolite front view,

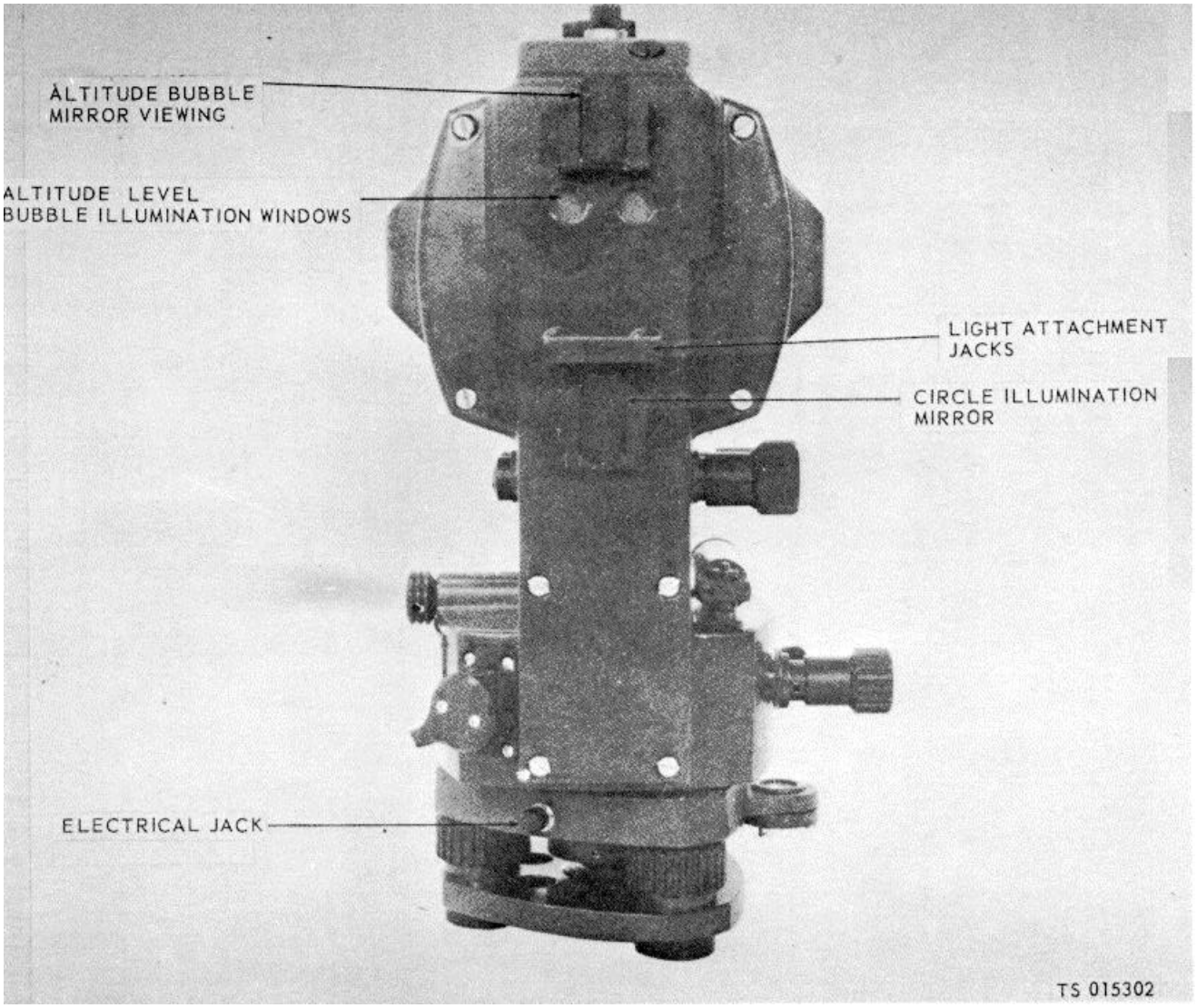


Figure 1-2. Theodolite, left side view.

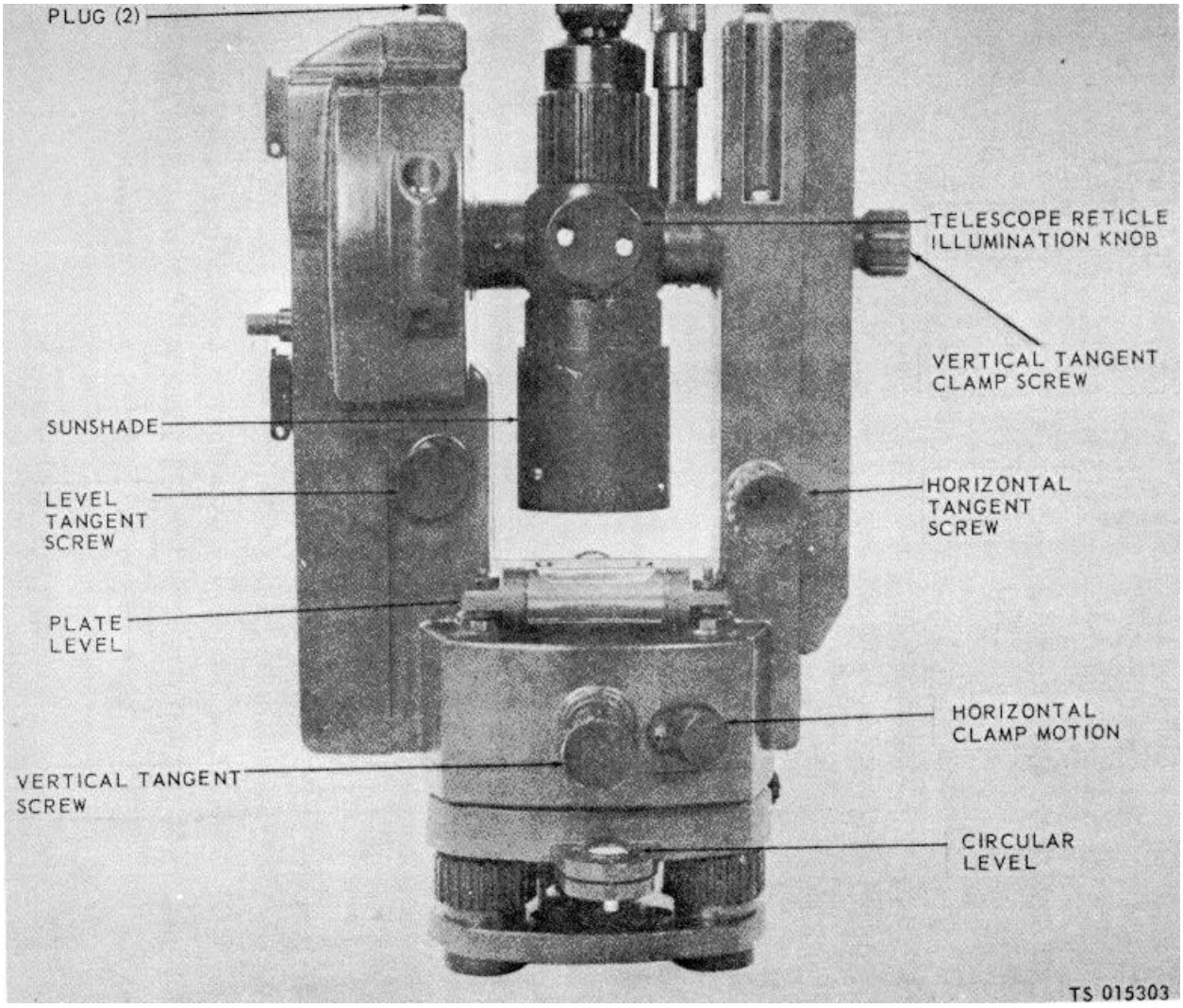


Figure 1-3. Theodolite, rear view.

b. Accessories. The accessories and the tools are contained in the tool and accessory case (fig. 2-5) and the battery case (fig. 2-6).

(1) The following items are contained in the tool and accessory case.

(*a*) *Compass.* The compass is a circular magnetic type that mounts on the alidade (fig. 212). The compass is equipped with a magnifying eyepiece to view the scale readings. Spare compass pivots (holder assemblies) are also contained in the case.

(*b*) *Prismatic eyepieces.* Two prismatic eyepieces are provided in the case; the larger one for the telescope and the smaller for the microscope (fig 2-10). The eyepieces are used for extreme inclined and declined sights when the observer cannot sight directly into the normal eyepieces. The telescope prismatic eyepiece has a filter adjacent to the lens which can be positioned over the eyepiece when making direct observations of the sun.

(*c*) *Telescope sun filter.* A sun filter is included in the case for use when making direct observations of the sun (fig. 2-11).

(*d*) *Light* attachment. A light attachment and light guide are contained in the case to permit viewing the altitude and plate level bubbles, circles, and telescope reticle during night operation. The light attachment mounts on the left cover of the alidade by means of two plugs which are inserted into two jacks in the cover. One end of the fiber light guide is inserted through the knurled fitting at the bottom of the

light attachment, the other end is inserted through a hole in the left end of the plate level.

(*e*) *Tools.* Screwdrivers and adjusting pins are in the case for adjustment and maintenance of the theodolite. Also provided is a spanner wrench for the tangent screws.

(*f*) *Miscellaneous.* The tool and accessory case also contains a tube of lubricant, cleaning brush, chamois, lens tissue, orange sticks, and plastic cover.

(2) *Battery case.* The battery case is a metal box with a carrying handle that can be mounted on the tripod. The case contains four batteries, four spare lamps, a cable with connectors, a hand lamp with cord and connector, jacks, and a rheostat. The four batteries are troop installed items. The cable installs in either jack in the side of the battery box and in the jack in the tribrach. The hand lamp cable is installed in the other jack in the case.

(3) *Knapsack.* The knapsack is provided for field transport of the theodolite. The canvas knapsack is equipped with shoulder straps and two pockets.

1-8. Identification and Tabulated Data

a. Identification. The equipment has the following identification markings:

(1) *Theodolite.* The manufacturer's name, model, part number, code number, contract number, year of manufacture, serial number, and the National Stock Number are printed on a plate mounted below the optical plummet eyepiece.

(2) *Carrying case.* The manufacturer's name and part number, and the Federal Stock Number are stenciled on the top of the carrying case.

b. Tabulated Data.

(1) *Theodolite.*

Manufacturer	Keuffel & Esser
Model	K E/G6-730075
Type	Directional Surveying
Serial number range	001 to 266

(2) *Telescope.*

Magnification	30 x (Power)
Minimum focus	4.8 feet (1.46 meter)
Field of view	10(degree) 30' (minutes)
Effective aperture	1.75 inch, 40 mm (millimeter) (4.44 centimeters)
Stadia Lines:	
Ratio	1:100
Constant	0

(3) *Circles.*

Diameters:	
Vertical	4 in. (10.16 centimeters)
Horizontal	4 in. (10.16 centimeters)
Divided	360 degrees
Direct reading	1 minute (60 seconds)
Reading by estimation	0.1 min

(4) *Levels.*

Sensitivity of plate level	20 sec (seconds) per 2 mm
Sensitivity of circular level	10 min per 2 mm
Sensitivity of telescope co-incidence level	60 sec per 2 mm
Sensitivity of altitude co-incidence level	45 sec per 2 mm

(5) *Centering device.*

Centering range of theodolite on tripod

(6) *Dimensions and weights.*

Theodolite:	
Dimensions	12 in. high x 8 in. wide x 7 in. deep
Weight	13 lbs. (pounds)
Tripod:	
Extended	59 in. (149.9 cm)
Retracted	36 in. (99.4 cm)
Weight	15 lbs.
Carrying case:	
Dimensions	9/4 x 15 3/4 x 101/2 in.
Weight (empty)	12 lbs.
Transportation case:	
Dimensions	10 3/4 x 20 1/4 x 15 in.
Weight (empty)	30 lbs. max.

1-9. Difference in Models

This manual covers only the Keuffel & Esser Model K E/G6-730075 Theodolite. No known differences exist for the model covered by this manual.

CHAPTER 2

OPERATING INSTRUCTIONS

Section I. SERVICE UPON RECEIPT OF EQUIPMENT

2-1. Inspecting and Servicing the Equipment

a. General. The theodolite and its carrying case are shipped in a fiberglass transportation case which is encased in a shipping container. The tool and accessory case, battery case, knapsack, and tripod are included in the same container.

b. Unpacking the Equipment.

(1) *Theodolite and carrying case.*

(*a*) Open shipping container, remove wrapping material, and lift out transportation case.

(*b*) Release locks (fig. 2-1) and open transportation case cover.

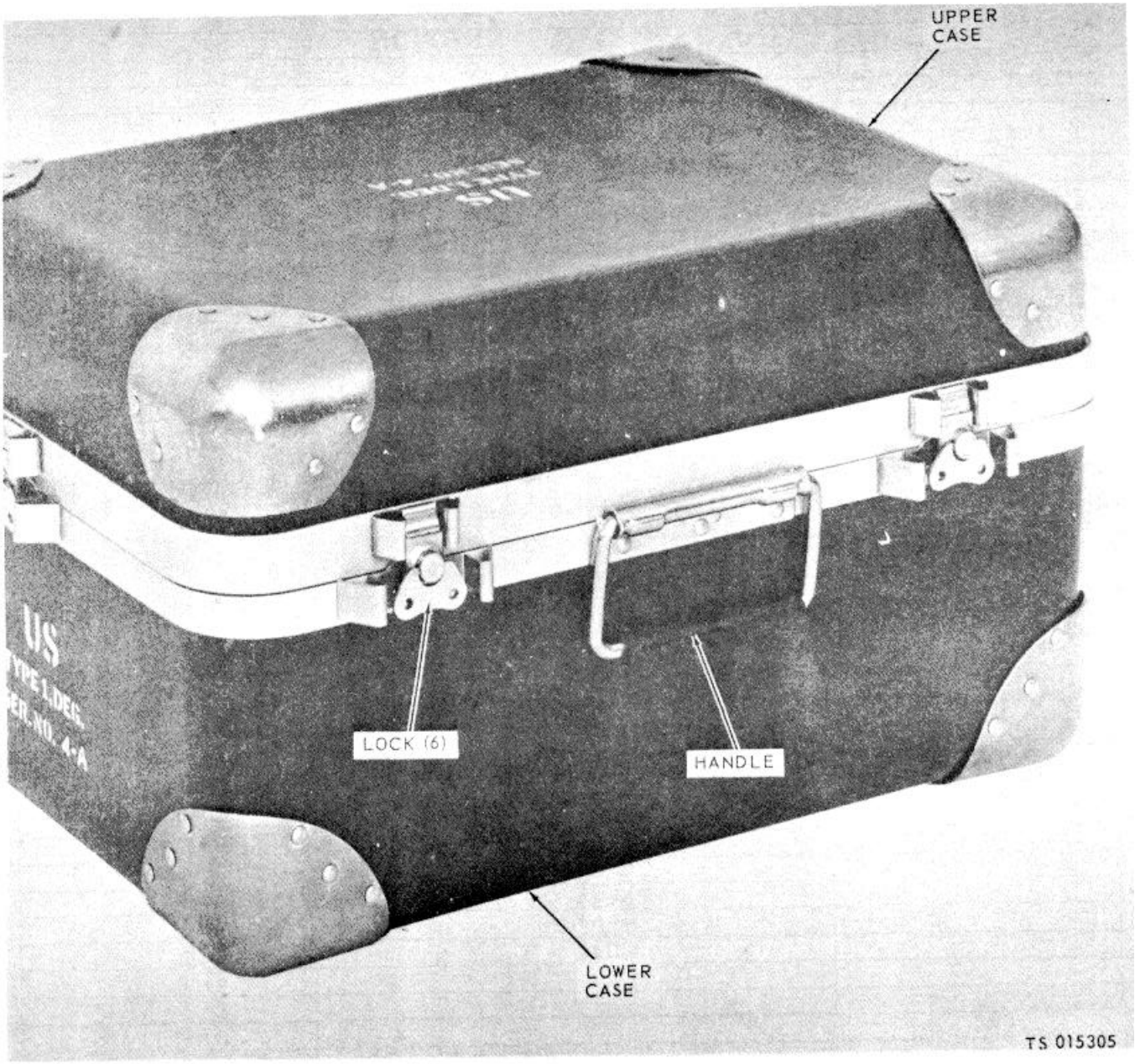


Figure 2-1. Theodolite transport case.

(c) Remove theodolite carrying case (fig. 2-2) from transportation case and set case on its base (fig. 2-3).

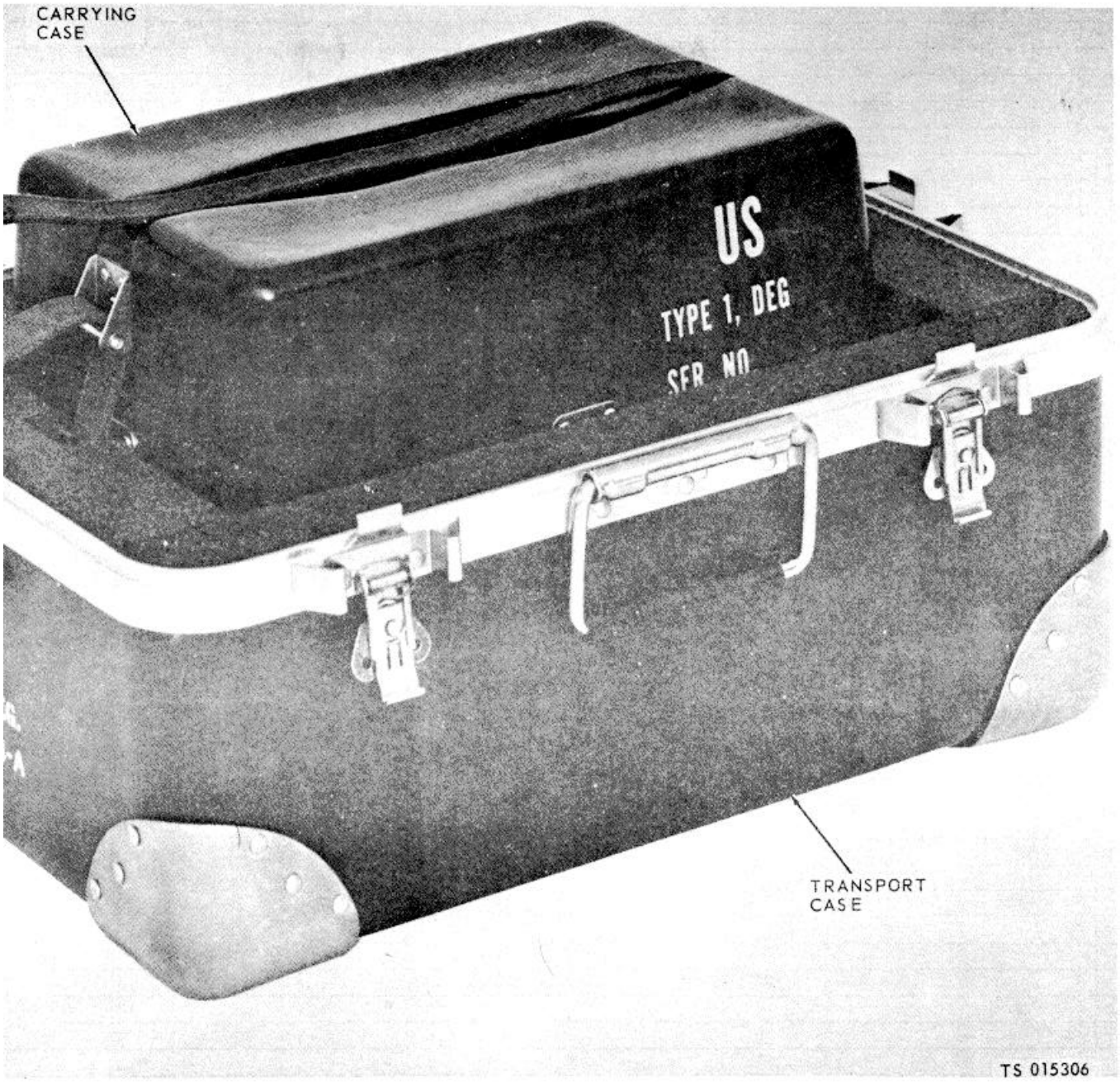


Figure 2-2. Theodolite carrying case, removal and installation.

Figure 2-3. Theodolite carrying case cover, removal and installation.

(*d*) Release latches (fig. 2-3) and lift off carrying case cover.

(*e*) Theodolite may now be lifted from carrying case (fig. 2-4) and mounted on tripod as given in paragraph 2-2.

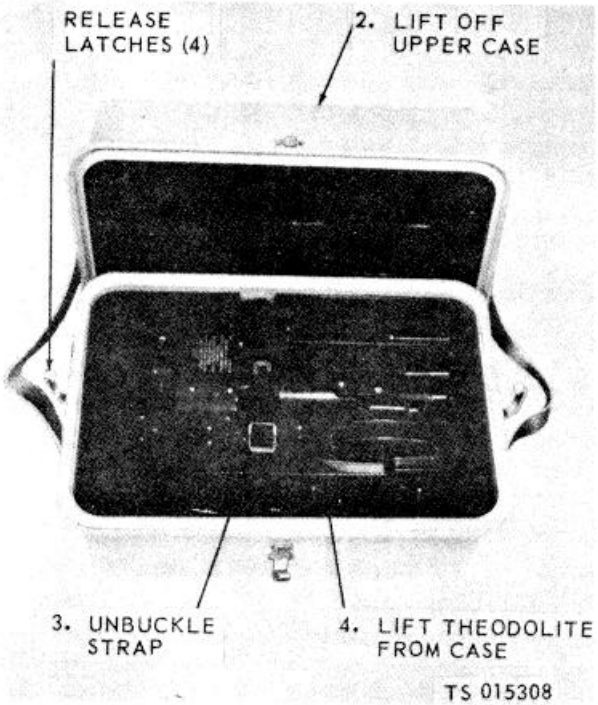


Figure 2-4. Theodolite carrying case, Theodolite removal and installation.

(2) *Tripod.* Remove wrapping and lift tripod out of shipping container.

(3) *Tool and accessory case, battery case, and knapsack.* Remove wrapping material, and remove tool and accessory case, battery case, and knapsack.

c. Inspection.

(1) *Transportation case.*

(*a*) Inspect transportation case for dents or cracks.

(*b*) Inspect locks and handles for security and damage.

(*c*) Check gasket for damage.

(2) *Carrying case.*

(*a*) Inspect carrying case for dents or cracks.

(*b*) Inspect carrying strap and latches for security and damage.

(*c*) Check carrying case gasket for damage.

(*d*) Check color of desiccant in case.

CAUTION

The desiccant should be blue in color. A pink color indicates the presence of excessive moisture saturation and the desiccant must be dried out or replaced. If the color is pink, inspect the theodolite for suspected moisture damage.

(3) Theodolite.

(a) Inspect theodolite for broken or missing parts, cracked or scratched lenses or mirrors, security of hardware, and any other damage.

(b) Check all controls for proper operation.

(c) Sight through all optical systems for signs of malfunction.

(4) Tripod.

(a) Set up and inspect tripod for damaged or missing parts and security of hardware.

(b) Check that plumb bob and tripod wrench are contained in holder and are in serviceable condition.

(5) Tool and accessory case.

(a) Check that all components shown in figure 2-5 are contained in tool and accessory case and are in serviceable condition.

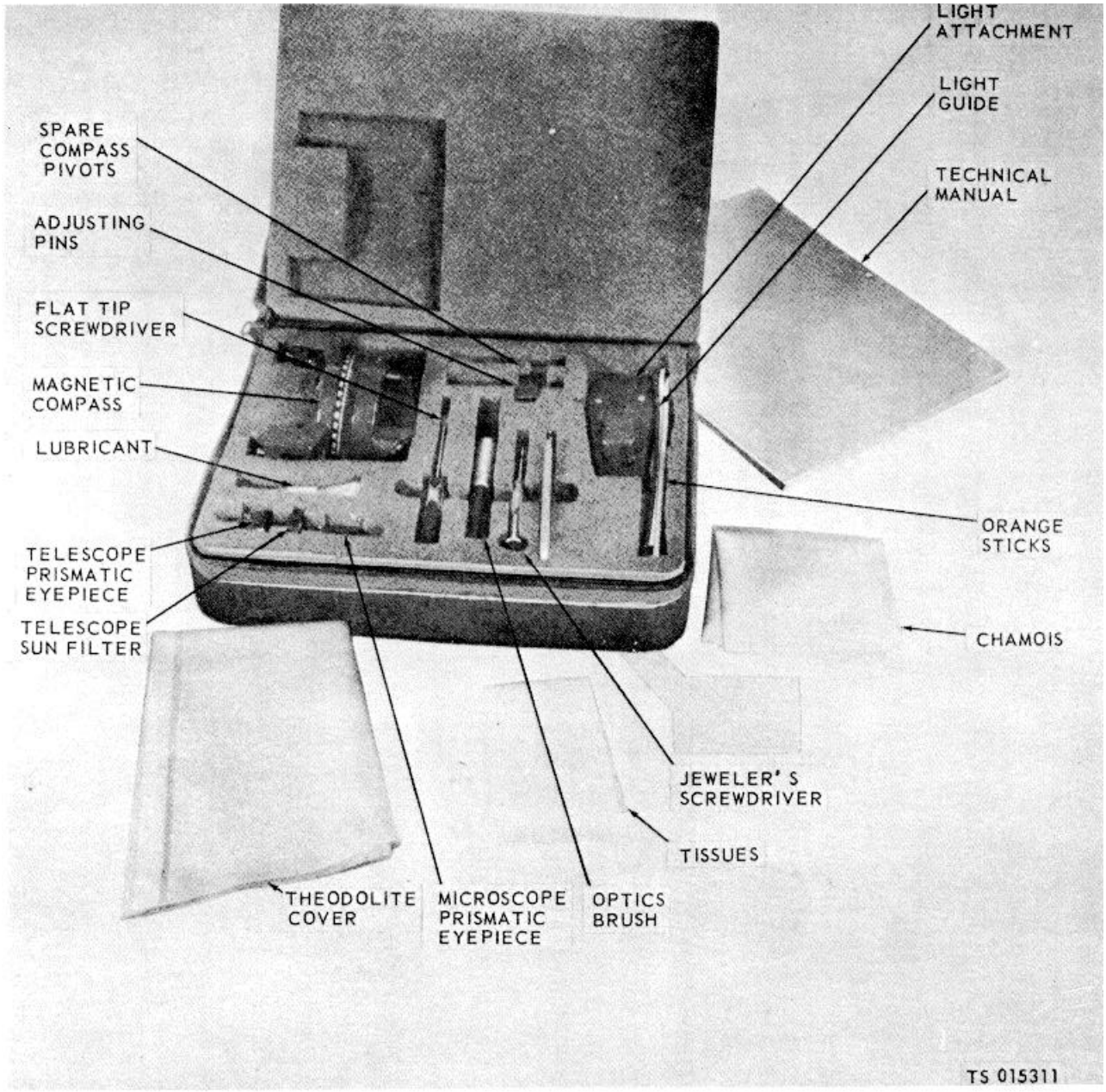


Figure 2-5. Tool and accessory case.

(*b*) Inspect prismatic eyepieces and sun filter for scratches or cracks.

(*c*) Check light attachment for damage or missing parts.

(6) *Battery case.*

(*a*) Inspect battery case (fig. 2-6) for damage and missing parts.

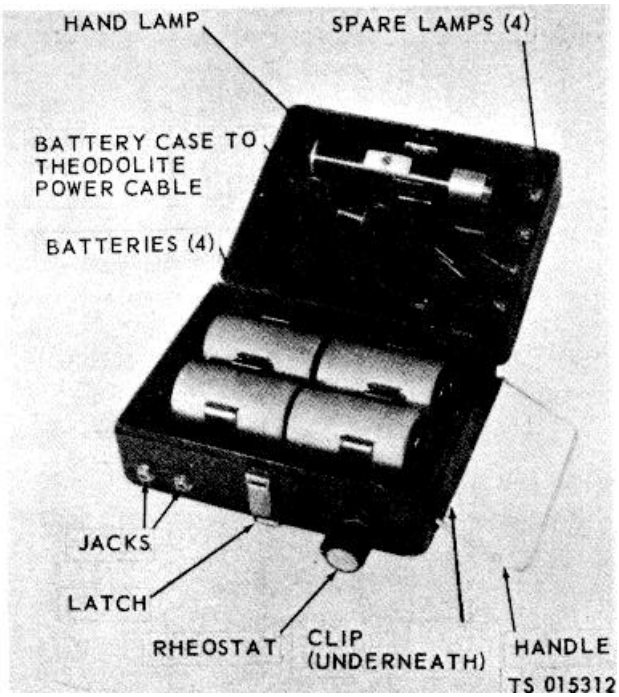


Figure 2-6. Battery case.

(b) Make sure that case contains hand lamp, cable, and spare lamps.

(c) Turn rheostat knob through its full travel and check that movement is smooth and free.

(d) Inspect all electrical contacts for corrosion and security.

(e) Inspect hand lamp for damage. Check operation of switch.

(f) Check electrical cable for condition of plugs and frayed or cracked insulation.

(7) Knapsack. Inspect knapsack for damaged straps, insecure or defective buckles, loose padding, tears, or missing parts.

2-2. Setting-Up Instruction

a. Tripod. Refer to figure 2-7 and set up tripod.

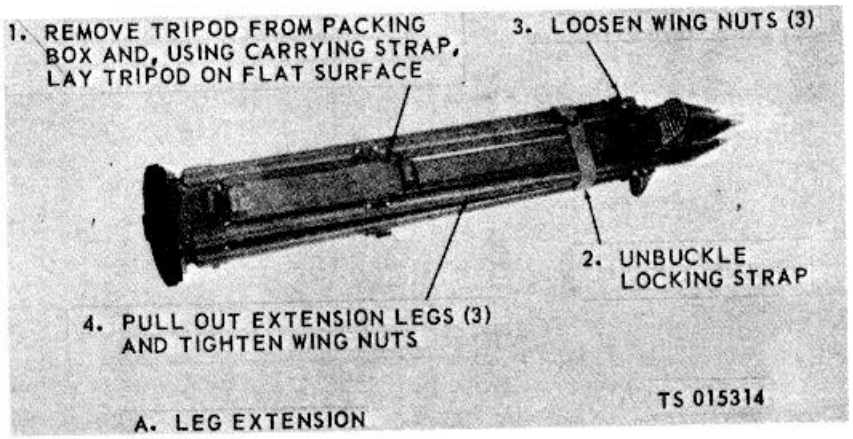


Figure 2-7. Tripod, setting up (Sheet 1 of2).

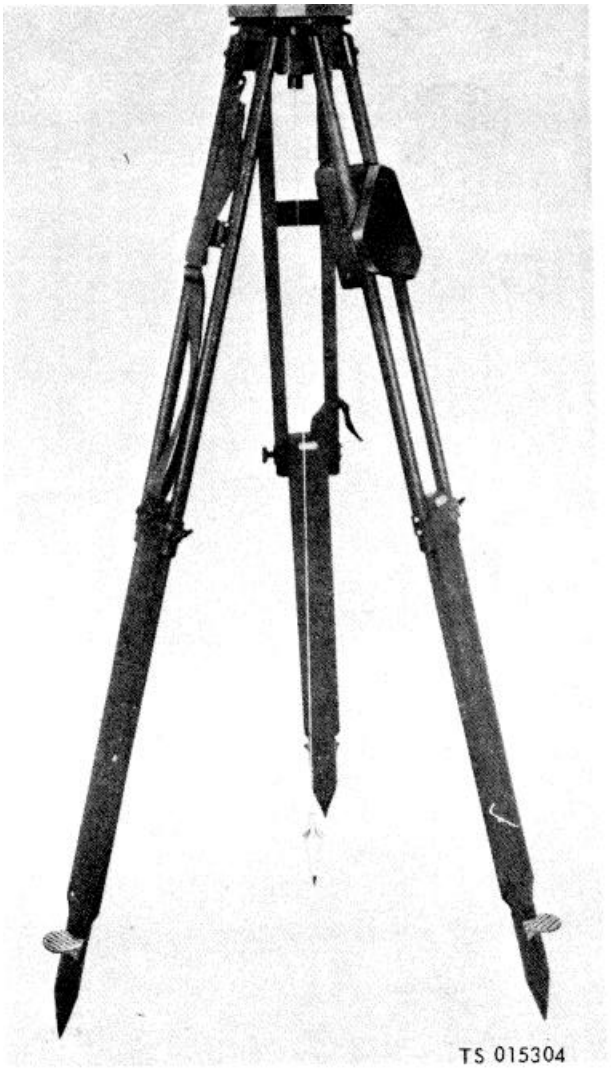


Figure 2-7. Tripod, setting up (Sheet 2 of 2).

b. Theodolite.

(1) Remove theodolite from carrying case (fig. 2-4).

(2) Refer to figure 2-8 and install theodolite on tripod.

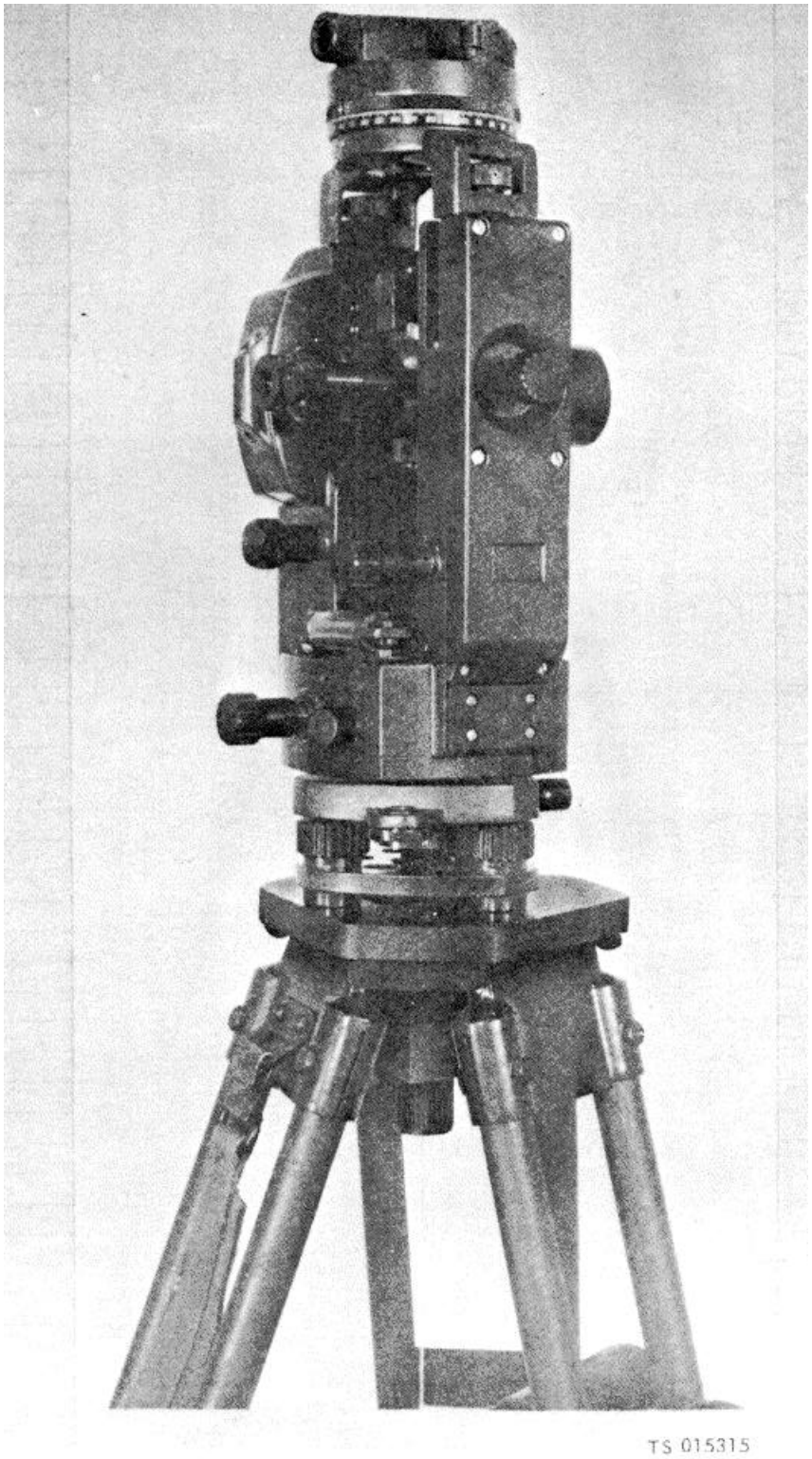


Figure 2-8. Theodolite, installation on tripod.

2-3. Equipment Conversion

a. General. During night or dark-day operation, the reading circles and bubbles are illuminated by installing the illumination system. For high-angle observations, install the prismatic eyepieces. For direct sun observations, filters are provided. A compass is provided for use when magnetic azimuth is required.

b. Night or Dark-Day Operation. Refer to figure 2-9 and install the illumination system.

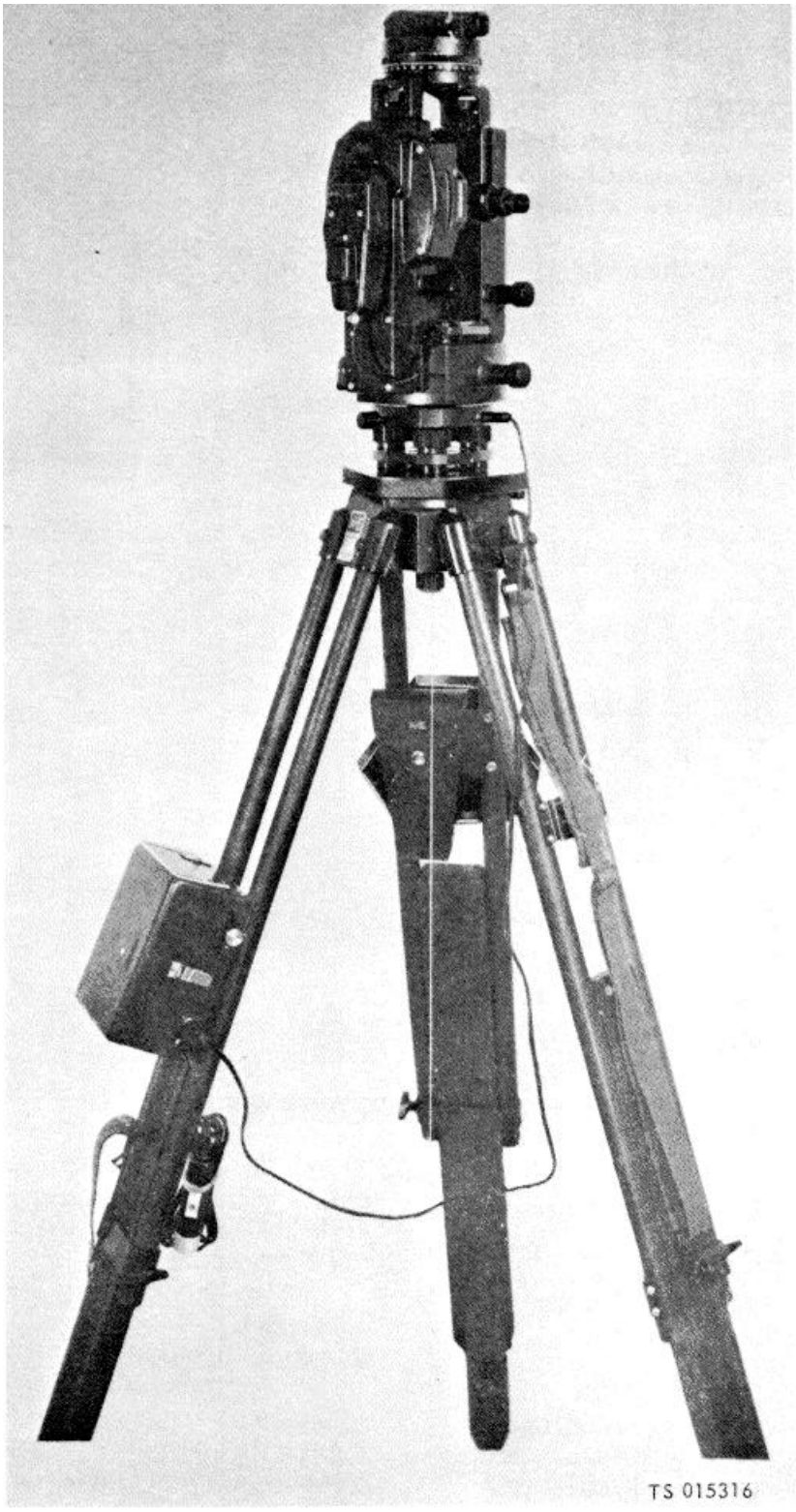


Figure 2-9. Illumination system, installation.

c. High-Angle Observations.

(1) Remove prismatic eyepieces from accessory case.

(2) Refer to figure 2-10 and install prismatic eyepieces.

WARNING

Severe dye damage can result from performing observations against direct sunlight without utilizing the sun filters.

d. Sun Observations.

(1) When sighting on the sun with the prismatic eyepiece, position sun filter over eyepiece (fig. 2-10).

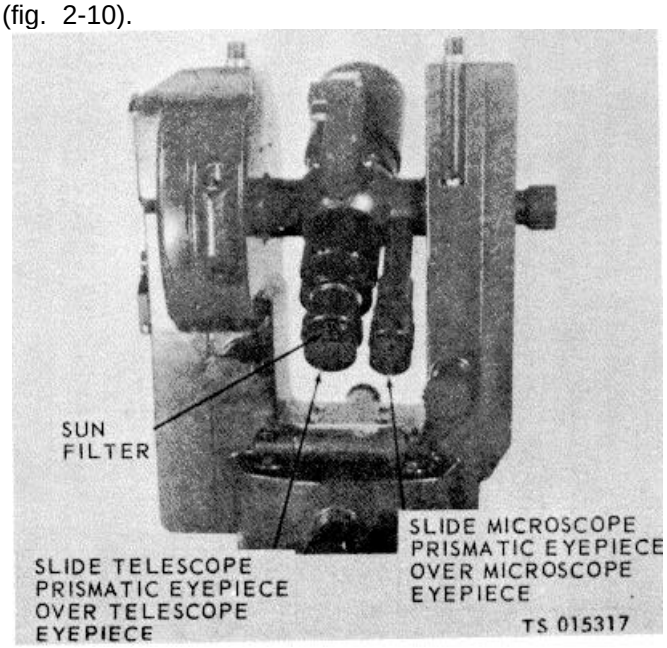


Figure 2-10. Prismatic eyepiece, installation.

(2) When sighting on the sun without the prismatic eyepiece, install telescope sun filter (fig. 2-11).

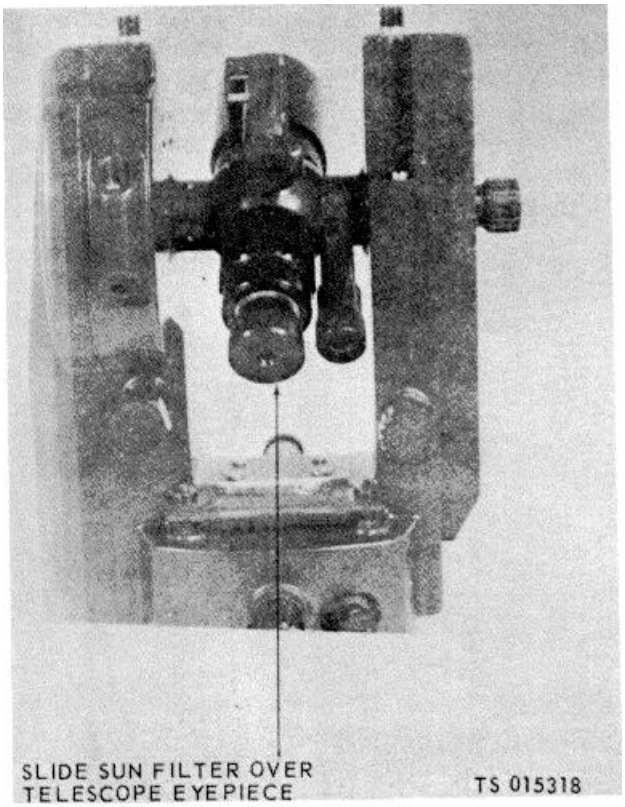


Figure 2-11. Sun filter, installation.

Section II. MOVEMENT' TO A NEW WORK SITE

2-4. Dismantling for Movement

a. Short Distances. For short distances across cleared, level areas, the operator may carry the instrument mounted on the tripod. If the instrument is carried while mounted on the tripod, the operator should not carry it in any position other than upright'.

CAUTION

Exercise care when moving the theodolite mounted on tripod. Handle the instrument carefully. Never subject It to bumps or jars. Never leave the instrument unattended for long periods of time unless it is returned to the carrying case. Never carry the instrument over the shoulder.

b. Long Distance.

(1) When theodolite must be carried for more than a short distance or over rough terrain, instrument should be transported in carrying case (figs. 2-3 and 2-4).

(2) Handle carrying case carefully to avoid sudden jolts, continued vibration, or other shocks that might damage delicate parts of instrument.

(3) If theodolite is to be carried long distance by manpower, the knapsack should be utilized.

(4) If theodolite is to be transported by vehicle for long distances, it should be carried in the transportation case (figs. 2-1 and 2-2).

2-5. Setting-Up After Movement

a. Refer to figure 2-7 and set up tripod.

b. Refer to figure 2-8 and install theodolite on tripod.

Section III. CONTROLS AND INDICATORS

2-6. General

This section provides the operator with the necessary information concerning the controls and indicators to properly operate the theodolite.

2-7. Controls and Indicators

All the controls and indicators are in the theodolite except for the lighting rheostat, and hand lamp. The lighting rheostat is mounted on the battery case (fig. 2-6), and the switch for the hand lamp is on the body of the hand lamp (fig. 26). The rheostat serves to control the intensity of the theodolite illumination system during night or dark-day operation. The description and use of the controls and indicators are given in table 2-1 and their locations shown in figure 2-12. The circle and microscope scales which are observed through the microscope eyepieces are shown in figure 2-13.

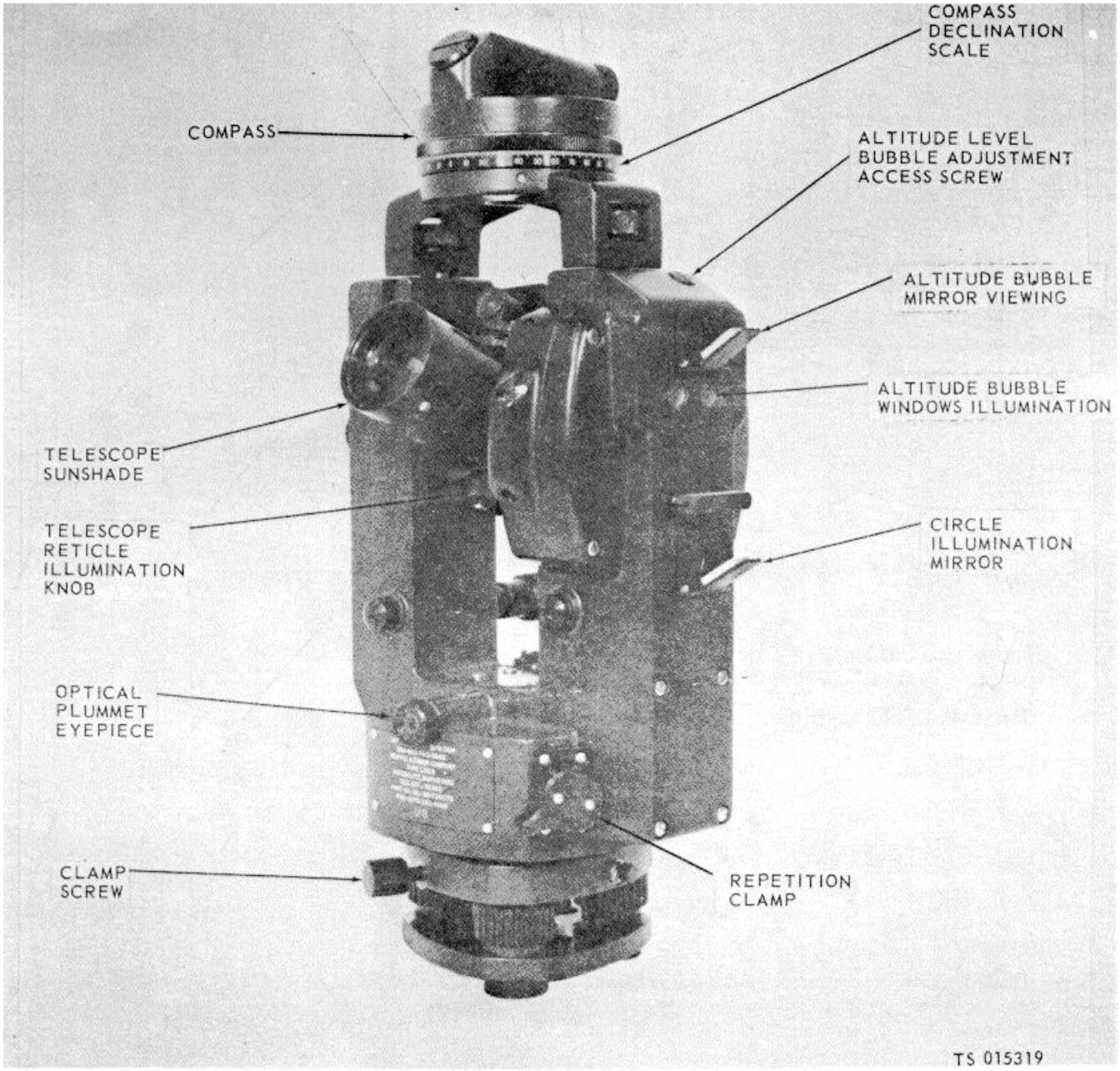


Figure 2-12. Controls and indicators (Sheet 1 of 2).

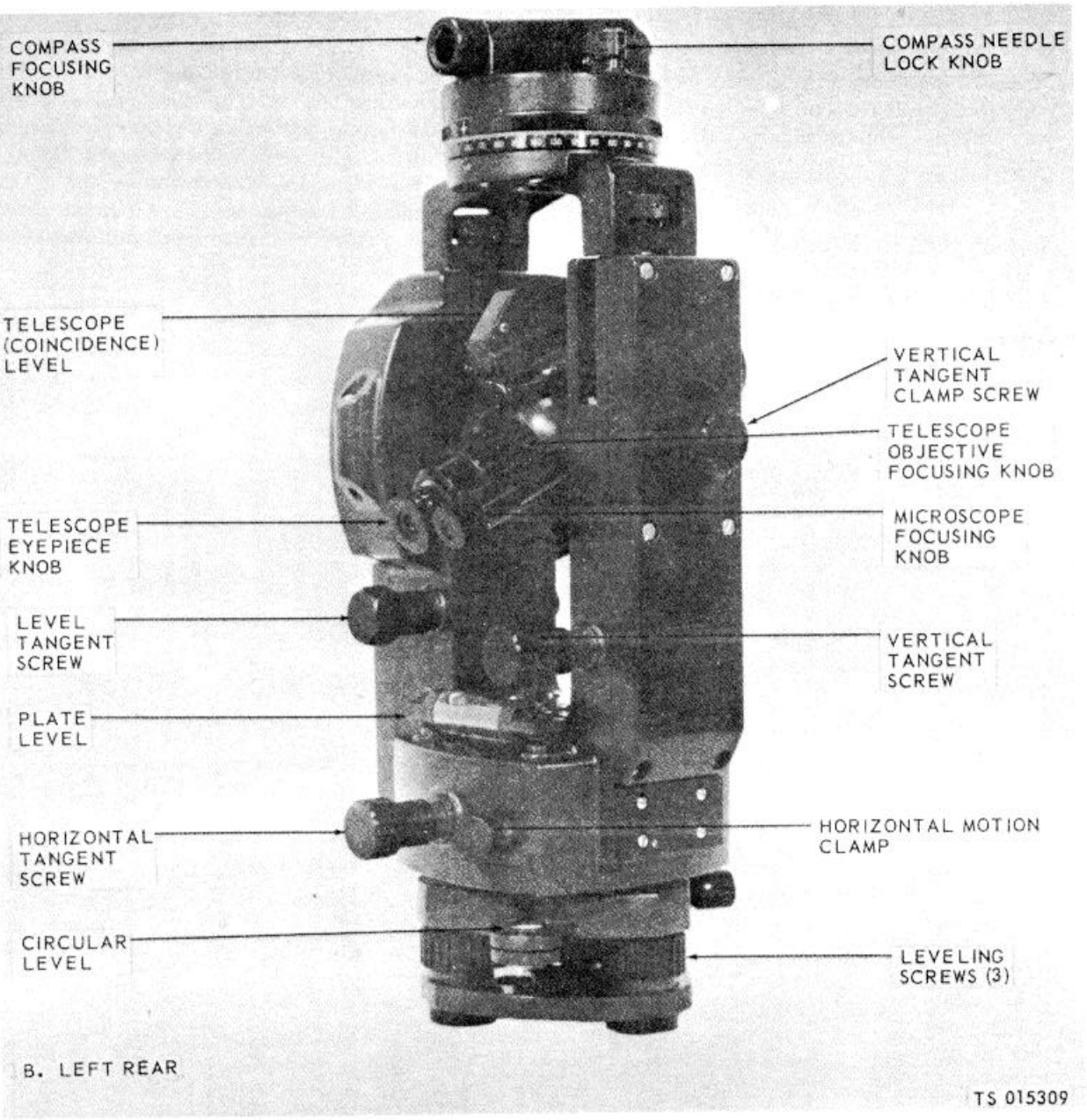


Figure 2-12. Controls and indicators (Sheet 2 of 2).

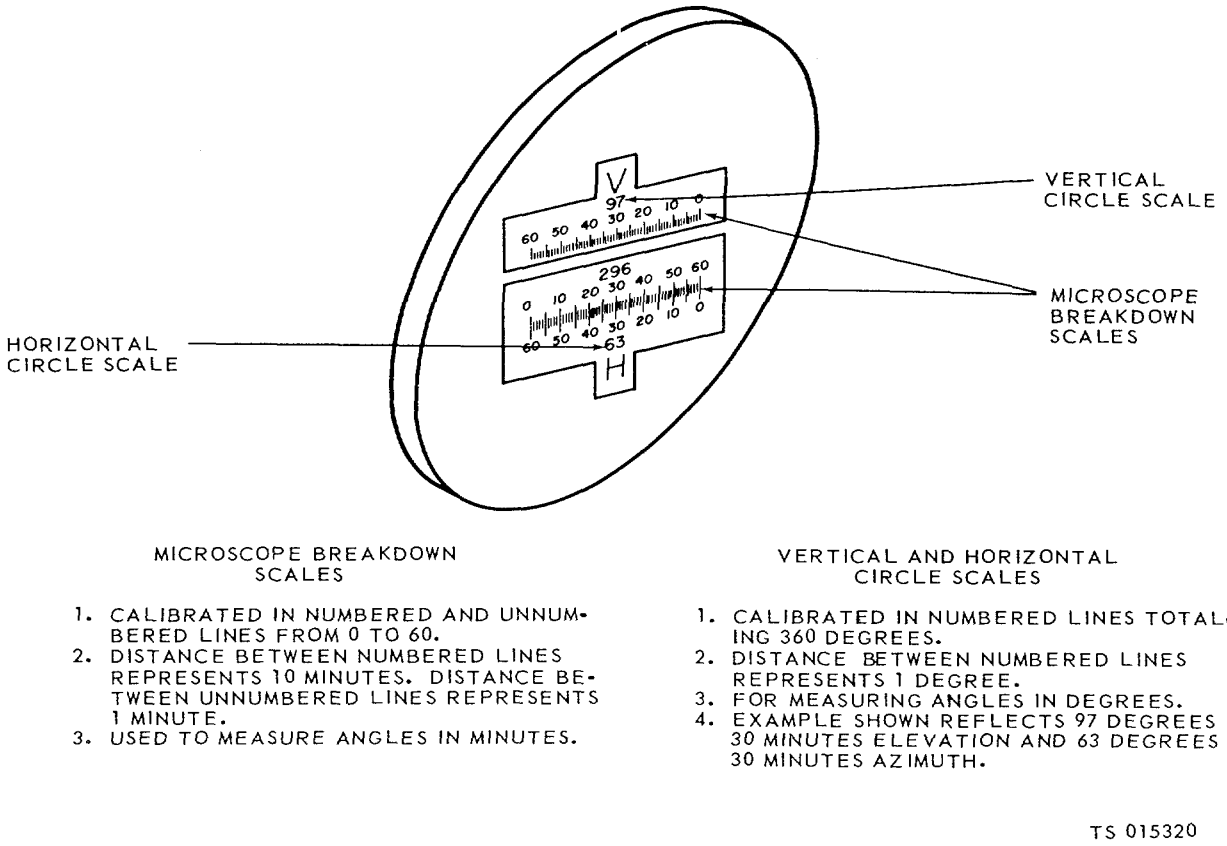


Figure 2-13. Circle and microscope scales.

Table 2-1 Controls and Indicators

Name	Description	Purpose
Compass focusing knob	Knurled ring	Focus on compass graduations
Telescope (coincidence) level	Bubble vial	Establishes horizon line of sight
Telescope objective focusing knob	Knurled cylinder	Focus on sighted object
Microscope focusing knob	Knurled ring	Focus on circle images
Telescope eyepiece knob	Knurled ring	locus on reticle lines
level tangent screw	Hex shaped knob	Center level bubble
Plate level	Bubble vial	Level theodolite
Horizontal motion clamp	Knurled knob	Lock horizontal tangent screw to leveling head
Horizontal tangent screw	Knurled knob	Precise horizontal positioning of telescope
Clamp screw	Knurled knob	Lock theodolite with tribrach
Vertical tangent screw	Knurled knob	Precise vertical positioning of theodolite
Circle illumination mirror	Hinged glass mirror	Reflect light on circle images during daytime operation
Telescope reticle illumination knob	Knurled knob	Project desired amount of light
Altitude bubble illumination mirror	Hinged glass mirror	Reflect light on bubble during daytime operation
Optical plummet eyepiece	Knurled ring	Focus on plummet reticle
Leveling screws	Knurled knobs	Leveling theodolite
Circular level	Bubble vial	Leveling theodolite

Table 2-1. Controls and Indicators--Continued

Name	Description	Purpose
Vertical tangent clamp screw	Knurled knob	Lock elevation tangent screw to telescope
Repetition clamp	Two position rotary knob	Lock horizontal circle to the alidade
Battery case rheostat	Adjustable resistor	Controls degree of bubble, circle, and telescope reticle illumination (fig 2-9)
Compass needle lock knob	Knob	Locks needle when compass not in use
Hand lamp knob	On-off switch	Energizes hand lamp bulb (fig 2-9)

Section IV. OPERATION UNDER USUAL CONDITIONS

2-8. General

Instructions in this section are for the information and guidance of personnel responsible for operation of the theodolite under normal conditions. This section gives instructions on handling and preparation for operation of the theodolite basic motions to perform the 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.

2-9. Adjustments

a. Pre-Adjustment Procedure. Before assuming that adjustments are necessary, make sure that the condition of the instrument is causing the apparent lack of adjustment and that the deficiencies noted are not caused by improper testing. To properly test an instrument in the field, proceed as follows:

(1) If possible, choose a cloudy day.

(2) Set up instrument as shown in figure 2-8 and paragraph 2-2).

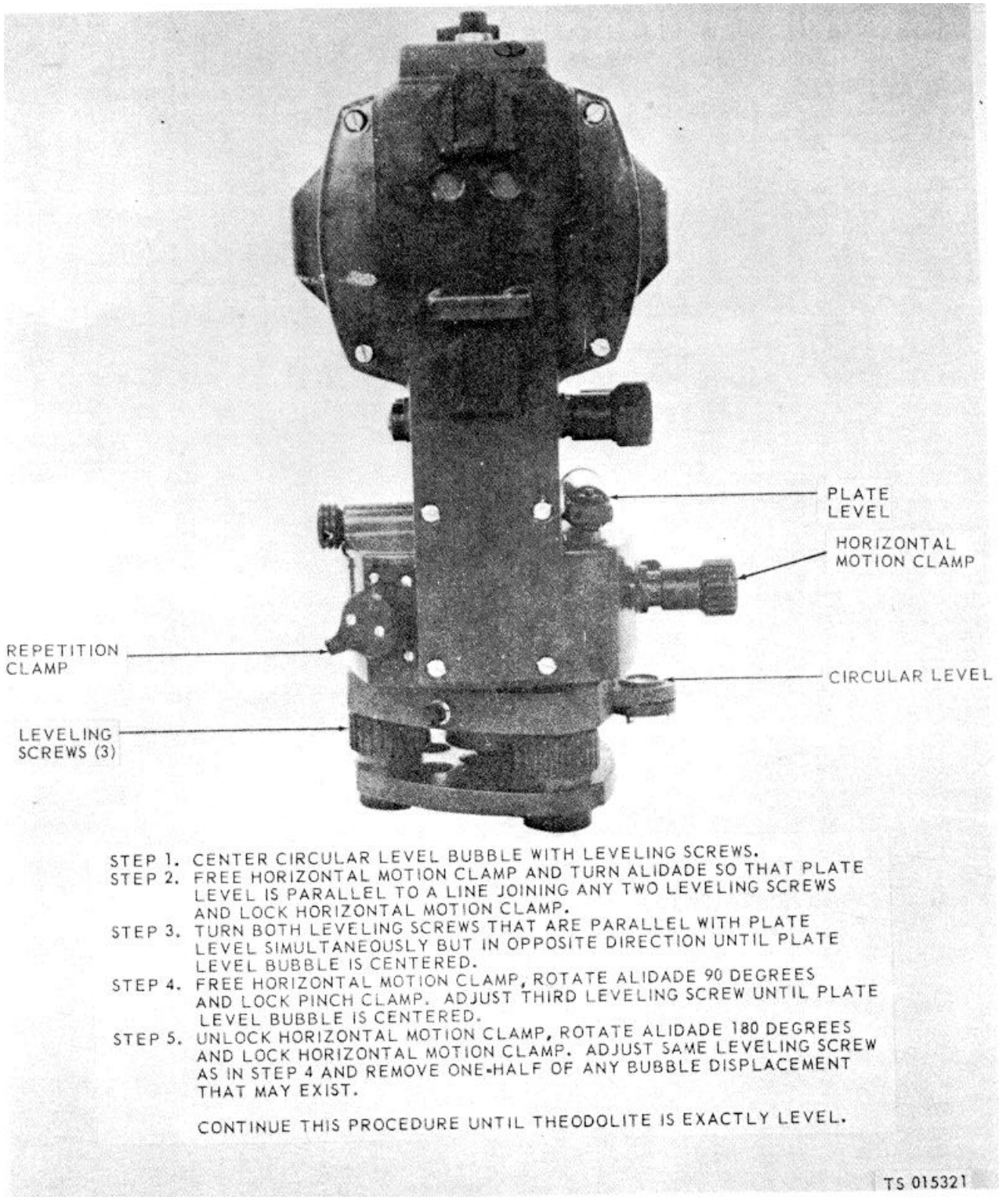


Figure 2-14. Theodolite, leveling.

(3) Level theodolite as given in figure 2-14. If theodolite cannot be leveled, proceed with the following steps.

(4) Perform all tests in order given. Do not adjust theodolite unless a particular test indicates same amount of error at least three times.

CAUTION

Be on the lookout for "creep", especially when adjusting the levels. After setting a bubble or the line of sight, let it stand for a few seconds to see that no movement occurs.

(5) After each adjustment has been accomplished, perform its applicable test at once.

(6) After required adjustments have been completed, perform all tests in order given to ensure that other adjustments have not been disturbed.

b. Plate Level.

(1) Testing. Level theodolite as given in figure 2-14. If plate level bubble fails to center, proceed as given in step (2) below.

(2) Adjustment. If bubble failed to center during the test in step (1) above, proceed as given in figure 2-15.

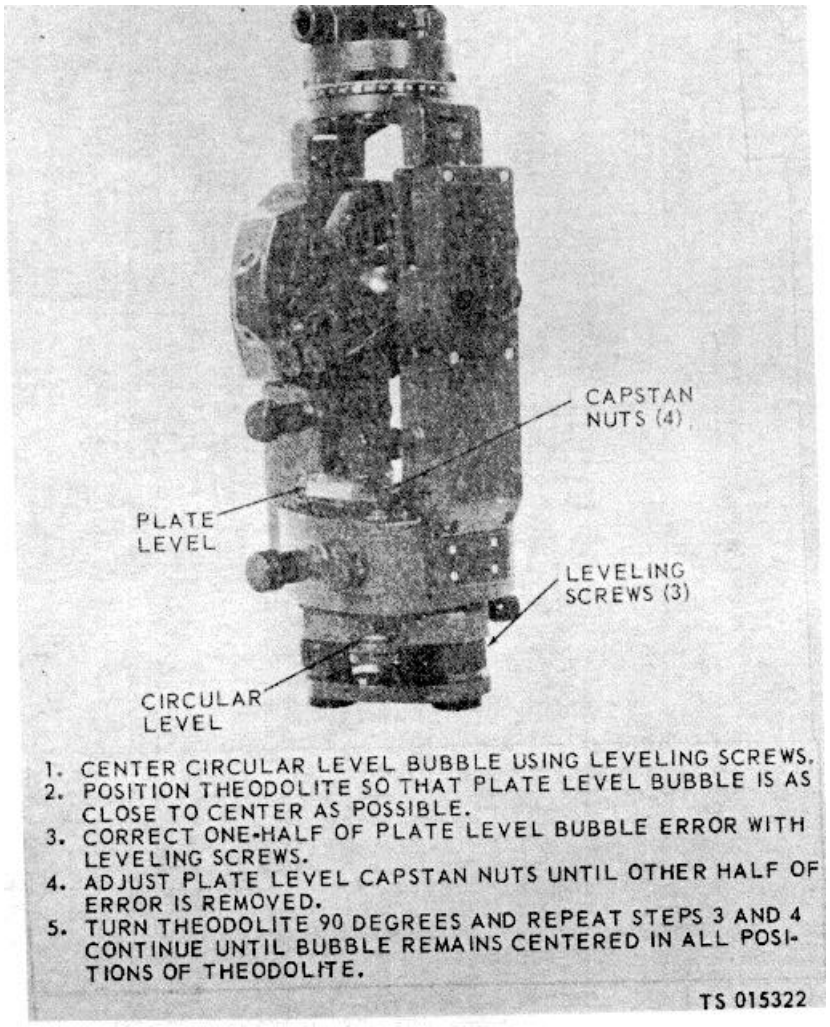


Figure 2-15. Plate level, adjustment.

c. Circular Level.

(1) Testing. Level theodolite with plate level as given in figure 2-14. If circular bubble fails to center, proceed as given in step (2) below.

(2) *Adjustment.* If circular level bubble fails to center after test in step (1) above, proceed as given in figure 2-16.

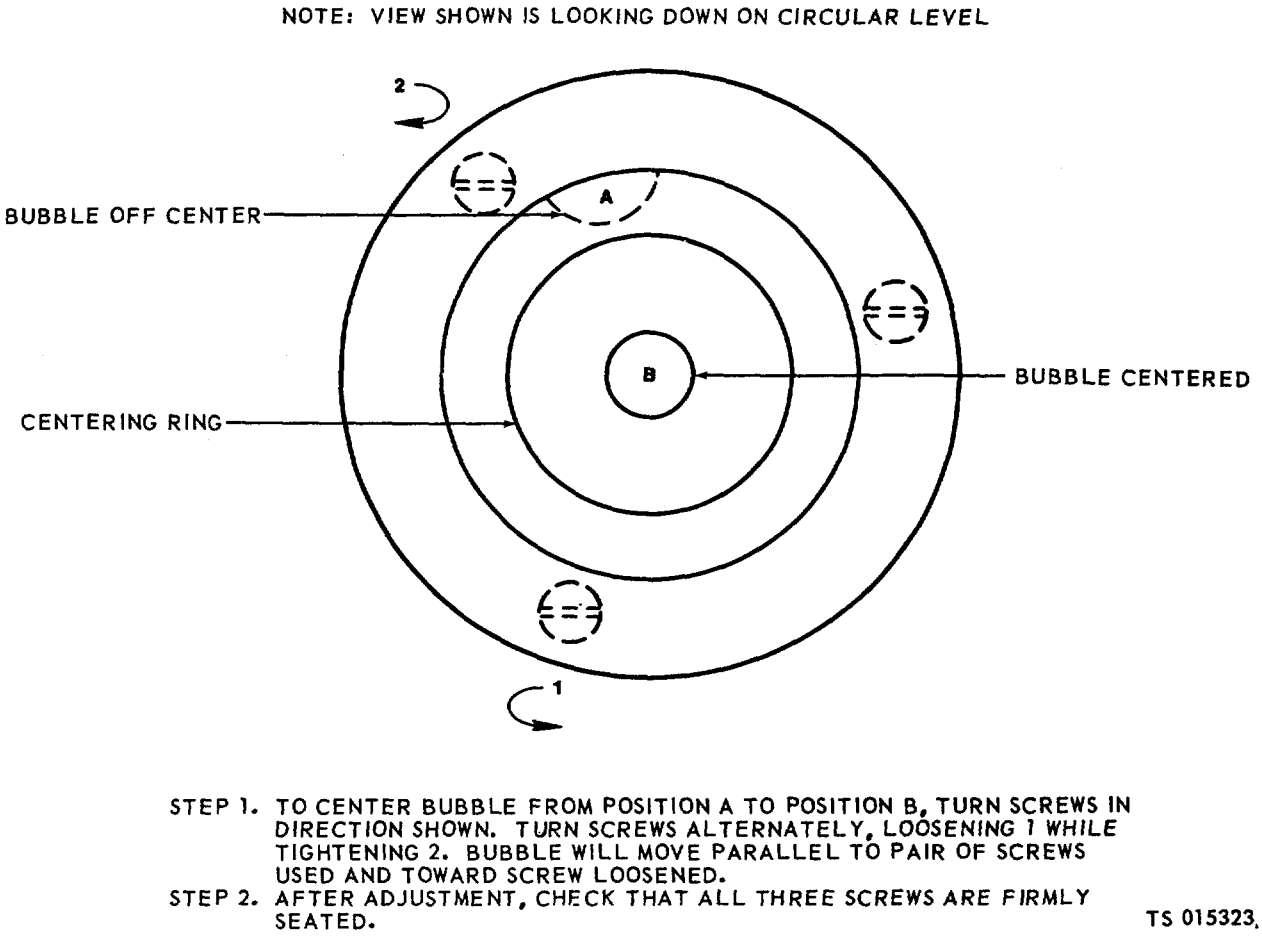


Figure 2-16. Circular level, adjustment.

d. Line of Sight.

(1) *Testing.*

(a) Reverse telescope and aim at a well defined point at least 330 feet away.

(b) Transit telescope on its vertical axis and note point that appears on vertical cross line at about same elevation and distance as first point.

(c) Turn theodolite horizontally and aim at original point.

(d) Transit telescope on its vertical axis. Vertical cross line should fall on second point. If it does not, proceed as given in step (2) below.

(2) Adjustment. If vertical cross line failed to fall on second point as described in step (1) above, make sure instrument remains in position, and proceed as given in figure 2-17.

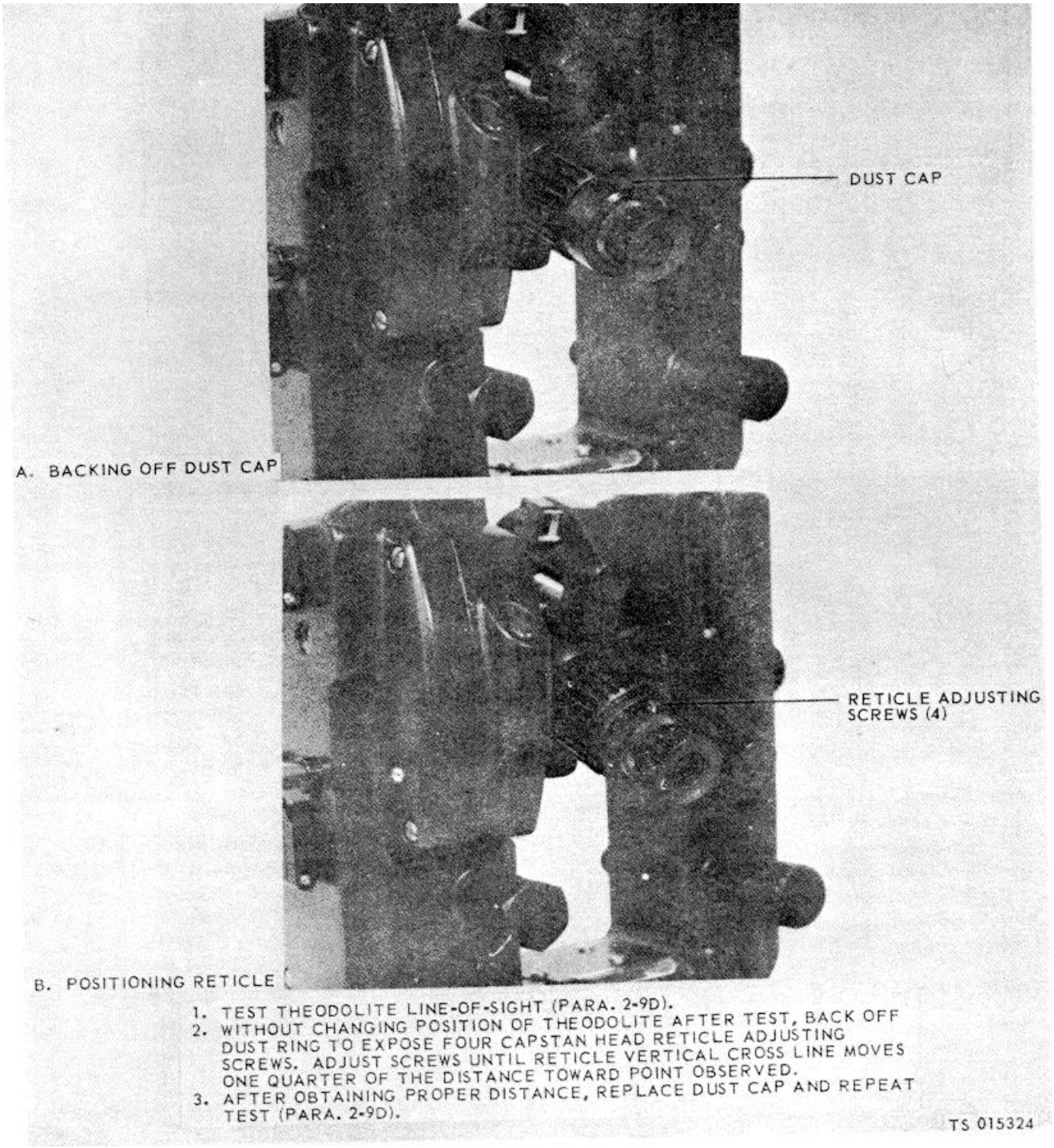


Figure 2-17. Line-of-sight adjustment.

e. Vertical Circle. Index.

(1) *Testing*.

(a) Carefully level theodolite (fig. 2-14) using plate bubble as reference. Level telescope using telescope bubble as reference. Level altitude level using altitude tangent screw.

(b) With telescope direct, aim on a clearly defined target and record elevation angle.

(c) Transit telescope on its elevation axis, recheck centering of the altitude level bubble, and point on same target. Record the elevation angle.

(d) The sum of the angles obtained in steps (b) and (c) above should equal 360 + 0.4 minute.

(*e)* If deviation is more than 0.4 minute, perform adjustment given in paragraph (2) below.

(2) *Adjustmen*t. Refer to figure 2-21 and adjust vertical circle index.

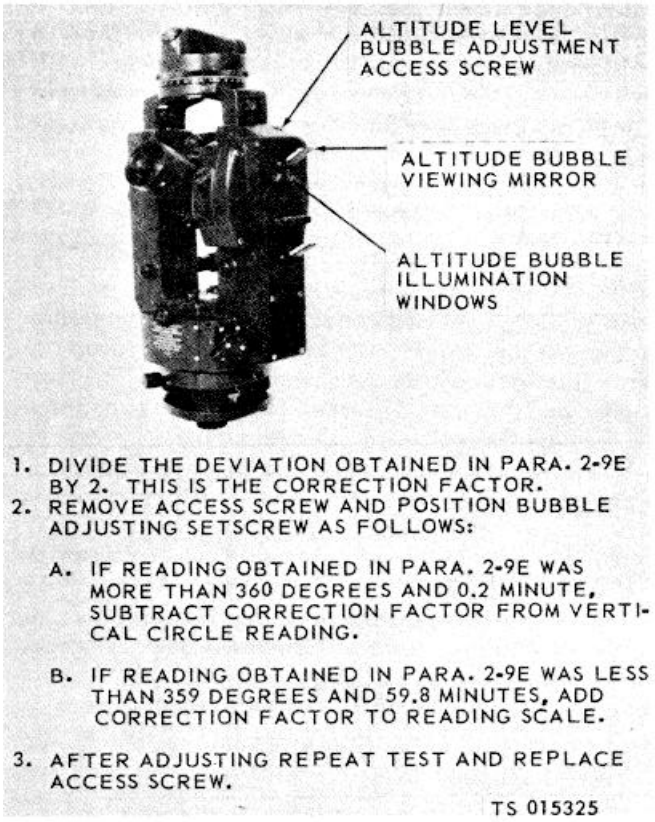


Figure 2-18. Vertical circle index, adjustment

Section V. OPERATION UNDER UNUSUAL CONDITIONS

2-10. Operation in Extreme Cold (Below 0° F.) The theodolite and its accessories may be used in extreme cold with no adverse effect on its capabilities. Its use is limited only by the endurance of the operating personnel and conditions affecting visibility.

CAUTION

Avoid subjecting the instrument to sudden changes in temperature. Extreme temperature changes may cause internal stresses affecting accuracy and optical components may become fogged.

WARNING

During operation in subfreezing temperatures, avoid touching any portion of the instrument with bare hands except the controls. Bare skin will stick to extremely cold metal parts.

2-11. Operation in Extreme Heat

If the theodolite is operated in extreme heat and under the direct rays of the sun, internal stresses and distortion may occur which would result in poor sightings. If possible, the theodolite should be protected from the sun by a surveyor's field umbrella or other suitable means. Taking sightings during early morning or late evening will help to minimize error magnitude. Also, shorter sightings will decrease the amount of sighting error.

NOTE

If the theodolite is kept in a cool storage area, it should be removed from storage in sufficient time before use to allow the temperature of the instrument to approach that of the outside air.

2-12. Operation in Dusty or Sandy Areas

Special precautions must be observed when the theodolite is used in a dusty or sandy environment, as dust and sand are highly abrasive. If foreign matter adheres to mating surfaces, the mechanisms may bind. The instrument should be frequently brushed and wiped clean. Optical surfaces should be brushed with the brush in the

tool and accessory case to remove surface particles and wiped gently with lens tissue. To remove stubborn spots, use alcohol or acetone. As an alternative, breathe on the lens and wipe with lens tissue. Use extreme care to avoid scratching any of the optics surfaces while cleaning. Protect the theodolite from blowing dust and sand. Always place a protective cover over the instrument when it is not in use.

2-13. Operation Under Rainy or Humid Conditions

Inspite of its enclosed construction, the theodolite is not water proof. In humid areas, a drop in temperature may cause condensate to fog the lenses and prisms. Internal fogging can usually be removed by placing the theodolite in a warm dry environment. External condensation may be removed using the chamois. During rainfall, protect the instrument with a surveyor's field umbrella; and between periods of use while it is set up on the tripod, cover it with the waterproof hood. If the theodolite is wet, do not keep it in the carrying case any longer than necessary. As soon as possible, remove the instrument and do not return it to the case until it is completely dry.

WARNING

J Dry cleaning solvent, P-D-680, used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100° F. 138° F. (38° C.-59°C.).

2-14. Operation in Salt Water Areas

Salt is highly corrosive to metal. When using the theodolite in salt water areas, wipe it frequently with the chamois. If salt water contacts the instrument, the exterior non-optical parts should be thoroughly cleaned with cleaning solvent, Federal Specification P-D-680. The exterior optical parts should be cleaned with alcohol or acetone.

2-15. Operation in Snow

Visibility is sharply reduced while snow is falling. When taking sightings after a snowfall, the use of suitable dark glasses by the instrument man is recommended to reduce eyestrain and fatigue. If snow conditions are accompanied by extreme cold (below 0° F. (-18° C.), refer to paragraph 2-10.

2-16. Operation in Mud

Mud is highly abrasive and if allowed to remain on threaded or sliding surfaces, moving parts of the theodolite will soon bind and the instrument will become inaccurate or inoperable. The theodolite should be carefully wiped clean. Be extremely careful not to scratch lens or prism surfaces during cleaning operations. Place a protective cover over the theodolite when not in use. When the tripod is set up on muddy ground, leveling is extremely important and should be checked frequently. Anchor tripod legs firmly to avoid slippage which will cause incorrect readings.

CHAPTER 3

OPERATOR/ CREW MAINTENANCE INSTRUCTIONS

Section I. BASIC ISSUE ITEMS LIST AND ITEMS TROOP INSTALLED OR AUTHORIZED LIST

3-1. Basic Issue Items and Troop Installed or Authorized

Tools, equipment and repair parts issued with troop installed or authorized for the theodolite are listed in the basic issue items and items troop installed or authorized list, Appendix C.

Section II. LUBRICATION INSTRUCTIONS

3-2. General

a. This section contains a lubrication chart and instructions which are supplemental to, and not specifically covered in the lubrication chart. Refer to figure 3-1 for the lubrication chart.

b. All moving parts of the theodolite, both smooth and threaded surfaces, are fitted within fine tolerances. For this reason, most parts of the theodolite are cleaned prior to lubrication. Any attempt to lubricate the theodolite without first cleaning it, may result in damage to the instrument. Only those lubricants approved for use on the theodolite will be used. No lubrication will be performed in the field unless specifically called. for.

3-3. Detailed Lubrication Information

a. *Care of Lubricants.* Special care should be taken to see that all instrument lubricants are kept 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 airtight.

b. Lubricants. No lubricants other than those approved for use on the theodolite will be stocked. Approved lubricants are noncorrosive and highly refined and must be free from all paint removing ingredients. The following lubricants are approved for use on this theodolite.

(1) OCW; oil, clock and watch.
(2) GIA; grease, aircraft and instrument.

c. 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 only by qualified personnel. Disassembling the instrument under other conditions, especially where dust might filter 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 apply oil on parts or into assemblies.

LUBRICATION CHART

THEODOLITE, SURVEYING, DIRECTIONAL; 1-MINUTE GRADUATION W/COMPASS AND EXTENSION LEG TRIPOD KEUFFEL & ESSER MODEL K&E/G6-730075 NSN 6675-00-353-4488

Reference: FEDERAL SUPPLY CATALOG C9100-IL

Intervals are based on normal hours of operations. During inactive periods, sufficient lubrication must be performed for adequate preservation.

Clean parts with SOLVENT, dry-cleaning, Federal Specification P-D-680. Dry before lubricating.

Lubricate points indicated by *dotted arrow shafts* on both sides of equipment.

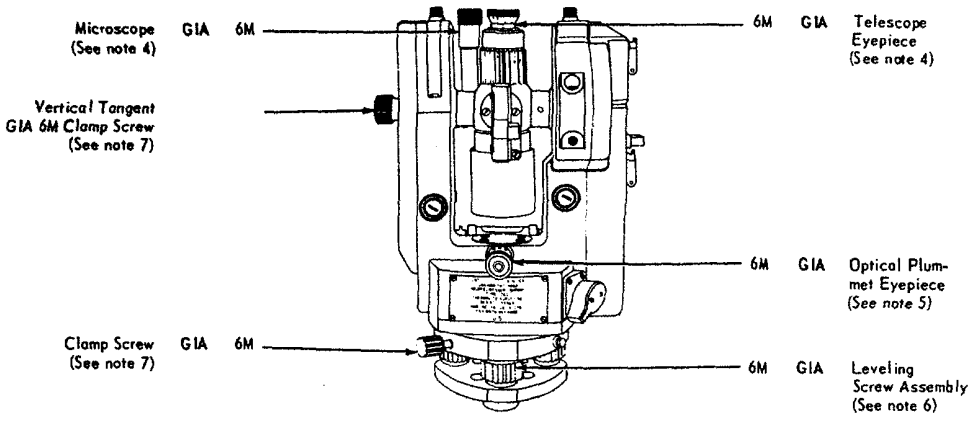
The time specified is the time required to perform all services at the particular interval.

*TOTAL MAN-HR	
INTERVAL 6M	MAN-HR 1.0

FOLD FOLD

LUBRICANT ● INTERVAL

INTERVAL ● LUBRICANT



FRONT VIEW

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LCS-6675-307-14

Figure 3-1. Lubrication chart (Sheet 1 of 2).

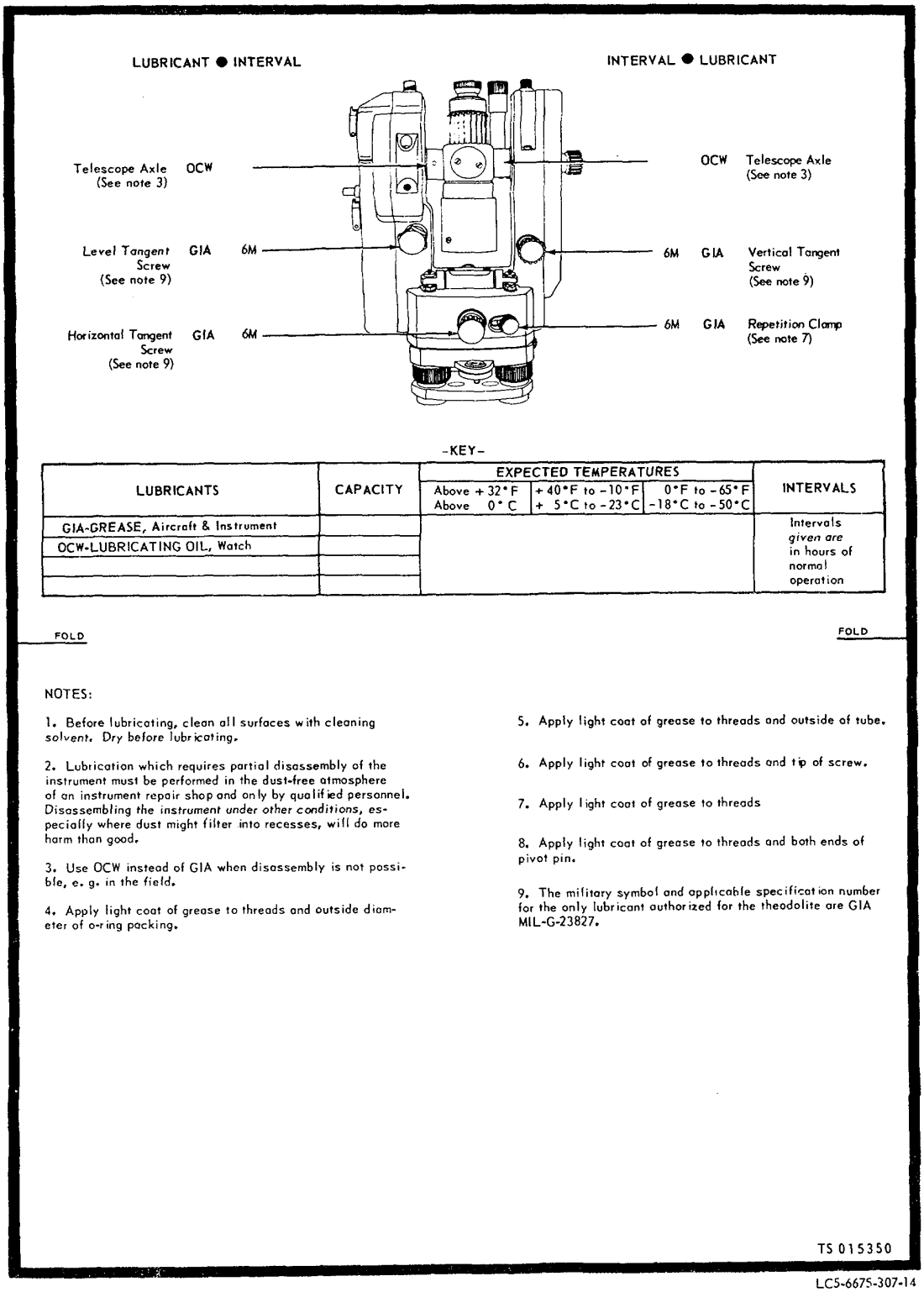

Figure 3-1. Lubrication chart (Sheet 2 of 2).

Section III. PREVENTIVE MAINTENANCE CHECKS AND SERVICES

3-4. 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 checks and services to be performed are listed and described in paragraph 3-5. The 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 noted during operation which would 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.

3-5. Preventive Maintenance Checks and Services This paragraph contains a tabulated listing of operator/crew periodic (daily) preventive maintenance checks and services. The sequence numbers are listed consecutively and indicate the minimum requirements for daily (D) and weekly (W) preventive maintenance, respectively. Refer to table 3-1 for the preventive maintenance checks and services.

Table 3-1. Operator/Crew Preventive Maintenance Checks and Services

D-Daily 0.6 **W-Weekly**
Time required: 0.6 **Time required:**

Interval and sequence no.		Item to be inspected procedure	Work time (M H)
D	W		
1		**CARRYING CASE** Inspect the carrying case for dents, cracks, and breaks. Be sure the instrument fits securely in the base assembly. Inspect to see that the theodolite hood clamps tightly to the ground plate. Check desiccant for proper color.	0.1
2		**THEODOLITE** Inspect the theodolite for broken or missing parts, cracked or scratched lenses and mirrors, loose or missing hardware, and other signs of damage.	0.1
3		**KNAPSACK** Inspect the knapsack for rips or tears, missing straps or buckles.	0.1
4		**TOOL AND ACCESSORY CASE** Inspect the accessory case for rips, tears, defective zipper, and other damage. Be sure all inside pockets are in good condition	0.1
5		**BATTERY CASE** Inspect the battery box for dents, cracks, missing or broken clamps, and other damage.	0.1
6		**TRIPOD** Inspect for missing components and damage.	0.1

Section IV. TROUBLESHOOTING

3-6. Scope
a. This section contains troubleshooting or malfunction information and tests for locating and correcting most of the troubles which may develop in the theodolite. Each malfunction or trouble symptom for an individual component, unit, or system is followed by a list of tests or inspections necessary for you to determine probable causes and suggested corrective actions for you to remedy the malfunction.

b. This manual cannot list all possible malfunctions that may occur or all tests or inspections, and corrective actions. If a malfunction is not listed or is not corrected by listed corrective actions, you should notify higher level maintenance.

c. Table 3-2 lists the common malfunctions that you may find during the operation of the theodolite or its components. You should perform the tests, inspections and corrective actions in the order listed.

NOTE
If you have a malfunction which is not listed in the table. notify the next higher level of maintenance

Table 3-2. Troubleshooting

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
THEODOLITE
1. THEODOLITE WILL NOT SEAT PROPERLY ON TRIPOD HEAD
Step 1. Check alinement of the locking screw. **Restart locking screw.**
Step 2. Check for dirty mating surfaces on the base plate and tribrach assembly. **Clean surfaces.**
'2. THEODOLITE WILL NOT STAY ON LINE
Step 1. Level theodolite, plate bubble fails to center. **Adjust the plate level as follows**: a. **Center circular level bubble using leveling screws.** b. **Position theodolite so that plate level bubble is as close to center as possible.** c. **Correct one-half of plate level bubble error with leveling screws.** d. **Adjust plate level capstan nuts until other half of error is removed.** e. **Turn theodolite 90 degrees and repeat Steps c and d. Continue until bubble remains centered in all positions of the theodolite.**
3. LIGHT ON CIRCLE SCALES UNEQUAL OR ABSENT
Check that illumination mirror is positioned correctly. **Reposition mirror**.

Section V. MAINTENANCE OF THEODOLITE

3-7. General

The only maintenance services authorized for the operator are those which are listed in table 3-1. Any other maintenance procedures are to be determined by organizational maintenance.

CHAPTER 4

ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

SECTION I. SERVICE UPON RECEIPT OF MATERIAL

4-1. Inspecting and Servicing the Equipment
Inspecting and servicing of the theodolite and its accessories is covered in paragraph 2-1.

4-2. Setting Up the Equipment
Instructions for preparing the theodolite and its accessories are given in paragraph 2-2.

SECTION II. MOVEMENT TO A NEW WORKSITE

4-3. Movement to a New Worksite
Refer to paragraph 2-4 for instructions on preparing the theodolite for movement to a new worksite.

4-4. Setting Up After Movement
Refer to paragraph 2-5 for instructions on setting up the theodolite after movement to a new worksite.

SECTION III. REPAIR PARTS, SPECIAL TOOLS, AND EQUIPMENT

4-5. Tools and Equipment
Tools, equipment, and repair parts issued with or authorized for the theodolite are listed in the basic issue items list and items troop installed or authorized list, Appendix C.

4-6. Special Tools
he special tools required to perform organizational maintenance on the theodolite are listed in table 4-1.

References and illustrations indicating the use of these tools are listed in table 4-1. References and illustrations indicating the use of these tools are listed in the table. The five-digit number preceding the stock number or manufacturer's part number is the Federal Supply Code for the manufacturer of tool(s). No special equipment is required by organizational maintenance personnel for performing maintenance on the theodolite.

Table 4-1. Special Tools

Item	NSN or Part No.	Figure Reference	Use
Pin, adjusting: 0.040 in	(33363) * A52130	2-7	Adjust theodolite adjusting screws.
Pin, adjusting: 0.050 in	(33363) * S7865-4	2-7	Adjust theodolite adjusting screws.
Pin, adjusting: 0.0	(33363) * S7865-3	2-7	Adjust theodolite adjusting screws.
Wrench, tangent screw	(33363) * A 51966	2-7	Tighten tangent screw housing.

*Federal Supply Code for the manufacturer.

4-7. Maintenance Repair Parts

Repair parts and equipment are listed and illustrated in the repair parts and special tools list, TM 5-6675-307-24P, covering organizational maintenance for this equipment.

Section IV. LUBRICATION

4-8. Lubrication Instructions

Refer to paragraph 3-2 and figure 3-1 for lubrication instructions.

Section V. PREVENTIVE MAINTENANCE CHECKS AND SERVICES

4-9. 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 checks and services to be performed are listed and described in paragraph 4-10. The 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 noted during operation which would 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.

4-10. Preventive Maintenance Checks and Services

This paragraph contains a tabulated listing of organizational preventive maintenance checks and services. The sequence numbers are listed consecutively and indicate the minimum requirements for daily (D) and weekly (W) preventive maintenance, respectively. Refer to table 4-2 for the preventive maintenance checks and services.

Table 4-2. Organizational Preventive Maintenance Checks and Services

Q-Quarterly
Total man-hours required: .07

Sequence number	ITEM TO BE INSPECTED PROCEDURE	WORK TIME (M H)
1.	**CARRYING CASE** Check straps for wear, tears, and security. Inspect latches for wear and security. Check gasket and inserts for deterioration. Inspect the case for cracks or other damage. Check color of the desiccant	0.1
2.	**THEODOLITE** Check for dirty lenses, mirrors, and window, clean as necessary. Inspect eyepieces and all controls for freedom of movement.	0.1
3.	**KNAPSACK** Inspect buckles and straps for serviceability. Remove dirt and dust. If necessary, clean knapsack with warm water and mild detergent.	0.1
4.	**TOOL AND ACCESSORY CASE** Check for presence and condition of accessories and tools, Refer to (fig. 2-7). Inspect the case for serviceability.	0.1
5.	**BATTERY CASE** Inspect to see that the spare lamps and batteries are in the case. Refer to (fig. 2-12) and install the illumination system and check operation.	0.1
6.	**TRIPOD** Inspect tripod for serviceability. Check to see that tripod wrench, plumb bob, and cord are in the pouch.	0.2

Section VI. TROUBLESHOOTING

4-11. Scope

a. This section contains troubleshooting or malfunction information and tests for locating and correcting most of the troubles which may develop in the theodolite. Each malfunction or troubles symptom for an individual component, unit, or system is followed by a list of tests or inspections necessary for you to determine probable causes and suggested corrective actions for you to remedy the malfunction.

b. This manual cannot list all possible malfunctions that may occur or all tests or inspections, and corrective actions. If a malfunction is not listed, or is not corrected by listed corrective actions, you should notify higher level maintenance.

c. Table 4-3 lists the common malfunctions that you may find during the operation or maintenance of the theodolite or its components. You should perform the test/inspections and corrective actions in the order listed.

NOTE

If you have a malfunction which is not listed in this table, notify the next higher level of maintenance

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
THEODOLITE
1 TRIPOD EXTENSION LEGS WILL NOT LOCK IN POSITION
Loose or defective extension leg wing nuts. **Tighten or replace wing nuts.**
2 THEODOLITE WILL NOT SEAT PROPERLY ON TRIPOD BASE PLATE
Step 1 Locking screw improperly started. **Restart locking screw**.
Step 2 Tribrach or base plate mating surfaces dirty. **Clean surfaces**.
Step 3 Defective tribrach **Replace tribrach.**
3 THEODOLITE WILL NOT STAY ON LINE
Check theodolite level bubbles for level. **Level Theodolite as follows:** *a.* Center circular level bubble with leveling screws. *b.* Unlock pinch clamp and turn alidade so that plate level is parallel to aline joining any two leveling screws and lock pinch clamp. *c.* Turn both leveling screws that are parallel with plate level simultaneously but in opposite direction until plate level bubble is centered. *d.* Unlock pinch clamp, rotate alidade 90 degrees and lock pinch clamp. Adjust third leveling screw until plate level bubble is centered. *e.* Unlock pinch clamp, rotate alidade 180 degrees and lock pinch clamp Adjust same leveling screw as in step d, and remove one-half of any bubble displacement that may exist. Continue this procedure until theodolite is exactly level.
4 PLATE LEVEL BUBBLE WILL NOT STAY CENTERED
Inspect the plate level, the bubble should be in the center. **Adjust plate level bubble as follows**: *a* Center circular level bubble using leveling screws. *b* Position theodolite so that plate level bubble is as close to center as possible. *c* Correct one-half of plate level bubble error with leveling screws. *d* Adjust plate level capstan nuts until other half of error is removed. *e* Turn theodolite 90 degrees and repeat steps c and d Continue until bubble remains centered in all positions of the theodolite.

Section VII. MAINTENANCE

4-12. General

This section contains instructions for the information and guidance of organizational maintenance personnel in maintaining the theodolite.

4-13. Telescope Sunshade

a. General. The sunshade is mounted over the objective end of the telescope to prevent reflections on the lens during bright day operation.

b. Removal. Refer to figure 4-1 and remove telescope sunshade.

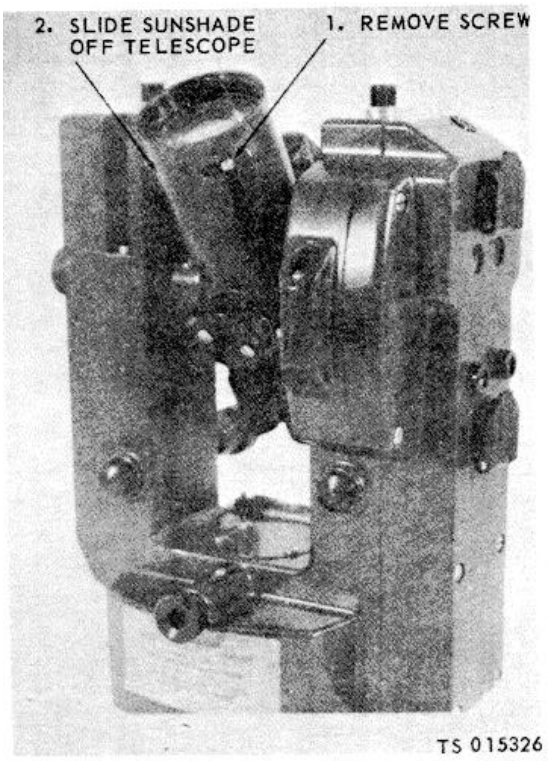

Figure 4-1. Telescope sunshade, removal and installation.

c. Cleaning and Inspection.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100° F. (380° C.) 138° F. (59 C.).

(1) Clean all metal parts with an approved solvent, P-D-680; dry thoroughly.

(2) Inspect the sunshade for damage or distortion.

(3) Inspect the retaining screw for stripped threads or burrs.

4-14. Tribrach

a. General. The tribrach serves as the mounting for the theodolite alidade. The tribrach mounts on the tripod base plate. The tribrach is equipped with leveling screws and a circular level to provide a perfectly level support for the theodolite.

b. Removal. Refer to figure 4-2 and remove the tribrach.

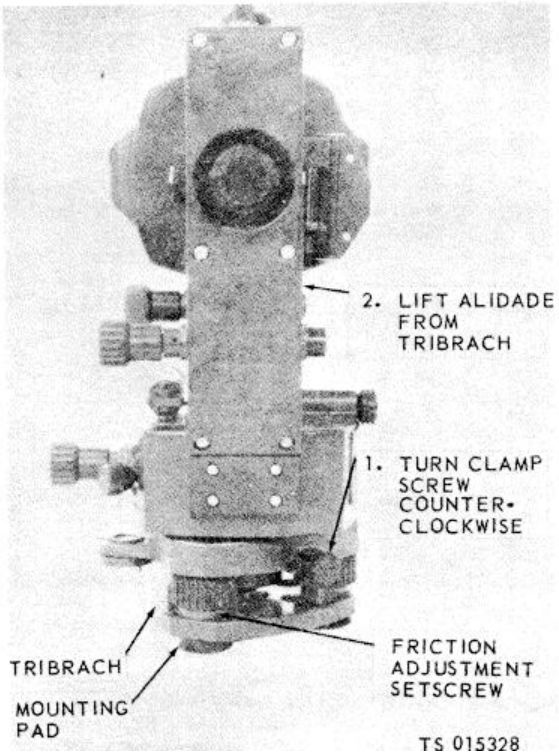

Figure 4-2. Tribrach, removal and installation.

c. Cleaning and Inspection.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100° F. (38° C.) 138° F. (59° C.).

(1) Clean all metal parts with an approved cleaning solvent, P-D-680, and dry thoroughly.

(2) Brush all dirt and dust from tribrach components. Wipe all external surfaces clean with a lint-free cloth.

(3) Inspect the tribrach for damage or distortion.

(4) Inspect the leveling screws for stripped threads or burrs.

Section VIII. TRIPOD ASSEMBLY, PLUMB BOB, AND TRIPOD WRENCH

4-15. General

The tripod assembly is of the extension leg type and consists of the tripod head, tripod leg assemblies and the cover plate. When the theodolite is being used for surveying work and other precision measuring, it is mounted on the tripod head. The plumb bob and tripod wrench are kept in the tripod accessory case mounted on one of the tripod legs. When the plumb bob is installed on the tripod head, the plumb bob makes it possible to center the instrument exactly over the station point. The tripod wrench is used to tighten or loosen the clamping screws, under the tripod head, that hold the tripod legs in position.

a. Disassembly. Refer to figure 4-3 and disassemble the tripod.

b. Removal. Refer to figure 4-4 and remove the tripod head cover.

c. Cleaning and Inspection.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100° F. (38° C.) 138° F. (59° C.).

(1) Clean all metal parts with an approved cleaning solvent, P-D-680, and dry thoroughly. Clean the wooden parts of the tripod with a soft cloth, soap and water, and dry thoroughly. Clean leather parts with saddle soap.

(2) Inspect the tripod head, and cover, shoes, bridge, clamps and battery box bracket for cracks, breaks and wear.

(3) Inspect the strap for cuts, wear and damaged seams.

(4) Inspect the tripod legs for cracks, splits and warping.

(5) Remove all burrs and scratches. Straighten dents and bends. Surfaces that require painting, shall be painted in accordance with MIL-T-704.

NOTE

The instrument contact surfaces of the tripod head and the threaded portion of all screws and fasteners shall not be painted.

(6) Replace all defective parts that cannot b(repaired.

d. Reassembly. Refer to figure 4-3 ant reassemble the tripod.

4-16. Plumb Bob and Tripod Wrench

a. General. Refer to figure 4-3 and disassemble the plumb bob.

b. Cleaning, Inspection and Repair.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100° F. (38° C.) 138 F. (59 C.).

(1) Clean all metal parts with an approved cleaning solvent, P-D-680, and dry thoroughly.

(2) Inspect the bayonet socket, ring, slide, and plumb bob for signs of wear, cracks or breaks. Inspect the lugs on the bayonet socket for burrs.

(3) Remove all burrs and replace damaged or defective parts. Use new cord when reassembling the plumb bob.

c. Reassembly. Refer to figure 4-3 and reassemble the plumb bob.

d. Tripod Wrench.

(1) Removal. Remove the tripod wrench from the holder (fig. 4-3).

(2) Cleaning, Inspection and Repair.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is °F. (38° C.) 138° F.(59° C.).

(*a*) Clean the wrench with an approved cleaning solvent and dry thoroughly.

(*b*) Inspect the wrench for wear, burrs, cracks or breaks. Remove minor burrs from the wrench. Check to see that the wrench engages the bolts on the tripod head in a satisfactory manner.

(*c*) Replace a damaged or defective tripod wrench.

(*d*) When the tripod wrench is not in use, it should be stowed in the accessory case.

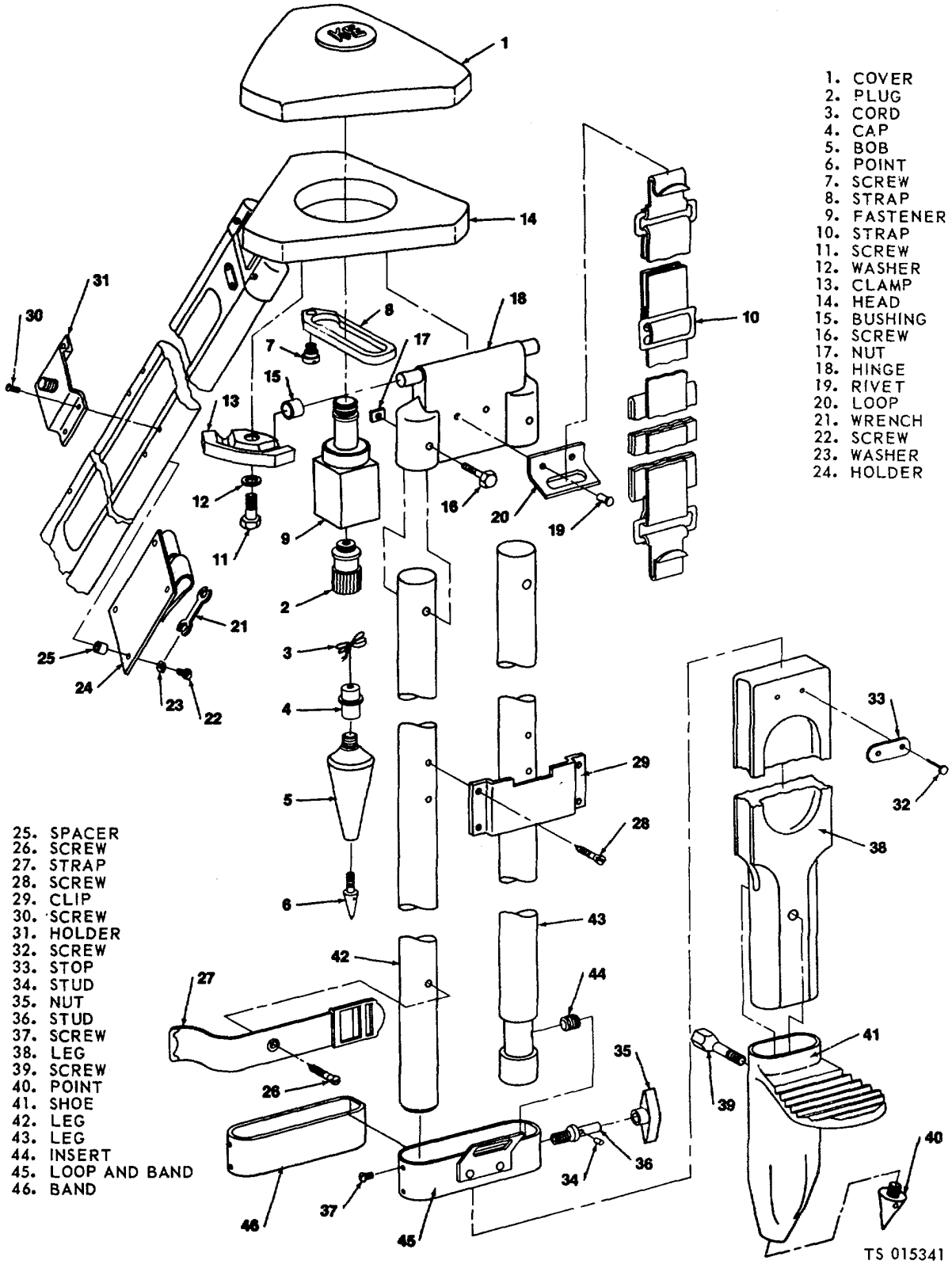

Figure 4-3. Tripod, exploded view.

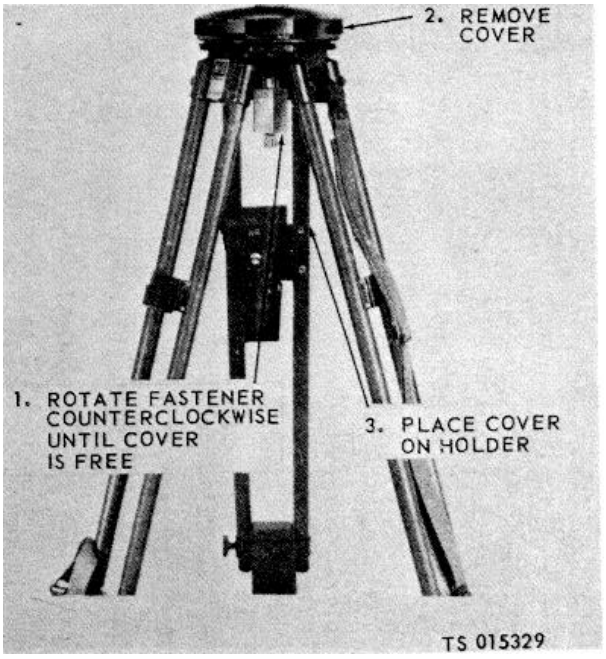

Figure 4-4. Tripod head cover.

Section IX. MAINTENANCE OF CARRYING CASE AND TRANSPORTATION CASE

4-17. Carrying Case

a. General. The carrying case for the theodolite consists primarily of two sections with inserts that serve to cushion the instrument during movement. The case is provided with a gasket which with a desiccant container protects the instrument from moisture while not in use.

b. Carrying Case Desiccant. Open the carrying case and check the color of the circles on the package; they should be blue in color. If the color is pink, it indicates the presence of moisture and the desiccant must be dehydrated or replaced.

c. Carrying Case Inserts.

(1) *Removal.* Refer to figure 4-5 and remove the inserts.

Figure 4-5. Carrying case inserts, removal and installation.

(2) Inspection and replacement.

(a) Inspect the inserts for dirt, deterioration, or damage.

(b) If inserts are dirty, wash them with warm water and mild detergent.

(c) If the inserts are damaged, replace them.

(3) Installation. Install the inserts in the reverse order of removal.

4-18. Transport Case

a. General. The transport case is made of fiberglass and contains inserts which are contoured to fit the exterior of the carrying case and act as cushions during transport or storage. The case is also provided with a gasket for moisture protection of the contents.

b. Insert Removal. Refer to figure 4-7 and remove the inserts.

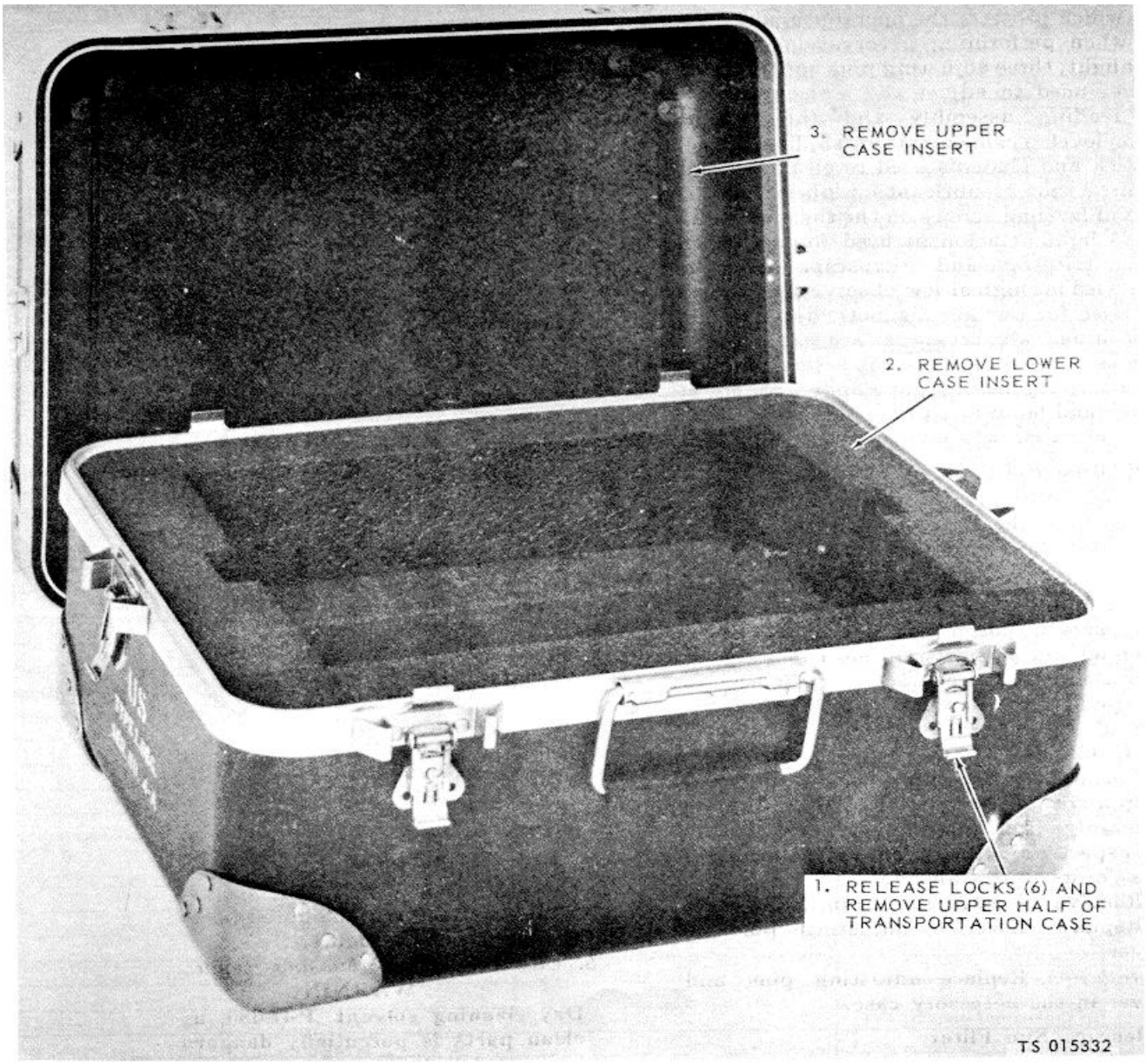

Figure 4-6. Transport case inserts, removal and installation.

c. Insert Inspection and Replacement.

(1) Inspect the inserts for deterioration, dirt, or damage.

(2) If any damage is present, replace the inserts.

d. Insert Installation. Install the inserts in the reverse order of removal.

Section X. MAINTENANCE OF ACCESSORIES

4-19. General

The accessories consist of a plastic cover to protect the theodolite when not in use; a telescope sunglass which protects the operator against eye damage when performing observations against direct sunlight, three adjusting pins and a flat-tip screwdriver used to adjust the horizontal axis; vertical reading assembly and the vertical collimation level; a camels-hair brush, lens tissue, orange stick and chamois used to clean the lens and prisms; a tube of lubricant for lubricating the tangent and leveling screws on the theodolite and tribrach; a light attachment used for night observations; telescope and microscope prismatic eyepieces used for high or low observations; and a compass used for reading magnetic declinations. When not in use, all accessories are stored in the accessory case. In addition to the accessory case, there is a battery case, hand lamp and power cable. The hand lamp and power cable are stored in the battery case when not in use.

4-20. Adjusting Pins and Screwdriver

a. Removal. Remove the adjusting pins and screwdriver from the accessory case.

b. Cleaning, Inspection and Repair.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100° F. (38° C.) 138° F. (59° C.).

(1) Clean adjusting pins and screwdriver with an approved cleaning solvent, P-D-680, and dry thoroughly.

(2) Inspect adjusting pins and screwdriver for bends, nicks, burrs and damage.

(3) Remove all burrs and straighten bends.

(4) Replace defective adjusting pins or screwdriver.

c. Installation. Replace adjusting pins and screwdriver in the accessory case.

4-21. Telescope Sun Filter

a. General. The telescope sunglass is a pushfit on the telescope eyepiece (fig. 2-11).

b. Cleaning and Inspection.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°F. (38°C.) 138° F. (59° C.).

(1) Clean all metal parts with a clean lint free cloth dampened with an approved cleaning solvent.

(2) Dust the lenses and prisms with a brush and wash with alcohol or acetone and dry with lens tissue.

(3) Inspect the lenses and prisms for chips and breaks. Inspect the metal parts for bends, breaks and burrs.

(4) Replace defective prismatic eyepieces.

c. Installation. Install the prismatic eyepieces in the accessory case.

4-23. Dust Brush, Chamois and Plastic Cover

a. General. The dust brush and chamois are used to clean the theodolite. The plastic cover is used to protect the theodolite.

b. Cleaning and Inspection.

(1) Clean the brush and plastic cover with soap and water and dry thoroughly.

(2) Inspect the brush for loose, frayed or broken bristles.

(3) Inspect plastic cover for cracks and rips.

(4) Inspect chamois for rips, frays and dirt.

(5) Replace a defective brush, plastic cover or chamois.

c. Installation. Install the brush, plastic cover and chamois in accessory case.

4-24. Light Attachment

a. General. The light attachment is used for night observation. It is mounted on the vertical circle side of the theodolite.

b. Cleaning, Inspection and Repair.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use

near open flame or excessive heat. Flash point of solvent is 100° F. (38°C.) 138° F. (59°C.).

(1) Clean all metal parts of the light attachment with an approved cleaning solvent, PD-680.

(2) Clean mirror with alcohol or acetone and dry with lens tissue.

(3) Inspect the light attachment for worn or damaged threads, bent or broken parts, scratched or broken mirror, defective lamp bulb, defective lamp cord and loose electrical connections.

(4) Replace all defective parts.

c. Installation. Refer to figure 2-5 and install the light attachment in the accessory case.

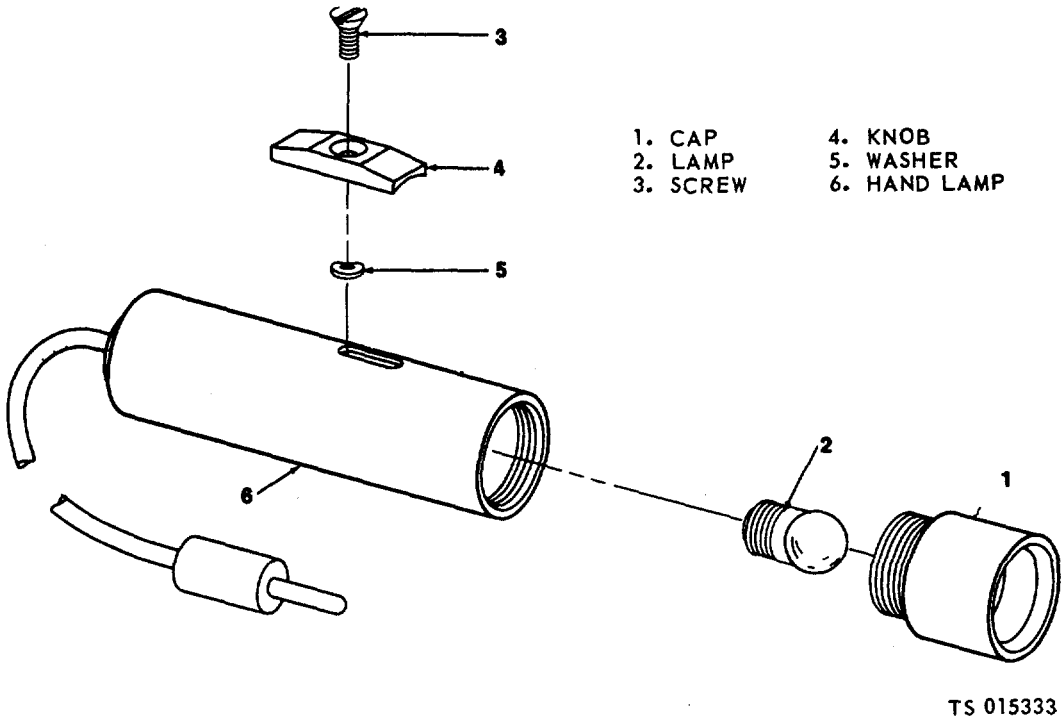

Figure 4-7. Hand lamp, exploded view.

4-25. Compass

a. General. The compass is mounted on the theodolite (fig. 2-12) and is used to determine magnetic declinations.

b. Cleaning and Inspection.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100° F. (38° C.) 138° F. (59° C.).

(1) Clean all metal parts with a clean cloth dampened with an approved cleaning solvent, PD-680.

(2) Clean the lenses, prisms and bezel glass with alcohol or acetone. Use lens tissue and dry thoroughly.

(3) Inspect the lenses, prisms and bezel glass for chips, cracks and fungus etching. Inspect the metal parts for bends, breaks and worn or damaged threads.

(4) Inspect operation of the compass by installing on the theodolite and compare with a known declination.

(5) If the compass is defective, refer to higher level of maintenance.

c. Installation. Refer to figure 2-5 and install the compass in the accessory case.

4-26. Accessory Case

a. General. The accessory case is used to store all of the accessories when not in use (fig. 2-5).

b. Insert Removal. Remove the inserts by lifting out of the case.

c. Cleaning and Inspection.

(1) Brush the accessory case and inserts to remove dust and dirt.

(2) Inspect the accessory case and inserts for damage.

(3) Replace defective accessory case or insert.

4-27. Battery Case

a. General. The battery case is a metal box with a handle that hooks onto the tripod (fig. 2-7).

The case supplies the power for illuminating the theodolite during night or dark day operation.

The case contains a hand lamp, power cable, four spare lamps and space for four size D flashlight batteries.

A rheostat is provided to control the degree of brilliance.

A pocket is provided on the knapsack for carrying the battery case when not in use.

b. Removal. Remove the hand lamp, batteries, spare lamps and power cable from the battery case.

c. Cleaning and Inspection.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100° F. (38° C.) 138° F. (59° C.).

(1) Clean all metal parts with a cloth dampened with an approved cleaning solvent, PD-680. Remove all corrosion from terminals and contacts. Clean dirt and foreign matter from lamp trunk, springs, washers and rheostat.

(2) Inspect the cables, contacts and terminals for damage.

(3) Inspect the lamp trunk for damage. Check the rheostat for proper operation and damage.

(4) Inspect the battery box for damage. Replace all defective parts that cannot be repaired. If repair or replacement is beyond your capability or responsibility, refer to next higher level maintenance.

d. Reassembly. Refer to figure 2-6 and reassemble the components in the battery case.

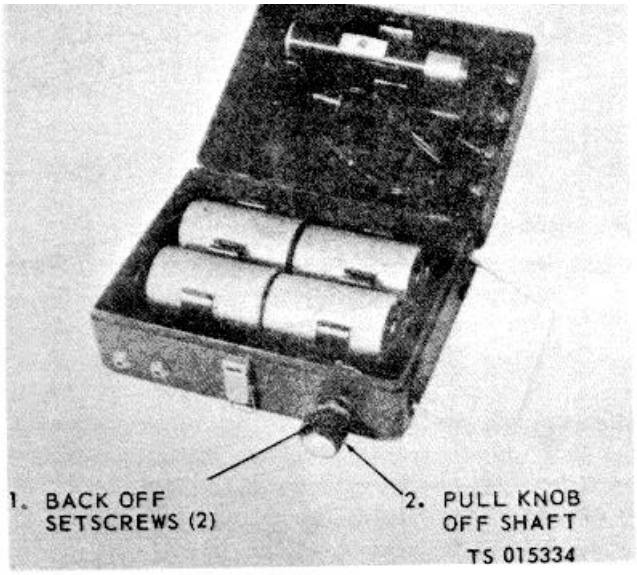

Figure 4-8. Battery case, rheostat knob, removal and installation.

CHAPTER 5

DIRECT SUPPORT AND GENERAL SUPPORT

MAINTENANCE INSTRUCTIONS

Section I. REPAIR PARTS, SPECIAL TOOLS AND EQUIPMENT

5-1. Tools and Equipment

Tools, equipment, and repair parts issued with or authorized for the theodolite are listed in the basic issue items list and items troop installed or authorized list, Appendix C.

5-2. Special Tools

The special tools required to perform direct support and general support maintenance on the theodolite are listed in table 5-1. References and illustrations indicating the use of these tools are listed in the table. The five-digit number preceding the stock number or manufacturer's Part number is the Federal Supply Code for the manufacturer of tool(s). No special equipment is required by direct support and general support maintenance personnel for performing maintenance on the theodolite.

Table 5-1. Special Tools

Item	NSN or Part No	Figure Reference	Use
Pin, adjusting: 0.040 in dia.	133363) * A52130	2-7	Adjust theodolite adjusting screws.
Pin, adjusting: 0.050 in dia.	(33363) * S7865-4	2-7	Adjust theodolite adjusting screws.
Pin, adjusting:	(33363) * S7865-3	2-7	Adjust theodolite adjusting screws.
Wrench, tangent screw	(33363) * A51966	2-7	Tighten tangent screw housing.

* Federal Supply Code for the manufacturer

5-3. Maintenance Repair Parts

Repair parts and equipment are listed and illustrated in the repair parts and special tools list, TM 5-6675-307-24P, covering direct and general support maintenance for this equipment.

Section II. TROUBLESHOOTING

5-4. Scope

a. This section contains troubleshooting or malfunction information and tests for locating and correcting most of the troubles which may develop in the theodolite. Each malfunction or trouble symptom for an individual component, unit, or system is followed by a list of test or inspections necessary for you to determine probable causes and suggested corrective actions for you to remedy the malfunction.

b. This manual cannot list all possible malfunctions that may occur or all test or inspections, and corrective actions. If a malfunction is not listed, or is not corrected by listed corrective actions, you should notify higher level maintenance.

c. Table 5-2 lists the common malfunctions that you may find during the operation or maintenance of the theodolite or its components. You should perform the tests/inspections and corrective actions in the order listed.

NOTE

If you have a malfunction which is not listed in this table, notify the next higher level of maintenance.

Table 5-2. Troubleshooting

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION
TRIPOD AND THEODOLITE

1. TRIPOD LEGS WILL NOT LOCK IN POSITION
Inspect to see if leg clamping screws are loose.
Tighten or replace screws.

2. THEODOLITE WILL NOT SEAT PROPERLY ON TRIPOD HEAD
Step 1. Check alignment of the central fixing screw.
Restart central fixing screw.
Step 2. Inspect tribrach assembly for defects
Repair or replace defective tribrach (para 6-3).

3. FOOTSCREWS TOO TIGHT OR TOO LOOSE
Check for footscrews out of adjustment.
Adjust footscrews.

4. CIRCULAR LEVEL BUBBLE DOES NOT STAY IN CENTER OF CIRCLE
Step 1. Check for circular level out of adjustment.
Adjust circular level (fig. 5-1).
Step 2. Check for circular level defects.
Repair or replace circular level.

NOTE: VIEW SHOWN IS LOOKING DOWN ON CIRCULAR LEVEL

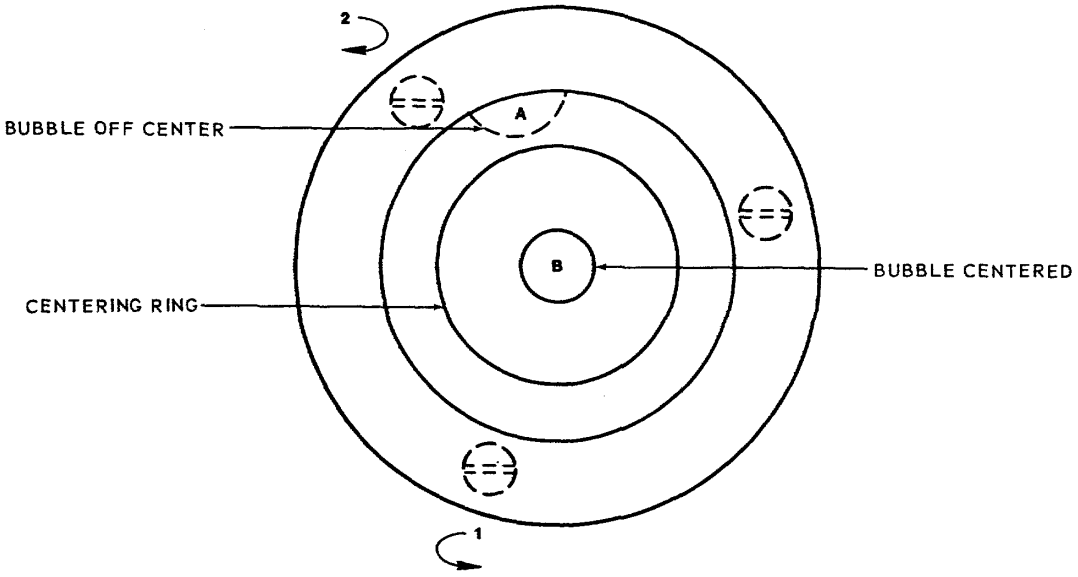

Figure 5-1. Circular level adjustment.

Table 5-2. Troubleshooting-Continued

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

5. THEODOLITE WILL NOT TRAVEL VERTICALLY ON LINE

Step 1. Check theodolite for level.
Level theodolite.
a. Position theodolite on tripod head and secure with central fixing screw.
b. Center circular level using leveling screws.

Step 2. Check for plate level or altitude level out of adjustment.
a. Adjust plate level as follows:
(1) Center circular level bubble using leveling screws.
(2) Position theodolite so that plate level bubble is as close to center as possible.
(3) Correct one-half of plate level bubble error with leveling screws.
(4) Adjust plate level capstan nuts until other half of error is removed.
(5) Turn theodolite 90 degrees and repeat Steps 3 and 4. Continue until bubble remains centered in all positions of the theodolite.
b. Adjust altitude level as follows:
(1) Carefully level the theodolite and center altitude level with vertical tangent screw.
(2) With telescope direct, aim on a clearly defined target and record elevation angle.
(3) Transit telescope on its elevation axis, recheck centering of the altitude level bubble, and point on same target. Record the elevation angle.
(4) The sum of the angles obtained in Steps 2 and 3 above should equal 360 + 0.1 minute.
(5) If deviation is more than 0.1 minute, perform the following adjustments:
(a) Divide the deviation obtained in b (2) and (3) by 2. This is the correction factor.
(b) Remove access screw and position bubble adjusting screw as follows:
1. If reading obtained in b (2) and (3) was more than 360 degrees and 0.1 minute. subtract correction factor from vertical circle reading scale.
2. If reading obtained in b (2) and (3) was less than 359 degrees and 59.9 minutes, add correction factor to the vertical circle reading scale.
(c) After adjusting, repeat test and replace access screw.

Step 3. Check for reticle out of adjustment.
Adjust reticle as follows:
a. Level theodolite, reverse telescope and aim at a well-defined point at least 330 feet away.
b. Transit telescope on its vertical axis and note point that appears on vertical cross line at about same elevation and distance as first point.
c. Turn theodolite horizontally and aim at original point.
d. Transit telescope on its vertical axis. Vertical cross line should fall on second point. If it does not. proceed as follows:
(1) Without changing position of theodolite after test, back off dust ring to expose four capstan head reticle adjusting screws. Adjust screws until reticle vertical cross line moves one quarter of the distance toward point observed.
(2) After obtaining proper distance, replace dust cap and repeat Steps a thru d.

6. TELESCOPE COINCIDENCE LEVEL OUT OF LEVEL

Inspect to see if coincidence level is out of level.
Adjust coincidence (telescope) level as follows:
a. Carefully level the level with the vertical tangent screw.
b. Rotate the theodolite 180 degrees.
c. Correct one-half of coincidence level bubble with vertical tangent screw.
d. Adjust adjusting screws until other half of error is removed.
e. Rotate the theodolite 180 degrees and repeat Steps a, b, c and d. Continue until bubble remains centered in all positions of theodolite.

7. COMPASS WILL NOT OPERATE PROPERLY

Step 1. Check for compass not seating properly on compass bridge.
Replace compass.

Step 2. Check for compass reference mark not clearly visible or out of focus.
Clean reading prisms.

Step 3. Check if compass circle will not balance or rotate freely.
Replace compass pivot (para 5-15).

Section III. GENERAL MAINTENANCE

5-5. General

a. This section provides general cleaning, inspection and repair instructions that are common to components of the theodolite.

b. Special cleaning, inspection and repair instructions applicable to any individual component is covered with the component in the applicable sections of the manual.

5-6. General Disassembly Instructions

a. Do not touch the surfaces of any lenses, prisms, mirrors, or other optical elements.

b. Disassemble the equipment only to the extent necessary to effect repair.

c. Keep groups of related parts together in a tray, to prevent their being lost.

5-7. General Cleaning Instructions

WARNING

Dry cleaning solvent, P-D-680, used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100 °F. (38° C.) 138 F. (59 °C.).

Use a soft, clean, lint-free cloth to wipe nonoptical parts. Use an approved solvent for cleaning. Lenses, mirrors, prisms, and other optical elements should be cleaned with the optical brush and wiped with lens tissue. For stubborn spots, clean optical parts with alcohol or acetone. As an alternative, lens can be breathed on and wiped with lens tissue. Use care to avoid touching the surfaces of optical components.

5-8. General Inspection Instructions

a. General. The importance of carefully inspecting disassembled parts cannot be over emphasized since reassembly of substandard or defective parts can result in needless troubleshooting and rework.

b. Shop Practice. Good shop practice includes keeping complete and accurate inspection records as specified in TM 38-750. Such records not only expedite reworking the equipment but ensure a complete and thorough repair. Inspection records should be based upon the requirements outlined in this paragraph. Parts requiring repair or replacement should be tagged and a notation of the disposition of these parts should be entered in the inspection records.

c. Metallic Parts. The following procedures should be followed when inspecting metal parts.

(1) Burrs. Inspect gear teeth, retaining ring grooves, and mating surfaces for burrs.

(2) Nicks and scratches. Inspect mating and polished surfaces for nicks and scratches.

(3) Parts with external threads. Inspect thread parts for damage. If threads are damaged, reject the part.

(4) Threaded holes. Inspect threaded holes for damaged threads and obstructions which may be wedged in the bottom.

(5) Springs. Inspect springs for distortion and cracks.

5-9. Repair

a. Corrosion. Corrosion on non-mating surfaces may be removed with crocus cloth. After repair, remove any deposits by cleaning as specified in paragraph 5-7.

b. Painted surfaces. Damaged painted surfaces should be repainted as soon as possible to prevent corrosion.

c. Canvas. All canvas parts should be repaired in accordance with TM 10-269.

5-10. Assembly

Step-by-step procedures for assembly of the theodolite and its accessories are provided in Chapter 6.

5-11. Lubrication

Specific instructions for lubrication of parts during assembly are given in Chapter 6.

Section IV. REMOVAL AND INSTALLATION OF MAJOR COMPONENETS

5-12. Telescope (Coincidence) Level Assembly

a. Removal. Refer to figure 5-2 and remove the telescope level assembly.

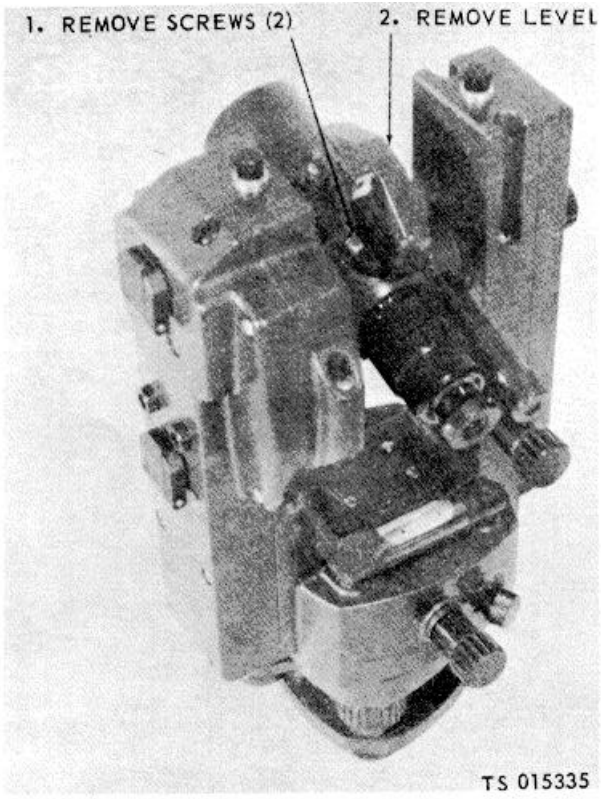

Figure 5-2. Telescope level, removal and installation.

b. Inspection and Repair.

(1) Check vial and prisms for cracks, etching and defective bubble.

(2) Check metal parts for distortion, cracks, or other damage.

(3) If any damage is present, refer to paragraph 6-2 for repair instructions.

c. Installation. Install level assembly in reverse order of removal.

5-13. Optical Plummet Eyepiece

a. Removal. Refer to figure 5-3 and remove optical plummet eyepiece.

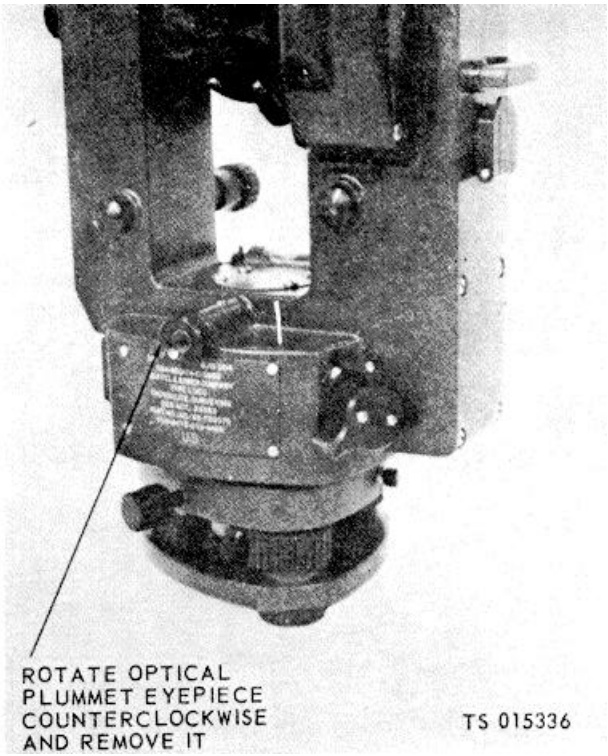

Figure 5-3. Optical plummet eyepiece, removal and installation.

b. Cleaning and Inspection.

(1) Carefully clean non-optical portion of eyepiece with clean, dry, lint-free cloth.

(2) Remove dust or dirt from lenses with optical brush or lens tissue.

(3) Inspect non-optical part for worn or damaged threads, cracks, or distortion.

(4) Check lens for chips, scratches, and etching.

(5) If any damage exists, replace eyepiece.

c. Installation.

(1) Apply light coating of grease, Spec. MIL-G-10924 on threads.

(2) Install eyepiece in reverse order of removal.

5-14. Plate Level

a. Removal. Refer to figure 5-4 and remove plate level.

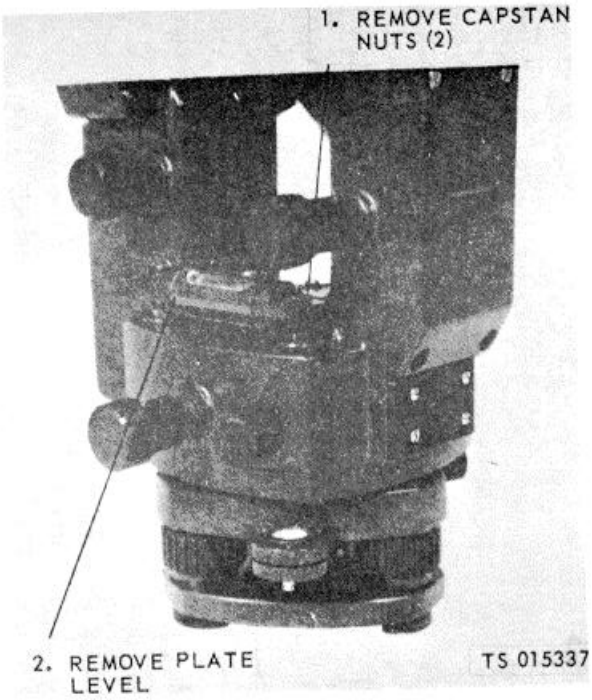

Figure 5-4. Plate level, removal and installation.

b. Inspection.

(1) Inspect vial for cracks, scratches, etching and defective bubble.

(2) Check metal portion for cracks and distortion.

(3) Replace level if any damage exists.

c. Installation. Install plate level in reverse order of removal.

5-15. Compass Holder (Pivot) Assembly, Removal and Installation

a. General. The compass holder (pivot) assembly serves as the pivot for the compass needle. The pivot has a very precisely machined point and must be handled with care. Be sure that no dirt or moisture enters the compass during replacement. Spare holders are contained in the tool and accessory case.

b. Removal. Refer to figure 5-5 and remove holder assembly.

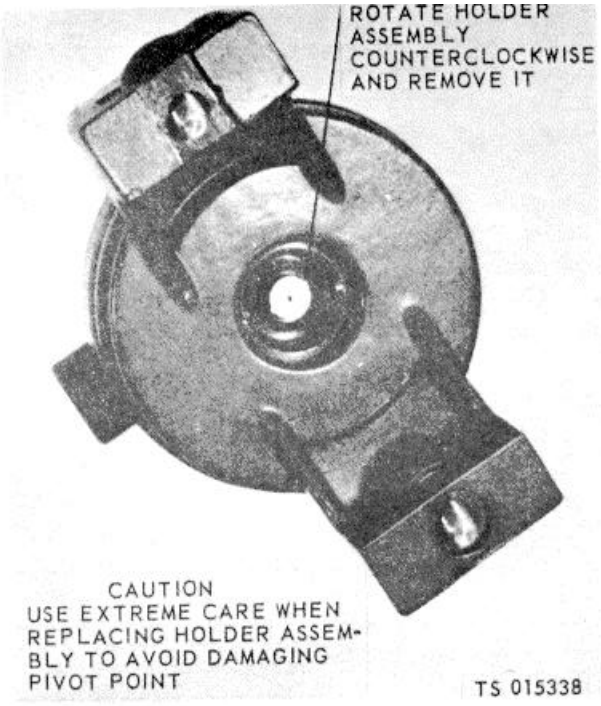

Figure 5-5. Compass holder (pivot) assembly, removal and installation.

c. Inspection.

(1) Inspect pivot for distortion and condition of tip.

(2) Check condition of threads.

d. Replacement. If any damage is noted, replace holder assembly.

e. Installation. Install holder assembly in reverse order of removal.

CHAPTER 6

REPAIR INSTRUCTIONS

Section I. REPAIR OF THEODOLITE

6-1. General

This section contains direct support and general support maintenance instructions for the theodolite and its components. Repair instructions for the tripod, cases and the accessories are given in Chapter 7.

6-2. Telescope (Coincidence) Level Assembly

a. General. The telescope coincidence level assembly is mounted on the top of the telescope. A prism on the left of the assembly permits viewing of the bubble from the eyepiece end of the telescope. The level indicates when the telescope line-of-sight is horizontal.

b. Removal. Refer to figure 5-1 and remove the level.

c. Disassembly. Disassemble the level in the order of the index numbers in figure 6-1.

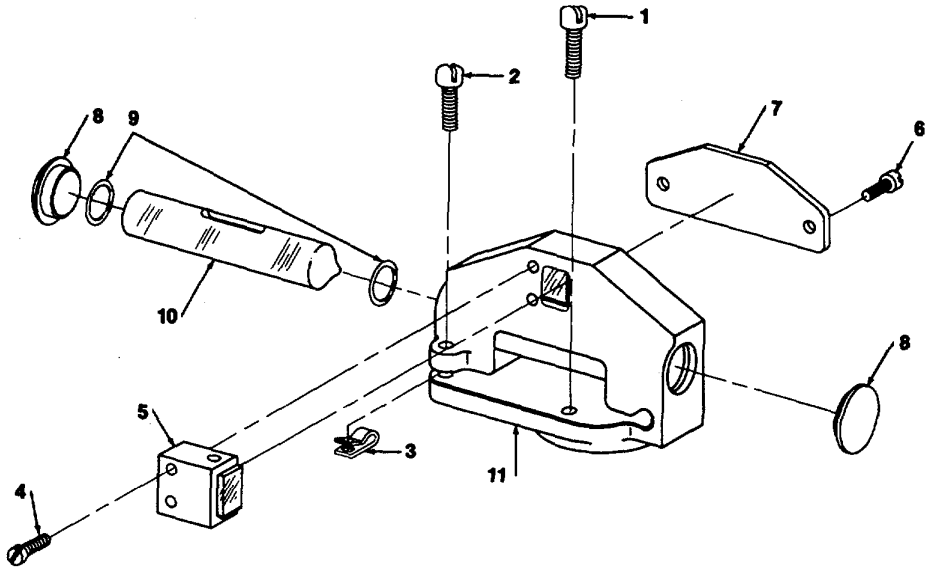

Figure 6-1. Telescope coincidence level, exploded view.

d. Cleaning.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash coincidence level, exploded view. point of solvent is 100° F. (38° C.) 138° F. (59° C.).

(1) Clean optical parts with lens tissue.

(2) Clean all metal parts thoroughly with cleaning solvent, Federal Specification P-D-680, and dry thoroughly.

e. Inspection and Repair.

(1) Inspect vial for cracks, scratches, etching and defective bubble.

(2) Check all metal parts for cracks, distortion and burrs.

(3) Remove any burrs. Replace any defective part.

f. Reassembly. Reassemble level in reverse order of disassembly.

g. Installation. Install plate level in reverse order of removal.

6-3. Tribrach Assembly

a. General. The tribrach assembly serves as the mount for the theodolite alidade. The tribrach in turn mounts on the tripod base plate. The tribrach is equipped with leveling screws and a circular level to provide a level support for the theodolite. The tribrach is secured to the theodolite by a clamp screw.

b. Removal. Refer to figure 4-3 and remove tribrach assembly.

c. Disassembly. Disassemble tribrach assembly in the order of the index numbers in figure 6-2.

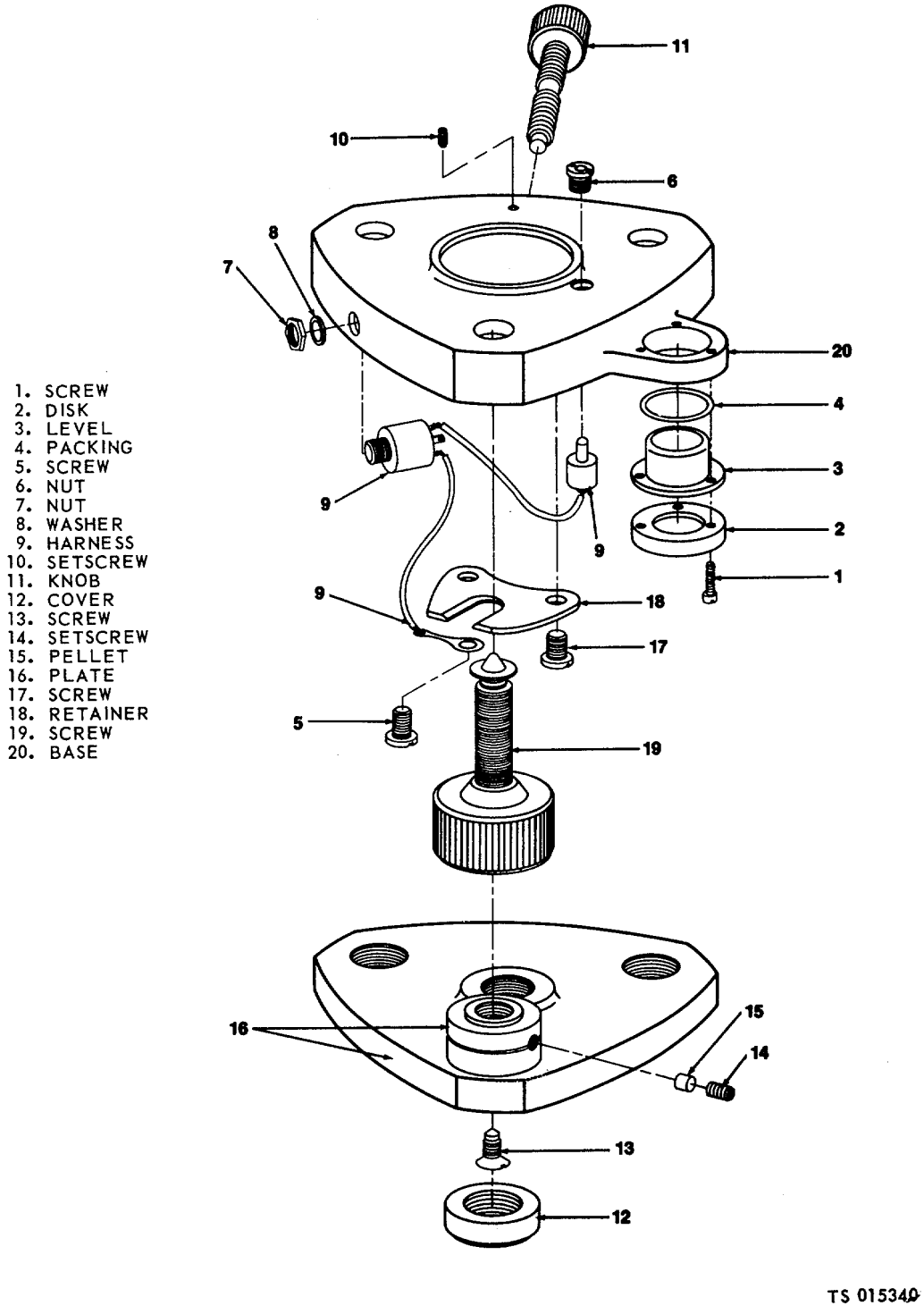

Figure 6-2. Tribrach, exploded view.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100° F. (38° C.) 138° F. (59° C.).

d. Cleaning. Clean all parts with a cleaning solvent, Federal Specification P-D-680, and dry thoroughly.

e. Inspection.

(1) Check all parts for distortion, cracks, burrs, and condition of threads.

(2) Inspect circular level glass for cracks, chips, and scratches.

f. Repair. Replace any defective part.

g. Reassembly.

(1) Apply light coating of grease to threads and tip of adjusting screws (17, fig. 6-2), threads of knob (9), and slot of retainer (16).

(2) Reassemble tribrach in reverse order of disassembly.

h. Installation. Install tribrach in reverse order of removal.

CHAPTER 7
MAINTENANCE OF MATERIAL USED IN CONJUNCTION WITH THE THEODOLITE

7-1. General

This chapter contains the direct and general support maintenance instructions for the tripod, carrying case, and the theodolite accessories as directed by the maintenance allocation chart. Maintenance instructions for the theodolite and its components are given in Chapter 6.

Section I. MAINTENANCE OF TRIPOD

7-2. Tripod

a. General. The tripod consists basically of three adjustable wooden legs on which a base plate is mounted to serve as the support for the theodolite. The base plate is protected by a removable plastic cap and a pouch is attached to one leg. The pouch contains the clamping nut wrench, plumb bob, and cord.

b. Disassembly. Disassemble the tripod in the order of the index numbers in figure 7-1.

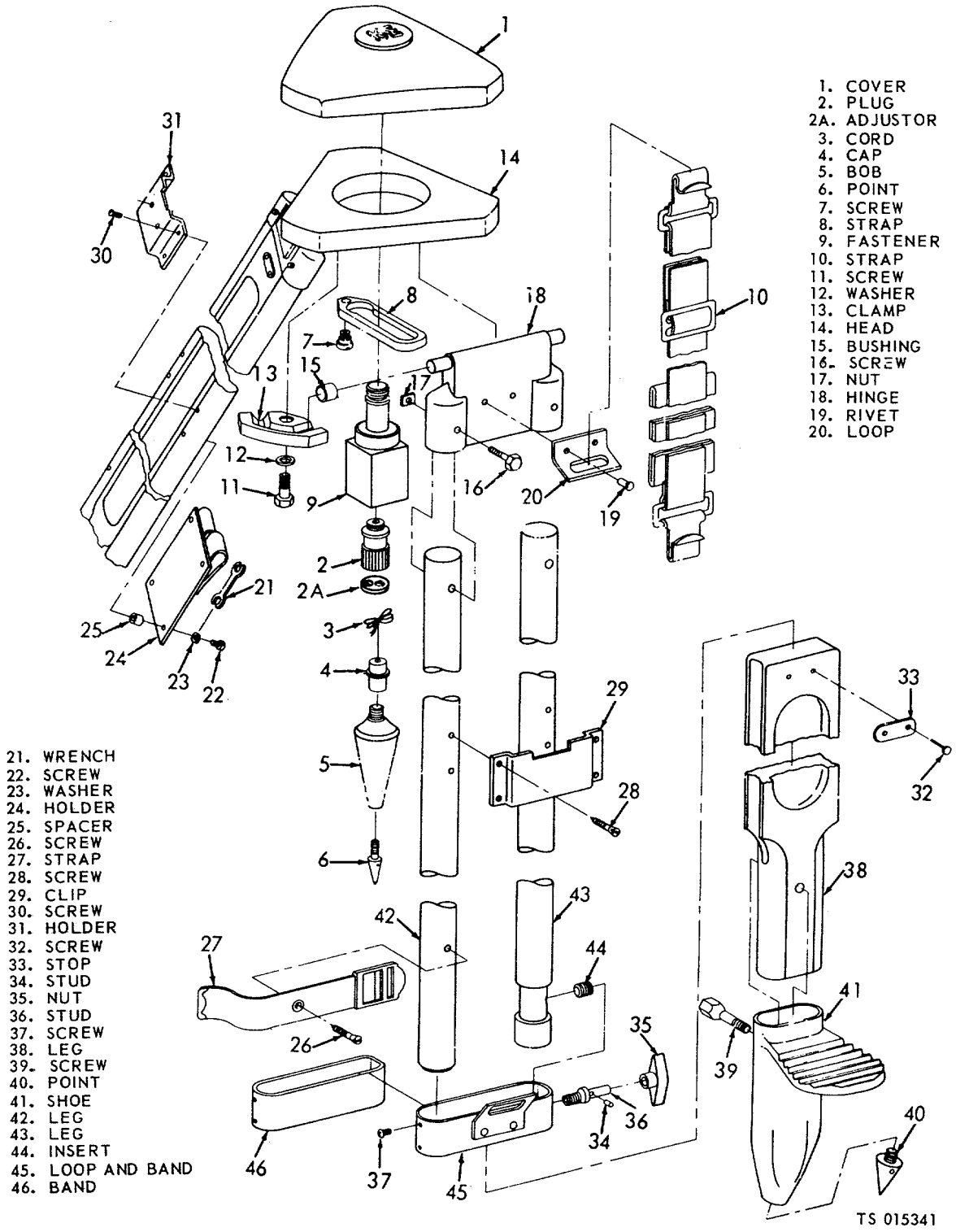

Figure 7-1. Tripod, exploded view.

c. Inspection and Repair.

(1) Inspect straps for cuts, wear, and damaged seams.

(2) Check wooden legs for cracks, splits, wear and warping.

(3) Paint wooden legs if protective coating is worn or damaged.

(4) Replace any defective part that cannot be repaired as given above.

d. Reassembly.

(1) Apply light coating of grease, Specification MIL-G-10924 to upper threads of screw (9, fig. 7-1), surface of pins on hinges (18), inside and outside of bushing (15) and threads of wing nuts (36).

(2) Reassemble tripod in the reverse order of disassembly .

Section II. MAINTENANCE OF CARRYING AND TRANSPORT CASES

7-3. Carrying Case

a. General. The carrying case consists of two halves which contain inserts which serve to cushion the theodolite during transport or storage. The halves are held together by latches which are secured to the case by stainless steel rivets. A gasket is provided which with desiccant, protects the instrument from moisture.

b. Disassembly. Disassemble carrying case in the order of the index numbers in figure 7-2.

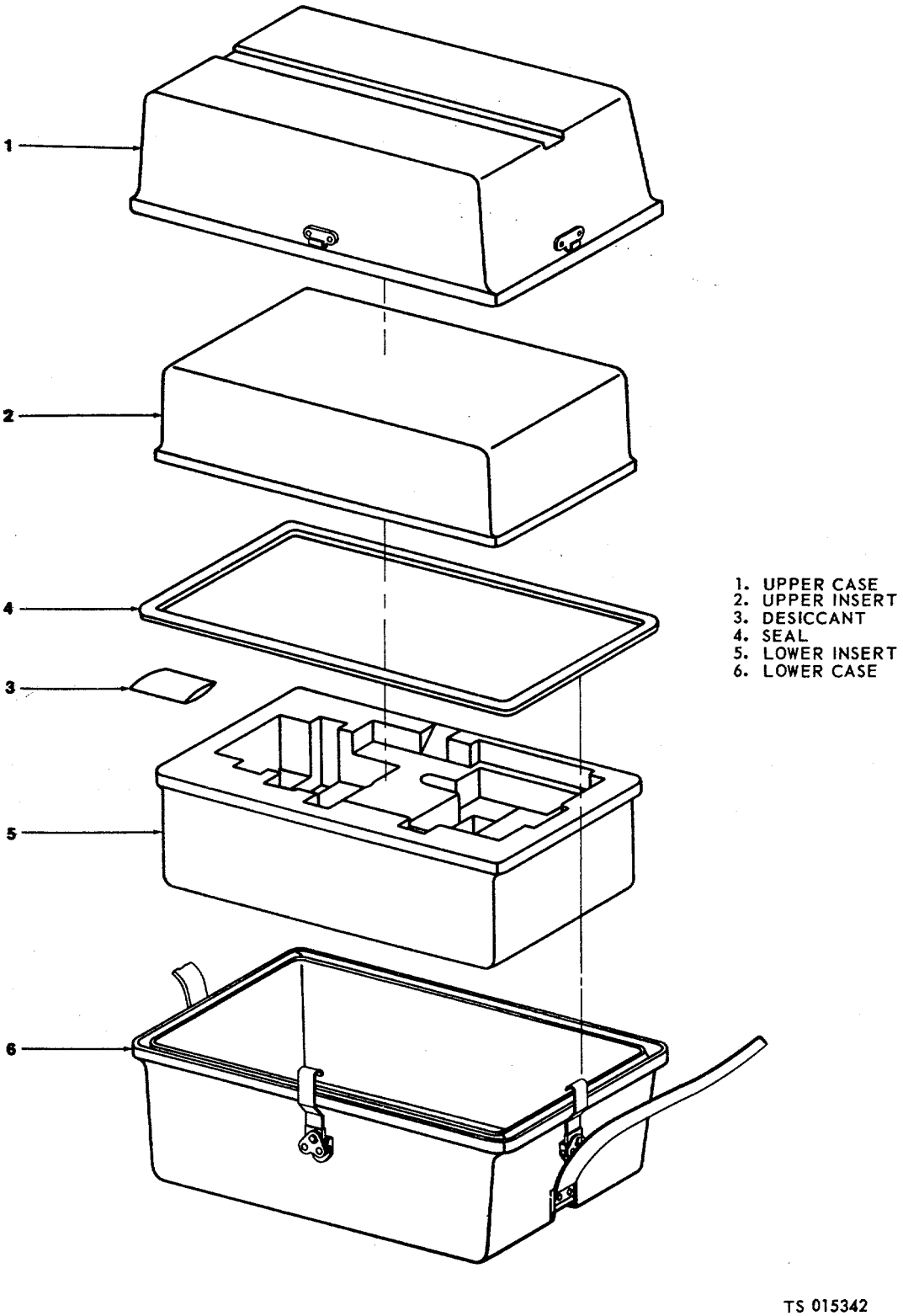

Figure 7-2. Carrying case, exploded view.

c. Inspection.

(1) Inspect gaskets and inserts for deterioration or other damage.

(2) Check carrying strap for wear, tears, and condition of seams.

(3) Check case for cracks or other damage.

(4) Replace any damaged part.

d. Reassembly.

(1) Apply light coat of grease, Specification MIL-G-10924, to pivot parts of tips of latch (15, fig. 7-2)

(2) Reassemble case in reverse order of disassembly.

7-4. Transport Case

a. General. The transport case consists of two halves containing inserts which serve as a cushion for the carrying case during shipment or storage. The two halves of the case are held together by locks which are secured to the case by stainless steel rivets.

b. Disassembly. Disassemble transport case in the order of the index numbers in figure 7-3.

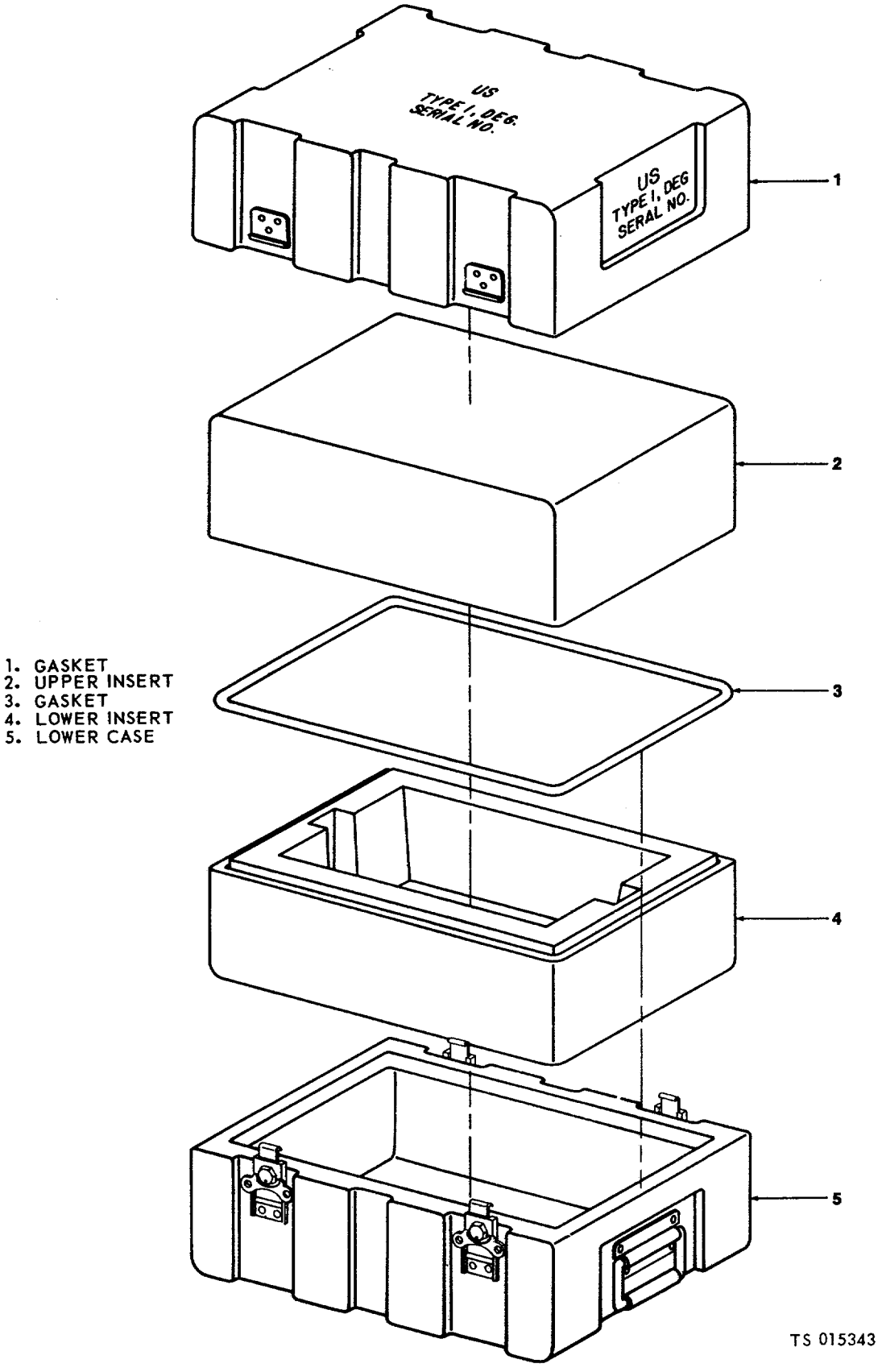

Figure 7-3. Transport case, exploded view.

c. Inspection.

(1) Inspect gasket and inserts for deterioration or other damage.

(2) Check locks and handles for security and damage.

(3) Replace any damaged parts.

d. Reassembly.

(1) Apply light coat of grease, Specification MIL-G-10924, to pivot parts of lock.

(2) Reassemble transport case in reverse order of disassembly.

Section III. MAINTENANCE OF THEODOLITE ACCESSORIES

7-5. Light Attachment

a. General. The light attachment provides illumination for the theodolite altitude and plate level bubbles and circles during night or dark day operation. The light attachment mounts on the left cover assembly of the theodolite by means of two plugs which fit into jacks on the cover. A fiber optics light guide transmits light from the light attachment to the plate level bubble. Power for the light attachment is supplied by the battery case.

b. Disassembly. Disassemble the light attachment in the order of the index numbers in figure 7-4.

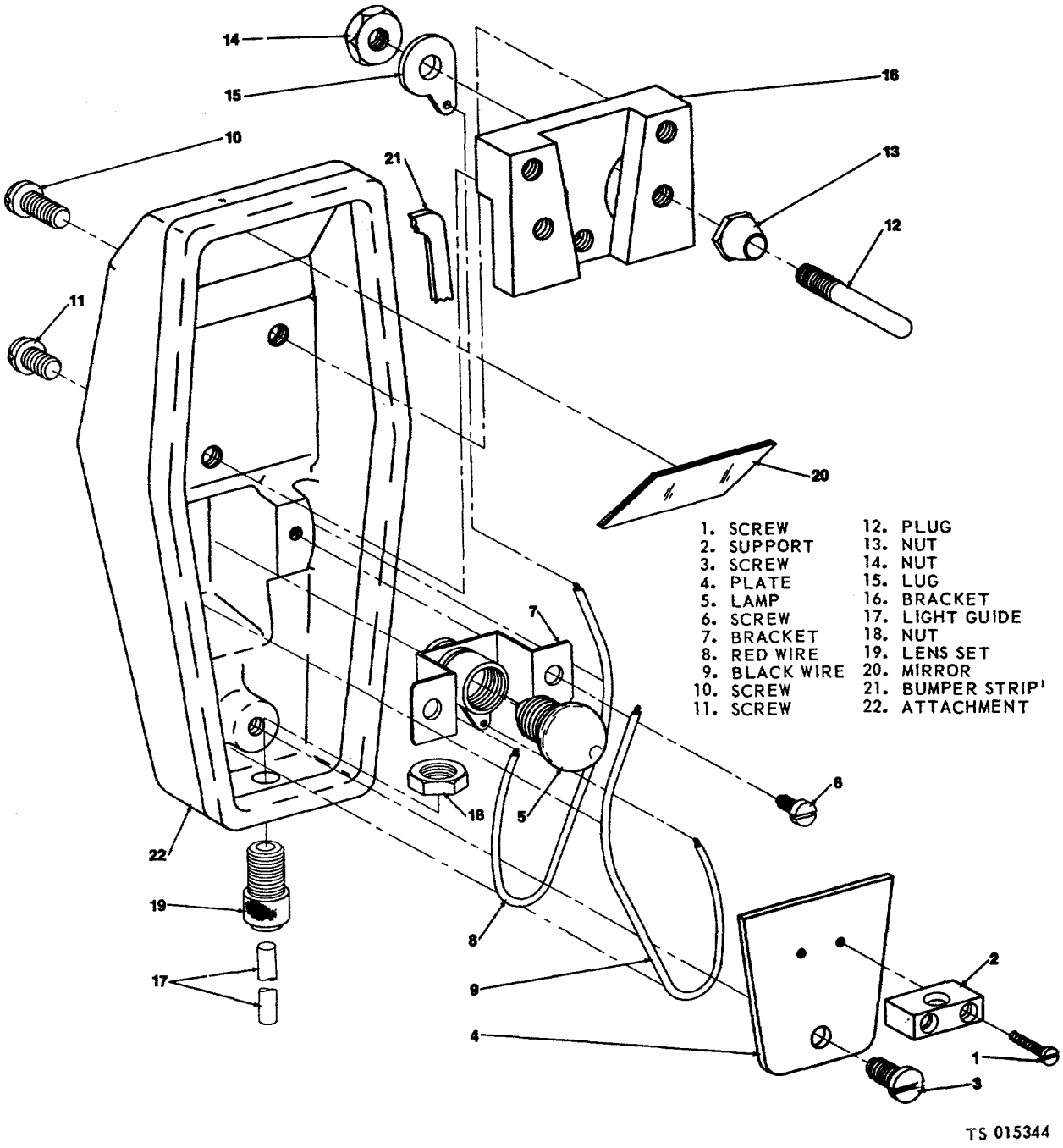

Figure 7-4. Light attachment, exploded view.

c. Inspection.

(1) Check all parts for distortion, cracks and burrs.

(2) Check electrical terminals for corrosion and loose contacts.

(3) Check mirror for chips, cracks, scratches and etching.

d. Repair.

(1) Tighten any loose electrical connections and wipe off corrosion.

(2) Replace any part that is damaged.

e. Reassembly. Reassemble the light attachment in the reverse order of disassembly.

7-6. Battery Case

a. General. The battery case contains the hand lamp, four batteries, the battery case to theodolite power cable, four spare lamps, and a rheostat. The case has a handle which loops over a clip on the tripod. The case serves as the power supply for the illumination system.

b. Disassembly. Disassemble battery case in the order of the index numbers in figure 7-5.

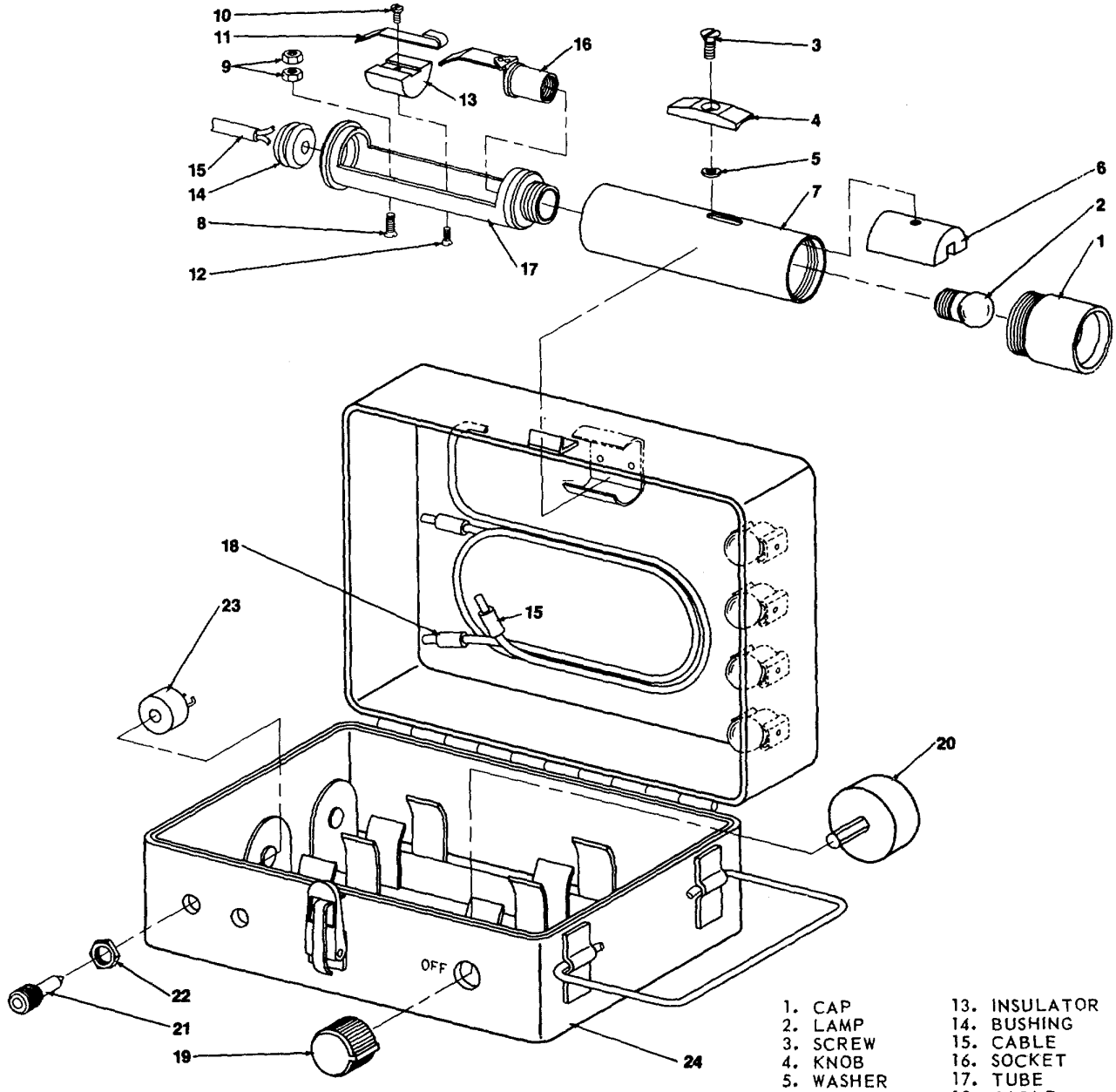

Figure 7-5. Battery case, exploded view.

c. Cleaning.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100 °F. (38° C.) 138° F. (59° C.).

(1) Clean all metal and plastic parts with cleaning solvent, Federal Specification P-D-680.

(2) Wipe any corrosion from terminals.

d. Inspection and Repair.

(1) Inspect wiring, cables, plugs, and jacks for damage, corrosion, and broken wires. If it is necessary to replace wiring, a schematic diagram of the case is given in figure 7-6.

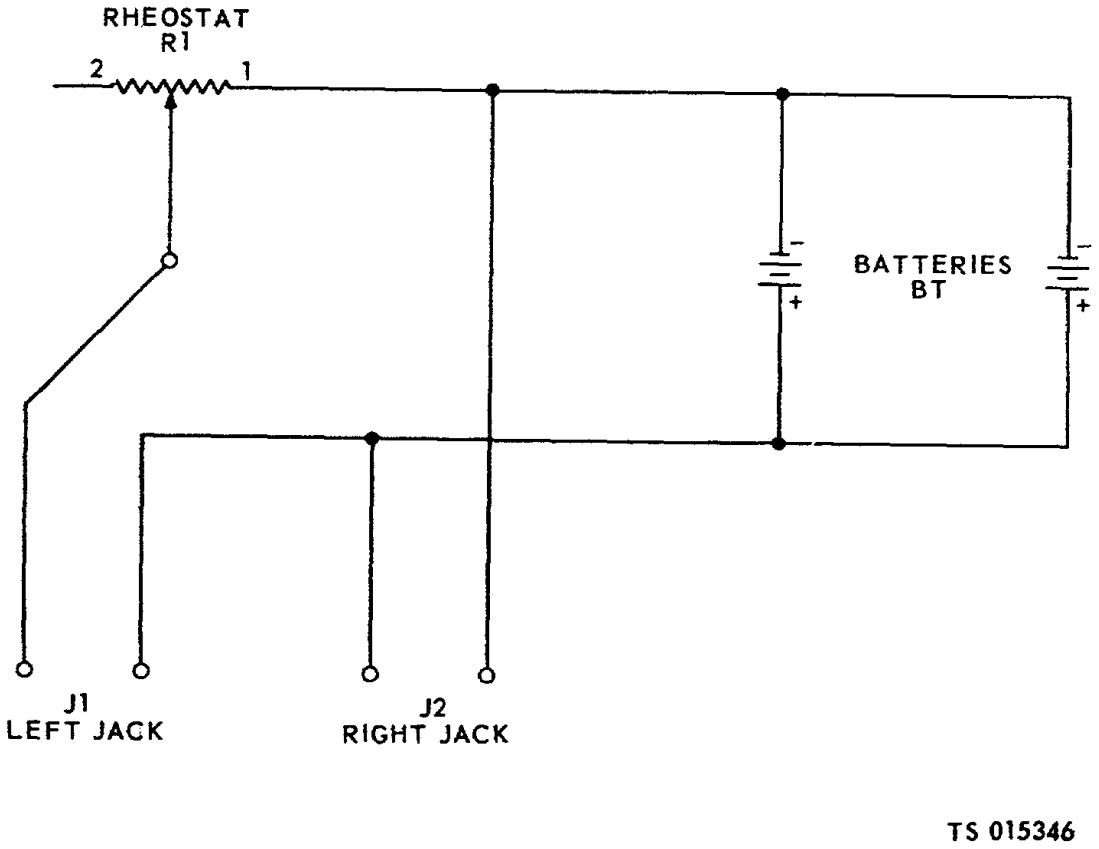

Figure 7-6. Battery case, schematic diagram.

(2) Inspect condition of hinges, latch, and handle.

(3) Check security of battery, lamp, and jack mountings.

(4) Check condition of rheostat and that knob moves smoothly.

(5) Replace any part that is damaged.

7-7. Telescope Prismatic Eyepiece

a. General. The telescope prismatic eyepiece mounts over the telescope eyepiece when making acute angle observations. The eyepiece is provided with a sun filter to allow direct observation of the sun.

b. Disassembly. Disassemble prismatic eyepiece in the order of the index numbers in figure 7-7.

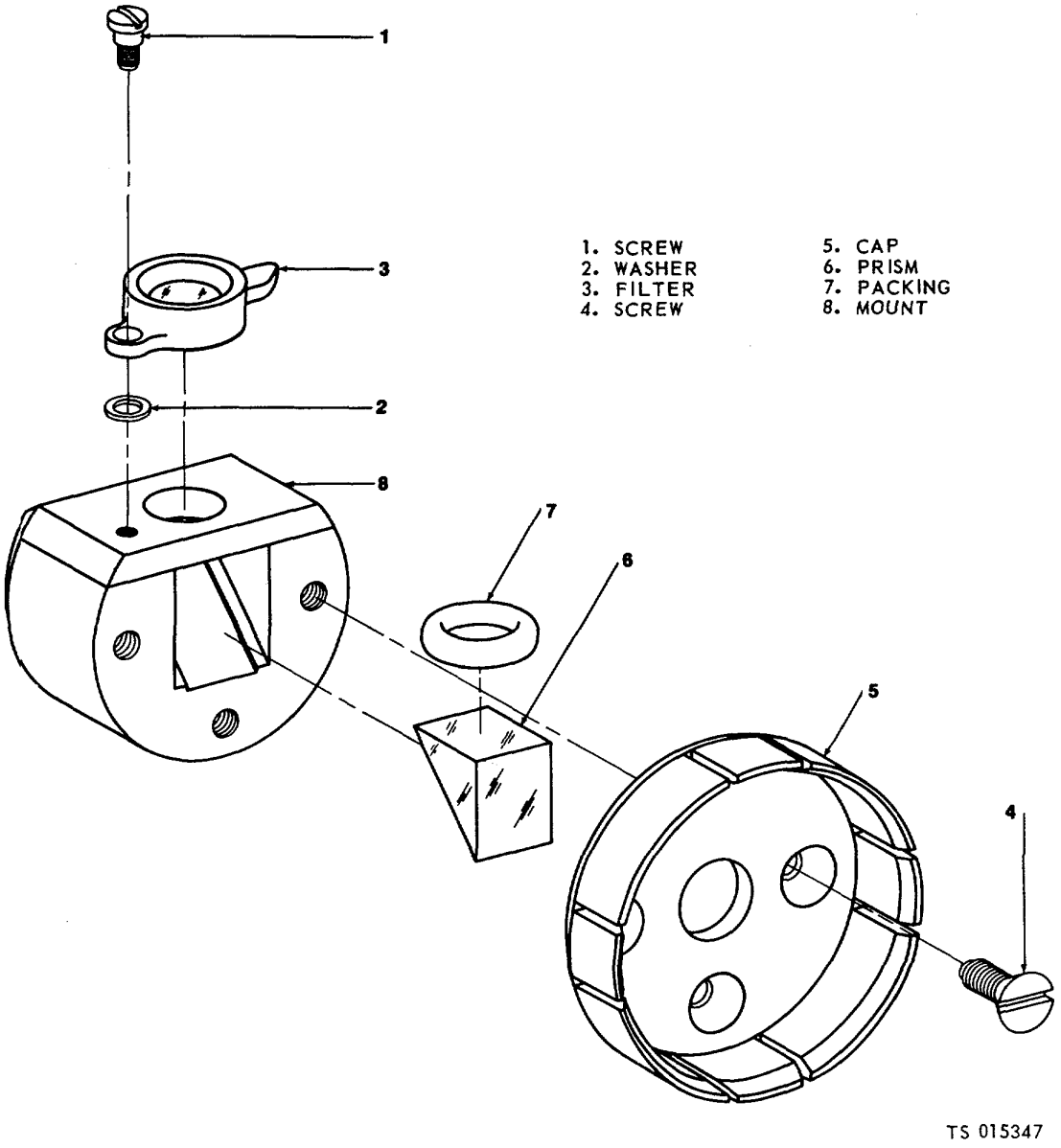

Figure 7-7. Telescope prismatic eyepiece.

c. Cleaning

WARNING

Dry cleaning solvent, P-D-680, used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100° F. (38° C.) 138° F. (59° C.).

(1) Clean non-optical parts with cleaning solvent, Federal Specification P-D-680, and dry thoroughly.

(2) Clean prism and sun filter with lens tissue.

d. Inspection.

(1) Inspect prism for chips, cracks, scratches and etching.

(2) Check metal parts for cracks and distortion.

(3) Check condition of threads. Replace any defective part.

e. Reassembly. Reassemble prismatic eyepiece in reverse order of disassembly.

7-8. Microscope Prismatic Eyepiece

a. General. The microscope prismatic eyepiece mounts on the microscope focusing knob and is used when making acute angle observations.

b. Disassembly. Disassemble prismatic eyepiece in the order of the index numbers in figure 7-8.

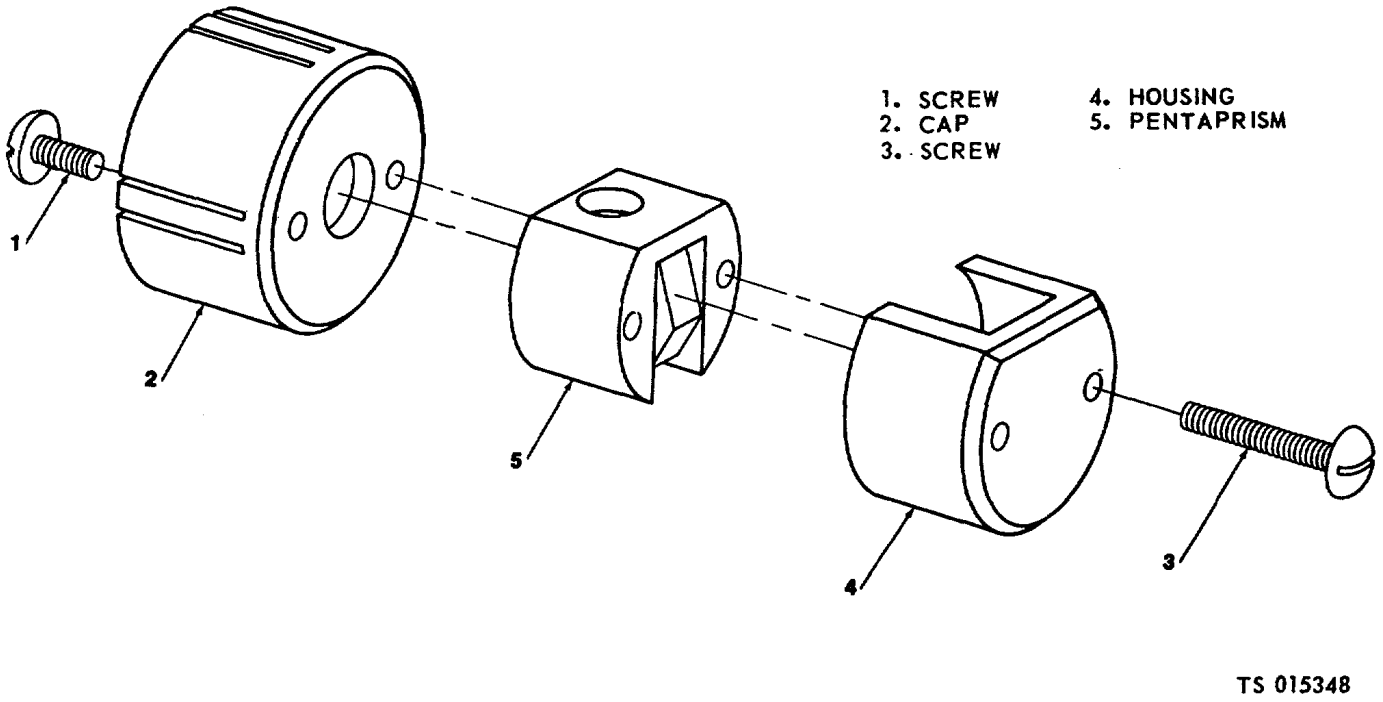

Figure 7-8. Microscope prismatic eyepiece, exploded view.

c. Cleaning.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°F. (38°C.) 138 ° F. (59 ° C.).

(1) Clean non-optical parts with cleaning solvent, Federal Specification P-D-680.

(2) Clean pentaprism with lens tissue.

d. Inspection.

(1) Inspect pentaprism for chips, cracks, scratches and etching.

(2) Check non-optical parts for cracks and distortion.

(3) Check condition of threads. Replace any damaged parts.

e. Reassembly. Reassemble prismatic eyepiece in reverse order of disassembly.

APPENDIX A

REFERENCES

A-1. Painting

TM 43-0139	Painting Instructions for Field Use

A-2. Shipment and Storage

TB 740-97-2	Preservation of USATROSCOM Mechanical Equipment for Shipment and Storage
TM 740-90-1	Administrative Storage of Equipment
TM 10-269	General Repair for Canvas and Webbing

A-3. Maintenance

DA Pam 738-750	The Army Maintenance Management System (TAMMS)
TM 5-6675-307-24P	Organizational, Direct and General Support, and Depot Maintenance Repair Parts and Special Tools List

A-4. Demolition

TM 750-244-3	Destruction of Equipment to Prevent Enemy Use

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 Surveying 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 Surveying 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 *Surveying 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 items. This manual is your authority to requisition replacement BII, based on Table(s) or 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 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*
CGN	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 COMPONENTS OF END ITEM

(1) Illustration		(2)	(3)	(4)	(5)	(6)	(7)	(8) Quantity			
(a) Figure No.	(b) Item No.	National Stock Number	Part No. & FSCM	Description	Location	Usable On Code	Qty Reqd	Rcv'd	Date	Date	Date
1-1		4710-00-394-2715	D51736(33363)	Tribach Assy		CGN	1				
1-3			B51655 (33363)	Sunshade		GCN	1				
2-2			M74-0075-1 (73748)	Case Assy, Carrying		CGN	1				
2-1			34-7300 (74284)	Case Assy, Transport		CGN	1				
2-5				Case, Tool & Accessory containing the following:		CGN	1				
2-5			B51921 (33363)	Case, Tool & Accessory		CGN	1				
2-5		3110-00-155-6234	A21349(33363)	Cover, Theodolite		CGN	1				
2-6				Case, Battery, consisting of the following:		CGN	1				
2-6			C5 1886 (33363)	Case, Assy, Battery		CGN	1				
2-6			A51916(33363)	Cable, Power		CGN	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
2-6			C51636(33363)	Hand Lamp Assy		CGN	1				
not illus			E51502 (33363)	Knapsack		CGN	1				
				Tripod Assy, consisting of the following:		CGN	1				
2-7			E52571 (33363)	Tripod Assy		CGN	1				
4-4	2		C52531(33363)	Cover, Head, Tripod		CGN	1				
not called out			B46249 (33363)	Holder, Plumb Bob Assy and Wrench		GCN	1				
not called out			A52569 (33363)	Wrench, Tripod		CGN	1				
not called out			A47024-2 (33363)	Plumb Bob Assy		CGN	1				
2-5			A51684(33363)	Eyepiece, Prismatic Microscope		CGN	1				
2-5			A51694(33363)	Eyepiece, Prismatic Telescope		CGN	1				
2-5			A5 1743 (33363)	Light Guide (Fiber Optics)		CGN	1				
2-5			A5 1642 (33363)	Filter, Sun, Telescope		CGN	1				
2-5			D51823(33363)	Compass Assy		CGN	1				

Section II INTEGRAL COMPONENTS 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	(8) Quantity Date	(8) Quantity Date	(8) Quantity Date
				TM 5-6675-307-14 Operators', Organizational Direct Support & General Support Maintenance Manual		CGN	1				
2-5			S7865-3 (33363)	Pin Adjusting		CGN	2				
2-5			A52130(33363)	Pin Adjusting		CGN	1				
2-5			ASISO1505 (33363)	Screwdriver, Flat Tip		CGN	1				
2-5			KKC300 (81348)	Chamois		CGN	1				
2-5			A52126(33363)	Screwdriver, Jewelers		CGN	1				
2-5			A51939(33363)	Brush, Optics		CGN	1				

APPENDIX C
ADDITIONAL AUTHORIZATION LIST

Section I. INTRODUCTION

C.1. Scope
This appendix lists additional items you are authorized for the support of the Surveying 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.

C-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*
Not Applicable	

Section II. ADDITIONAL AUTHORIZATION LIST

(1) National stock number	(2) Description		(3)	(4)
	Part number & FSCM	Usable on code	U/M	Qty Auth
	BA30 (81349)	Battery Dry 1.5 volts	ea	8

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 functions on the identified end item or component and the work measurement time required to perform the functions by the designated maintenance level. The implementation of the maintenance functions upon the end item or component will be consistent with the assigned maintenance functions.

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

D-2. Explanation of Columns in Section II

a. Column (I), Group Number. Column I lists group numbers to identify related components, assemblies, subassemblies, and modules with their next higher assembly. The applicable groups are listed in the MAC in disassembly sequence beginning with the first group removed.

b. Column (2), Component/Assembly. This column contains the noun names of components, assemblies, subassemblies and modules for which maintenance is authorized.

c. Column (3), Maintenance Functions. This column lists the functions to be performed on the item listed in Column 2. The maintenance functions are defined as follows:

(1) *Inspect.* To determine serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination.

(2) *Test.* To verify serviceability and detect incipient failure by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

(3) *Service.* Operations required periodically to keep an item in proper operating condition, i.e., to clean (decontaminate), to preserve, to drain, to paint, or to replenish fuel, lubricants, hydraulic fluids, or compressed air supplies.

(4) *Adjust.* To maintain within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to specified parameters.

(5) *Align.* To adjust specified variable elements of an item to bring about optimum or desired performance.

(6) *Calibrate.* To determine and cause corrections to be made or to be adjusted on instruments or test measuring and diagnostic equipments used in precision measurement. Consists of comparison of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

(7) *Install.* The act of emplacing, seating, or fixing into position an item, part, or module (component or assembly) in a manner to allow the proper functioning of an equipment or system.

(8) *Replace.* The act of substituting a serviceable like type part, subassembly, or module (component or assembly) for an unserviceable counterpart.

(9) *Repair.* The application of maintenance services (inspect, test, service, adjust, align, calibrate, or replace) or other maintenance actions (welding, grinding, riveting, straightening, facing, remachining or resurfacing) to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.

(10) *Overhaul.* That maintenance effort (service/ action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards (i.e., DMWR) in appropriate technical publications. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to a like new condition.

(11) *Rebuild.* Consists of those services/actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with original manufacturing standards. Rebuild is the highest degree of materiel maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours/miles, etc.) considered in classifying Army equipments/components.

d. Column (4). Maintenance Category. This column is made up of subcolumns for each category of maintenance. Wgrk time figures are listed in these subcolumns for the lowest level of maintenance authorized to perform the function listed in Column 3. These figures indicate the average active time required to perform the maintenance function at the indicated category of maintenance under typical field operating conditions.

e. Column (5). Tools and Equipment. This column is provided for referencing by code, the common tool sets (not individual tools), special tools, test and support equipment required to perform the designated function.

D-3. Explanation of Columns in Section III

a. Column (1), Reference Code. This column consists of an arabic number listed in sequence from Column 5 of Section II. The number references the common tool sets, special tools and test equipment requirements.

b. Column (2), Maintenance Category. This column shows the lowest category of maintenance authorized to use the special tools or test equipment.

c. Column (3), Nomenclature. This column lists the name or identification of the common tool sets, special tools or test equipment.

d. Column (4), National/Nato Stock No. (NSN). This column is provided for the NSN of common tool sets, special tools and test equipment listed in the nomenclature column.

e. Column (5), Tool Number. This column lists the manufacturer's code and part number of tools and test equipment.

Section II. MAINTENANCE ALLOCATION CHART

(1) Group Number	(2) Component/Assembly	(3) Maintenance Function	(4) Maintenance Level* C	O	F	H	D	(5) Tools and Equipment
01	THEODOLITE	Inspect					0.1	
	Left Cover Assembly	Replace					0.5	
		Repair					0.8	
		Overhaul					1.0	
	Prism Assembly	Inspect					0.2	
		Replace					0.6	
		Repair					0.5	
	Window Assembly	Inspect		0.2				
		Replace					0.4	
		Repair					0.3	
	Mirror Assembly	Inspect		0.2				
		Replace					0.3	
		Repair					0.4	
	Knob	Inspect		0.2				
		Replace					0.3	
		Repair					0.5	
	Right Cover Assembly and Vertical Mechanism Assembly							
	Right Cover Assembly	Inspect					0.1	
		Replace					0.5	
		Repair					0.8	
		Overhaul					1.0	
	Vertical Tangent Screw Assembly	Inspect		0.2				
		Replace					0.3	
		Repair					0.4	
	Adapter Assembly	Inspect		0.2				
		Replace					0.5	
		Repair					0.5	
	Transfer Lens Assembly	Inspect					0.3	
		Replace					0.5	
		Repair					0.5	
		Overhaul					0.5	
		Align					0.3	1
	Level Tangent Screw, Spring and Cat							
	Level Tangent Screw Assembly	Inspect		0.2				
		Replace					0.3	
		Repair					0.5	
	Spring and Stop Assembly	Inspect		0.1				
		Replace					0.3	
		Repair					0.5	
	Telescope Bubble and Vertical Circle Subassembly							
	Telescope Level Assembly	Inspect		0.2				
		Replace					0.5	
		Repair					0.5	
		Overhaul					0.5	
		Adjust	0.2					2

* See footnote at end of chart.

Section II. MAINTENANCE ALLOCATION CHART - *Continued*

(1) Group Number	(2) Component/Assembly	(3) Maintenance Function	(4) Maintenance Level* C	O	F	H	D	(5) Tools and Equipment
01	THEODOLITE (Cont'd)							
	Vertical Circle Assembly	Inspect		0.2				
		Replace					0.8	
		Repair					0.6	
		Align					0.5	3
	Telescope Assembly	Inspect		0.2				
		Replace					1.0	
		Repair					1.0	
	Eyepiece Assembly	Inspect		0.2				
		Replace					0.5	
		Repair					0.6	
	Illuminator Assembly	Inspect		0.2				
		Replace					0.5	
		Repair					0.6	
	Reticule Assembly	Inspect		0.1				
		Replace					0.4	
		Repair					0.4	
		Adjust	0.1					4
	Collimation Lens Assembly	Inspect		0.1				
		Replace					0.5	
		Repair					0.6	
		Align						1
	Upper Optical Assembly							
	Level Optics Assembly	Inspect					0.1	
		Replace					0.5	
		Repair					1.0	
		Align					0.5	1
	Prism Assembly	Inspect					0.1	
		Replace					1.0	
		Repair					1.0	
		Align					1.0	1
	Plate Level Assembly	Inspect					0.1	
		Replace			0.6			
		Repair					1.0	
	Optical Plummet Prism, Eyepiece, and Reticle							
	Optical Plummet Eyepiece	Inspect					0.1	
		Replace					0.8	
		Repair					1.5	
	Optical Plummet Lens Assembly and Prism	Inspect		0.1				
		Replace					1.0	
		Repair					1.5	
		Align					0.5	1 and 2
	Alidade and Pinch Clamp	Inspect					0.2	
		Replace					1.0	
		Repair					1.5	
	Center Assembly Holder Assembly	Inspect					0.2	
		Replace					1.0	
		Repair					1.0	
	Horizontal CIRCLE Assembly	Inspect					0.2	
		Replace					0.5	5
		Repair					1.5	
		Align					0.5	
	Plummet Window Assembly	Inspect		0.1				
		Replace					0.7	
		Repair					0.5	
	Center Assembly	Inspect					0.5	
		Replace					0.8	
		Repair					1.0	
		Overhaul					1.5	

* See footnote at end of chart.

Section II. MAINTENANCE ALLOCATION CHART - *Continued*

(1) Group Number	(2) Component/Assembly	(3) Maintenance Function	(4) Maintenance Level* C	O	F	H	D	(5) Tools and Equipment
02	TRIBRACH ASSEMBLY							
	Tribrach	Inspect		0.2				
		Replace					0.2	
		Repair			0 5			
		Overhaul					2.0	
	Leveling Screw Assembly	Inspect		0.1				
		Service		0.5				
		Replace			0.5			
	Level Assembly	Inspect		0.1				
		Replace			0.5			
		Repair			1.0			
		Adjust	0.1					2
03	TRIPOD ASEMBLY	Inspect		0.2				
		Service	0.1					7
		Replace		0.2				
		Repair			1.0			7
04	ACCESSORIES							
	Compass Assembly	Inspect		0.2				
		Install	0.1					
		Replace					0.2	
		Repair					0.6	
		Overhaul					1.0	
		Adjust	0.1					2 and 6
	Lighting Attachment	Inspect		0.1				
		Replace		0.1				
		Repair			0.5			
	Battery Case	Inspect		0.1				
		Install	0.1					
		Replace			0.2			
		Repair				0.5		
	Prismatic Eyepiece, Telescope	Inspect		0.1			0.1	
		Install	0.1					
		Replace		0.2				
		Repair			0.5			
	Knapsack	Inspect		0.1				
		Service		0.5				
		Replace		0.2				
	Carrying Case	Inspect		0.2				
		Replace		0.2				
		Repair		1.0				
	Shipping Case	Inspect		0.2				
		Replace		0.2				
		Repair		1.0				

* Subcolumns are as follows: C-Operator Crew: O-Organizations1:
F-Direct Support. H-General Support: D-Depot

SECTION III. TOOL AND TEST EQUIPMENT REQUIREMENTS

(1) Reference code	(2) Maintenance category	(3) Nomenclature	(4) National Stock number (NSN)	(5) Tool number
1	C.O,D	Screwdriver, jeweler's	5120-00-078-2851	(3336fi) 5240-1 102
2	C, D	Pin, Adjusting		(33363) .78F65-3
3	D	Circle Alignment Fixture		(33363) ES 1981
4	C, O. D	Pin, Adjusting		(33363) S7865-3
5	D	Circle Alignment Fixture		(333631 D51865
6	C, O, D	Spanner		(333631 A51966
7	C, O, F	Wrench, Tripod		(33363) W3434-1

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 Surveying 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 I-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	F-Direct Support Maintenance
O-Organizational 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	7920-00-401-8035	Cloth, Lint-free. Non-abrasive, General Purpose Part No. 1001	bx
2	C	9150-00-985-7244	Grease, Instrument & Aircraft (GIA) MIL-G-23827	tu
3	C	9150-00-252-6382	Oil, Clock & Watch (OCW) 5CC	bt
4	C	6810-00-223-2739	Acetone, Technical, I pt can; Fed Spec MMM-A-185	pt
5	C	6850-00-664-5685	Cleaning Solvent, Fed Spec PD-680	qt
6	C		Lens Tissue, NNNP40TYPEICLASSI (81349)	pk
7	C		Orange Stick 13218E3063 (97403)	pk
8	C	6850-00-264-6573	Desiccant Impregnated w/Moisture Indicator 2 units per bag	cn

INDEX

By Order of the Secretary of the Army:

FRED C. WEYAND
General, United States Army
Chief of Staff

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Major General, United States Army
The Adjutant General

Distribution:
To be distributed in accordance with DA Form 12-25A, (qty rqr block no. 173)
Operator's maintenance requirements for Surveying Equipment.

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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 dekagram = 10 grams = .35 ounce
1 hectogram = 10 dekagrams = 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			

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