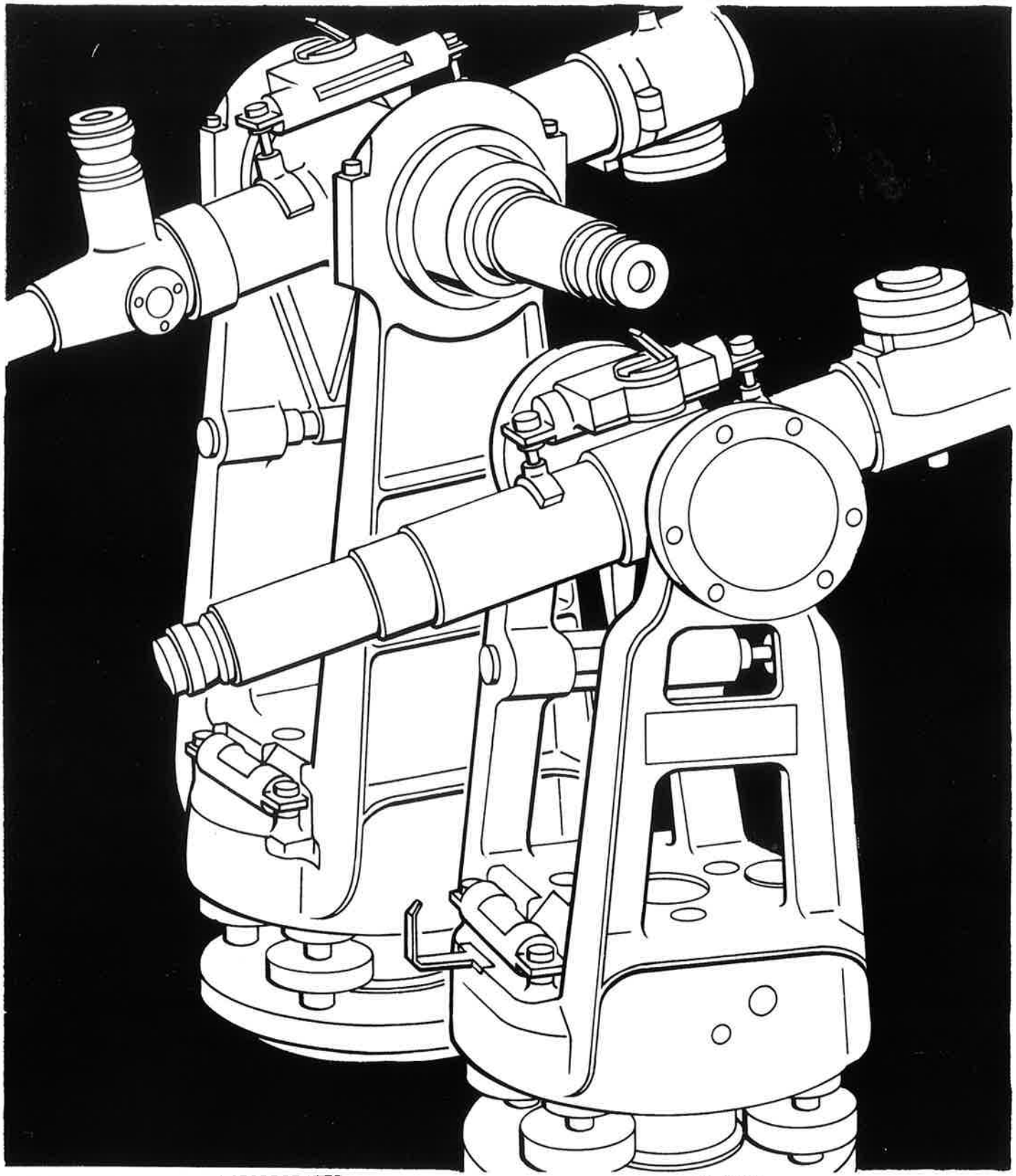
PARAGON® Jig Transit
PARAGON® Jig Transit Telescope Square
Operating Manual

Manual No. 71 1000-3

71 1026



71 1010

METROLOGY SOLUTIONS INCORPORATED DBA
CUBIC PRECISION

Additional manuals covering Optical Alignment Equipment are available from Cubic Precision. For a complete set of manuals plus binder, contact Cubic Precision, 27 Central Ave., Teterboro, NJ 07608.

Product Number
71 1001 Optical Alignment Equipment Operating Manuals

Set of four operating manuals with illustrations and complete instructions for the use, care and adjustment of Optical Alignment Equipment. Also includes a comprehensive glossary of Optical Alignment Terms for easy and convenient referral.

The set includes the following manuals:

1. Alignment Telescope, Bright Line Alignment Telescope, Line of Sight Telescope and Alignment Collimator, Straightness of Line of Sight Collimator Operating Manual.
2. PARAGON® Tilting level, PARAGON Leveling Kit Operating Manual.
3. PARAGON® Jig Transit, PARAGON Jig Transit Telescope Square Operating Manual.
4. Alignment/Auto-Collimating Laser System Operating Manual.
5. Glossary of Optical Alignment Terms.

OPTICAL ALIGNMENT EQUIPMENT

Any part of an Optical Alignment Instrument found by Cubic Precision to be defective in material or workmanship will be repaired, or at Cubic Precision's option, replaced, for the original purchaser within 90 days of original purchase, provided the instrument is returned*, transportation prepaid to the appropriate authorized Cubic Service Center within the warranty period and the instrument is in as good a condition as when originally purchased, ordinary wear resulting from careful use only accepted, and the instrument has not been subjected to misuse, rough handling, alteration or servicing by other than an authorized service representative, negligence, fire, accident, water damage, acts of God, or other casualty.

***NOTE:** Arrangements for the return of goods should be made in advance through Cubic or Cubic Dealer from which the goods were purchased.

The above is in lieu of any expressed or implied warranties and **THERE ARE NO IMPLIED WARRANTIES OF MECHANTIBILITY OR FITNESS FOR USE.** Cubic assumes no responsibility for any inconvenience, loss, injury, or direct or consequential damage arising from the possession or use of the instrument.

The following information is provided with each Optical Alignment Instrument purchased:

1. Operating Manual

BEFORE ATTEMPTING TO OPERATE ANY OPTICAL ALIGNMENT INSTRUMENT OR COMPONENT, IT IS ESSENTIAL TO READ AND FOLLOW THE PROCEDURES OUTLINED IN THE OPERATING MANUAL.

CUBIC WILL NOT BE RESPONSIBLE FOR DAMAGE THAT COULD OCCUR IF THESE PROCEDURES ARE NOT FOLLOWED.

Ownership of Goods in Transit—The Consignor's responsibility for delivery or damage of goods ceases when title passes to the Consignee, and therefore, Consignor's responsibility ceases as soon as the goods are delivered to the Carrier. Thereafter, responsibility for non-delivery, damage, and payment for goods resides in the Consignee. Claims against the Carrier must be made within time limits specified by the Carrier. The fact that notice has been given to the Carrier that the goods have not been delivered and that a request has been made to trace them, does not serve to extend the period within which claims for damage or loss may be made. When requested, we will furnish the necessary documents for making these claims. Shipments will be made without declaration of value unless Customer requests otherwise. Parcel Post shipments are insured for invoice price only, unless Customer requests otherwise. The Customer will be charged for the cost of any insurance. All prices are FOB shipping point unless other terms are specifically agreed upon.

TABLE OF CONTENTS

SECTION 1. INTRODUCTION

SECTION 2. OPERATION

SECTION 3. MAINTENANCE

APPENDIX-ACCESSORIES

INSTRUMENT STANDS

LIST OF ILLUSTRATIONS

Figure

APPENDIX

LIST OF TABLES

Table

SECTION I — INTRODUCTION

1-1. PURPOSE OF EQUIPMENT

The Jig Transit is an extremely versatile instrument which provides a very high degree of accuracy in optical tooling and alignment work. The Jig Transit can be used to establish precise vertical reference planes and plumb lines from which measurements can be taken. When it is equipped with accessory auto-reflection mirrors, it can be used to establish a vertical reference plane perpendicular to a pre-established line of sight; when it is equipped with an accessory right-angle eyepiece, zenith sights or upward plumb lines can be established. Cubic offers two versions: the 71 1010 PARAGON® Jig Transit and the 71 1026 Paragon® Jig Transit Telescope Square. (See Figure 1-1.)

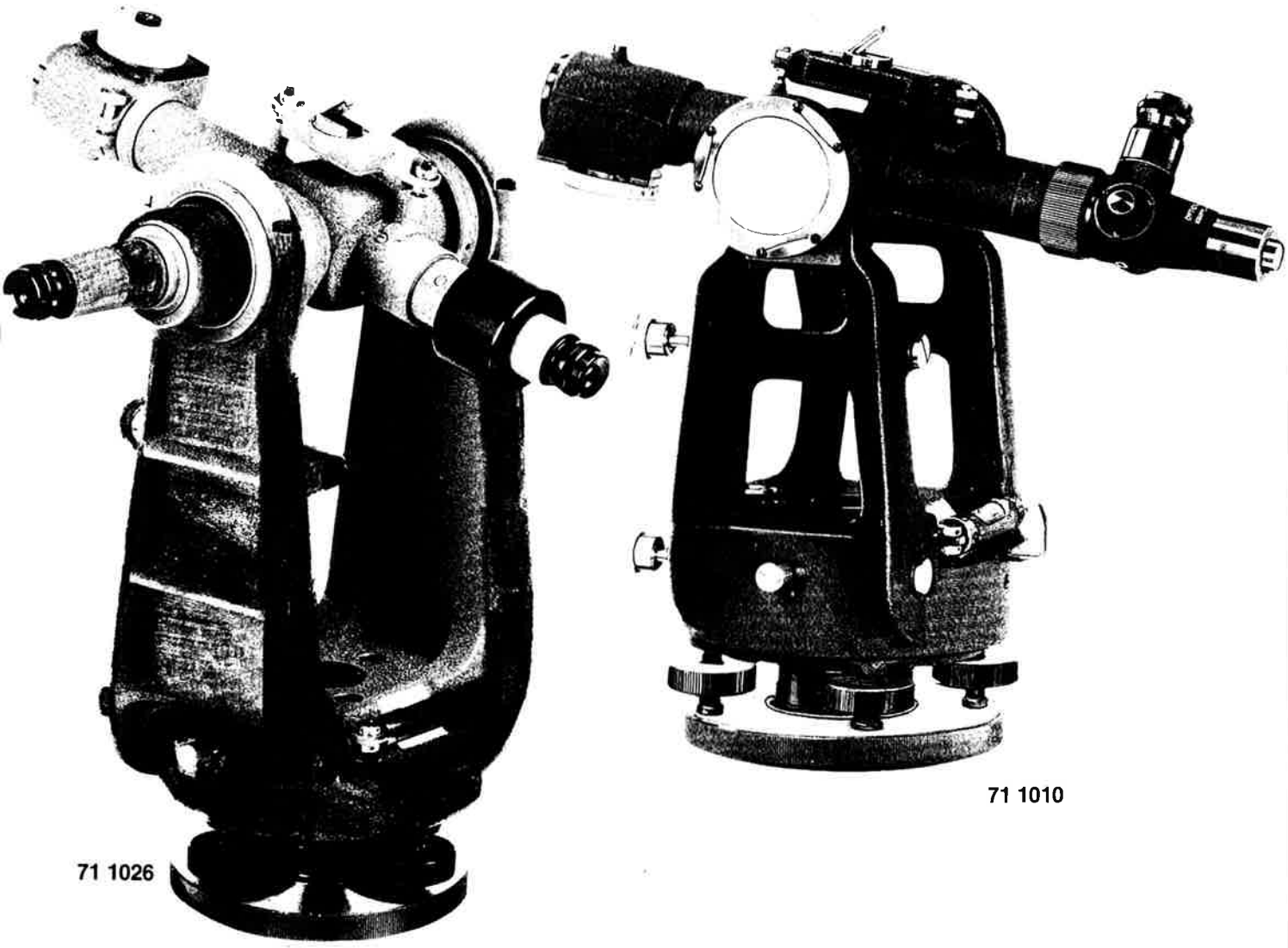


Figure 1-1. 71 1010 PARAGON® Jig Transit and 71 1026 PARAGON® Jig Transit Telescope Square

1-2. DESCRIPTION

1-3. 71 1010 PARAGON® Jig Transit

The 71 1010 PARAGON® Jig Transit consists of a high-quality telescope that pivots on a horizontal axle supported by a trunnion framework (alidade). The alidade is mounted on a vertical axle. The entire instrument can be rotated about the vertical axle to sight any desired point, and the telescope sweeps a vertical plane when it is swung on its elevation axis. (See Figure 1-2.) The azimuth center of the alidade is hollow and the line of sight is centered with this axis so that it is possible to sight down through the instrument base.

1-4. Accessory mirrors may be mounted on the ends of the elevation axle to facilitate auto-collimation with a reference line of sight. The axle mirrors are perpendicular to the elevation axle; therefore, when the instrument is auto-collimated with a reference sight line, the plane swept by the line of sight of the telescope is perpendicular to the reference sight line.

1-5. A four-screw leveling system is used. The standard Jig Transit is equipped with a level vial on the telescope, and a circular level on the plate. Leveling places the azimuth axis of the instrument in the direction of gravity.

1-6. Two-speed tangent screws on both the elevation and azimuth axes facilitate leveling and auto-collimation. An all-purpose glass reticle with a cross-pattern of single lines top and right and paired lines bottom and left is provided. The instrument telescope has a removable blank that enables field-conversion for auto-collimation.

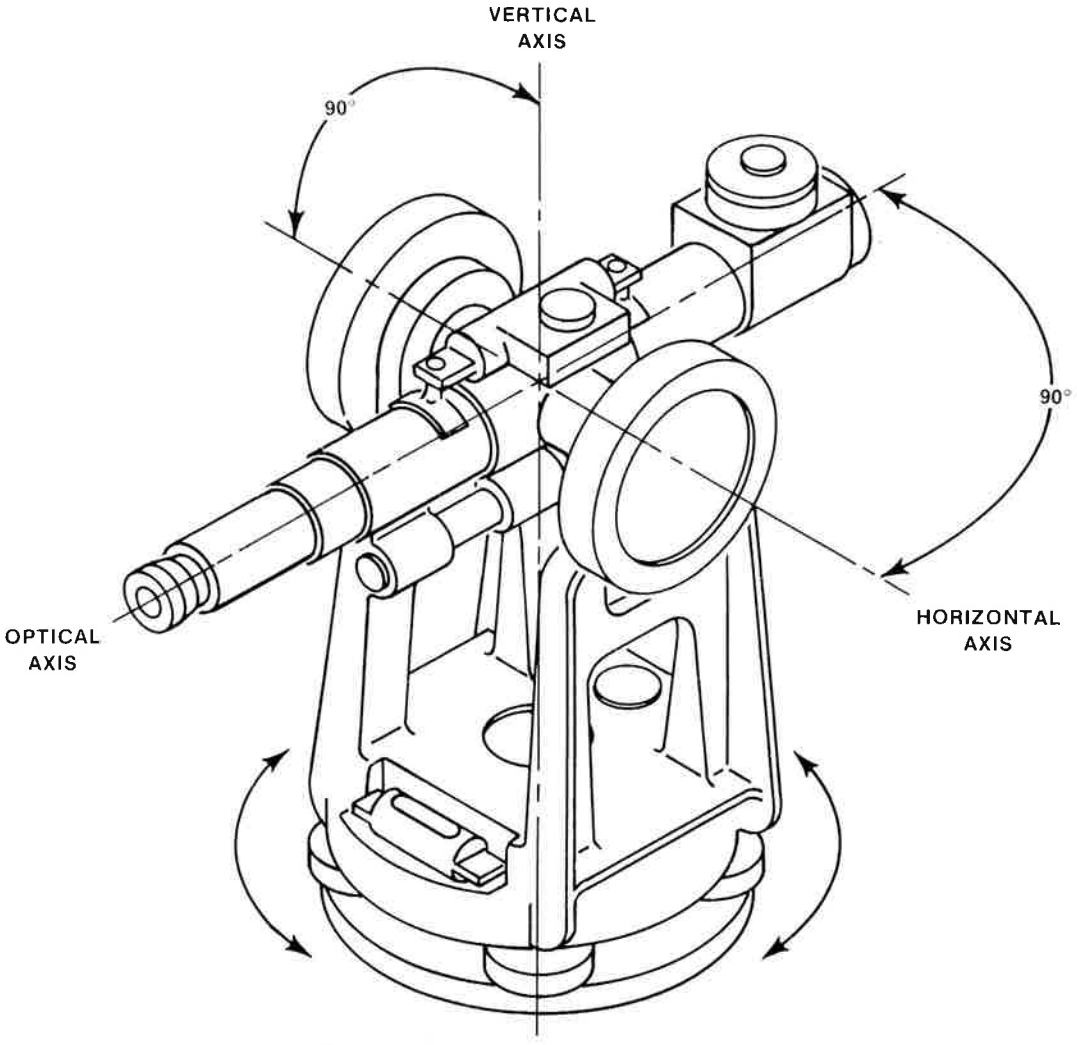


Figure 1-2. Geometry of Jig Transit

1-7. 71 1026 PARAGON® Jig Transit Telescope Square

The 71 1026 PARAGON® Jig Transit Telescope Square is similar to the 71 1010 PARAGON Jig Transit, except that the horizontal axle is hollow and mounts a cross-axis fixed infinity focus telescope instead of auto-reflection mirrors. The cross-axis telescope is perpendicular to the main telescope. This arrangement permits convenient, economical, one-man instrument setup; the need for an operator behind the reference line of sight instrument during setup, as is the case when using auto-reflection mirrors, is eliminated.

NOTE: References to "Jig Transit" in this manual hereafter refers to both instruments, unless otherwise stated.

1-8. INSTRUMENT SPECIFICATIONS

Table 1-1 lists specifications for 71 1010 PARAGON Jig Transit and 71 1026 PARAGON Jig Transit Telescope Square indicating characteristics common to both instruments.

TABLE 1-1. SPECIFICATIONS

Characteristics	71 1010	71 1026
Main Telescope:		
Length	11¼ inches with fully erecting achromatic optical system	Same as for 71 1010
Magnification	Varies automatically from 20x at 8 inches to 30x at infinity	Same as for 71 1010
Focusing Range	8 inches to infinity	Same as for 71 1010
Resolving Power	4 seconds of arc (per Bureau of Standards test procedure)	Same as for 71 1010
Field of View	55 minutes at infinity; 6.4 mm at near distance	Same as for 71 1010
Effective aperture	30 mm	Same as for 71 1010
Optics	Fully coated throughout	Same as for 71 1010
Eyepiece	Erecting, achromatic	Same as for 71 1010
Auto-Collimation	Removable blank provided for Auto-Collimation Conversion Unit	Same as for 71 1010
Reticle	All-purpose, double glass, dustproof; cross-pattern with single lines top and right, paired lines bottom and left	Same as for 71 1010
Telescope Axle	Bronze with steel journals sweated on; threaded ends and stop shoulders to accomodate auto-reflection mirrors	Bronze with steel journals sweated on; holow; equipped with cross-axis telescope
Cross-Axis Telescope:		
Length		13 inches with fully achromatic optical system
Magnification	—	28x
Focus	—	Fixed at infinity
Resolving Power	—	4 seconds of arc (per Bureau of Standards test procedure)

TABLE 1-1. SPECIFICATIONS (Continued)

Characteristic	71 1010	71 1026
Cross-Axis Telescope (Continued)		
Field of View	—	50.5 minutes at infinity
Effective Aperture	—	21 mm
Eyepiece	—	Achromatic
Auto-Collimation		Removable blank provided for Auto-Collimation Conversion Unit
Reticle	—	All purpose, double glass, dust-proof; cross-pattern with single line in two quadrants, paired lines in other two quadrants; aligned so that it is in horizontal/vertical position when main telescope is level
Standard	Reinforced, ribbed, U-type; bronze, one-piece casting; bearings V-type; bronze, adjustable for centering line of sight on azimuth axis in horizontal and vertical planes	Same as for 71 1010
Height	10¾ inches from bottom of base to center of telescope axis	13½ inches from bottom of base to center of telescope axis
Lower Part	Hollow azimuth axle with $1^{3}/_{16}$ inch diameter optical clearance	Same as for 71 1010
Center	Cylindrical, with high-precision thrust ball bearing; mounted in retaining ring between two precision, optically flat steel plates; enclosed in protective dust cover	
Levels:		
Telescope	Sensitivity of 20 seconds of arc per 2 mm movement; two $^{7}/_{32}$ inch diameter holes, spaced on 3½ inch centers, provided for mounting; provisions for mounting accessory 71 3250 Coincidence Level provided on telescope	Same as for 71 1010
Plate	Circular, sensitivity of 5 minutes per 2 mm movement; provisions for mounting accessory 71 3250 Coincidence Level perpendicular to line of sight	
Screws:		
Leveling	Four, with precision-generated threads; fully enclosed to exclude dust and retain lubricant	Same as for 71 1010

TABLE 1-1. SPECIFICATIONS (Continued)

Characteristic	71 1010	71 1026
Screws (Continued)		
Tangent	Two-speed, fine motion, for both azimuth and elevation motions	
Weight of Instrument	26½ lb. approx.	37 lb. approx.
Tripod Plate	Threaded 3½ X 8, U.S. Standard	Same as for 71 1010
Finish	Two-tone green	Same as for 71 1010
Instrument Carrying Case	High-impact plastic with rubber inserts, four large rubber supports, and adjusting tools	
Standard Equipment	Basic Jig Transit with circular plate level, 71 3260 Telescope Level Vial, and instrument carrying case	Basic Jig Transit Telescope Square with circular plate level, 71 3260 Telescope Level Vial, and instrument carrying case

1-9. ACCESSORIES

The complete line of accessories available for use with the Jig Transit and Jig Transit Telescope Square is described in the Appendix to this manual. Applicability of the various accessories to the two instruments is shown in Table 1-2.

TABLE 1-2. ACCESSORIES AND APPLICABILITY

Accessory	71 1010	71 1026
71 1111 Optical Micrometer with Vernier Scale	X	X
71 1113 Metric Optical Micrometer with Vernier Scale	X	X
*71 1115 Optical Micrometer	X	X
71 1140 WYTEFACE® Auto-Reflection Target (Aluminum)	X	X
71 1211 Auto-Collimation Conversion Unit	X	X
71 1231 Right-Angle Eyepiece	X	X
71 1241 Combination Auto-Collimation, Projection, Right-Angle Eyepiece	X	X
*71 1260 Prismatic Eyepiece	X	X
71 3250 Coincidence Level	X	X
71 3260 Level Vial	X	X
71 5511 Auto-Collimation Illumination Unit	X	X
71 1130 Circular Auto-Reflection Mirror	X	

* To order only

SECTION 2 — OPERATION

2-1. UNPACKING AND INSPECTION

Upon receipt of the instrument, perform a complete mechanical inspection. Remove the instrument carrying case carefully from the shipping container. Open the carrying case and check to make sure that all ordered items have been received. Remove the instrument from the carrying case by lifting it by its standards. Hold the instrument upright, with one hand holding the standards and the other hand supporting the base. Inspect the instrument thoroughly for any signs of damage that may have occurred during shipment. Especially examine glass components for cracks, scratches, and breakage.

2-2. INSTALLATION AND ADJUSTMENT OF ACCESSORIES

Select the accessory items that are to be used for the particular job at hand, and install and adjust the accessories on the Jig Transit in accordance with the applicable instructions in the Appendix of this manual.

2-3. OPERATING ELEMENTS

The main elements used in operation of the Jig Transits are shown in Figures 2-1 and 2-2, and their functions are described in Table 2-1.

NOTE: The instruments shown in Figures 2-1 and 2-2 are equipped with the 71 1111 Optical Micrometer with Vernier Scale, the 71 1241 Combination Auto-Collimation, Projection, Right-Angle Eyepiece, and the 71 3250 Coincidence Level. These are all accessory items.

TABLE 2-1. OPERATING ELEMENTS

Fig. & Index No.	Nomenclature	Function
2-1, 1 2-2, 1	Elevation clamp	Provides means for clamping telescope in vertical plane.
2-2, 2 2-2, 2	Telescope level	Used to level instrument and establish a level line of sight.
2-1, 3 2-2, 3	Eyepiece focusing ring	Provides means for focusing reticle image.
2-1, 4 2-2, 4	Auto-collimation eyepiece	Accessory: used in place of normal eyepiece to form straight-through vision system or right-angle vision system, or to convert Jig Transit Telescope into Auto-Collimating Telescope.
2-1, 5 2-2, 5	Standards (alidade)	Supports telescope.
2-1, 6 2-2, 6	Plate level	Accessory: used to level instrument and to monitor any damage in cross-leveling during a set-up.
2-1, 7 2-2, 7	Base	Supports instrument.
2-1, 8 2-2, 8	Leveling head	Contains instrument leveling mechanism.

TABLE 2-1. OPERATING ELEMENTS (Continued)

Fig. & Index No.	Nomenclature	Function
2-1, 9 2-2, 9	Leveling screws	Used to level instrument.
2-1, 10 2-2, 10	Azimuth clamp	Provides means for clamping instrument in azimuth plane.
2-1, 11 2-2, 11	Azimuth tangent screw	Provides means for fine azimuth adjustment of instrument when azimuth clamp is tight.
2-1, 12 2-2, 12	Circular plate level	Used for coarse leveling of instrument.
2-1, 13 2-2, 13	Elevation tangent screw	Provides means for fine elevation adjustment of telescope when elevation clamp is tight.
2-1, 14 2-2, 14	Focusing knob	Used to focus target image.
2-1, 15	Auto-reflection mirror	Accessory: used for establishing vertical plane perpendicular to a reference line of sight.
2-2, 15	Cross-axis telescope	Used for establishing vertical plane perpendicular to a reference line of sight.
2-1, 16 2-2, 16	Optical micrometer scale	Accessory: used to measure horizontal or vertical displacement from main telescope line of sight.

2-4. OPERATING INSTRUCTIONS

2-5. Initial Setup

1. Make sure that the instrument is equipped with the accessories required for the job at hand. Have an instrument stand or other support with standard 3½ by 8 threads ready in position. (See Figure 2-3.) For description of the Instrument Stands and Accessories, see the appendix of the manual page 4-11.

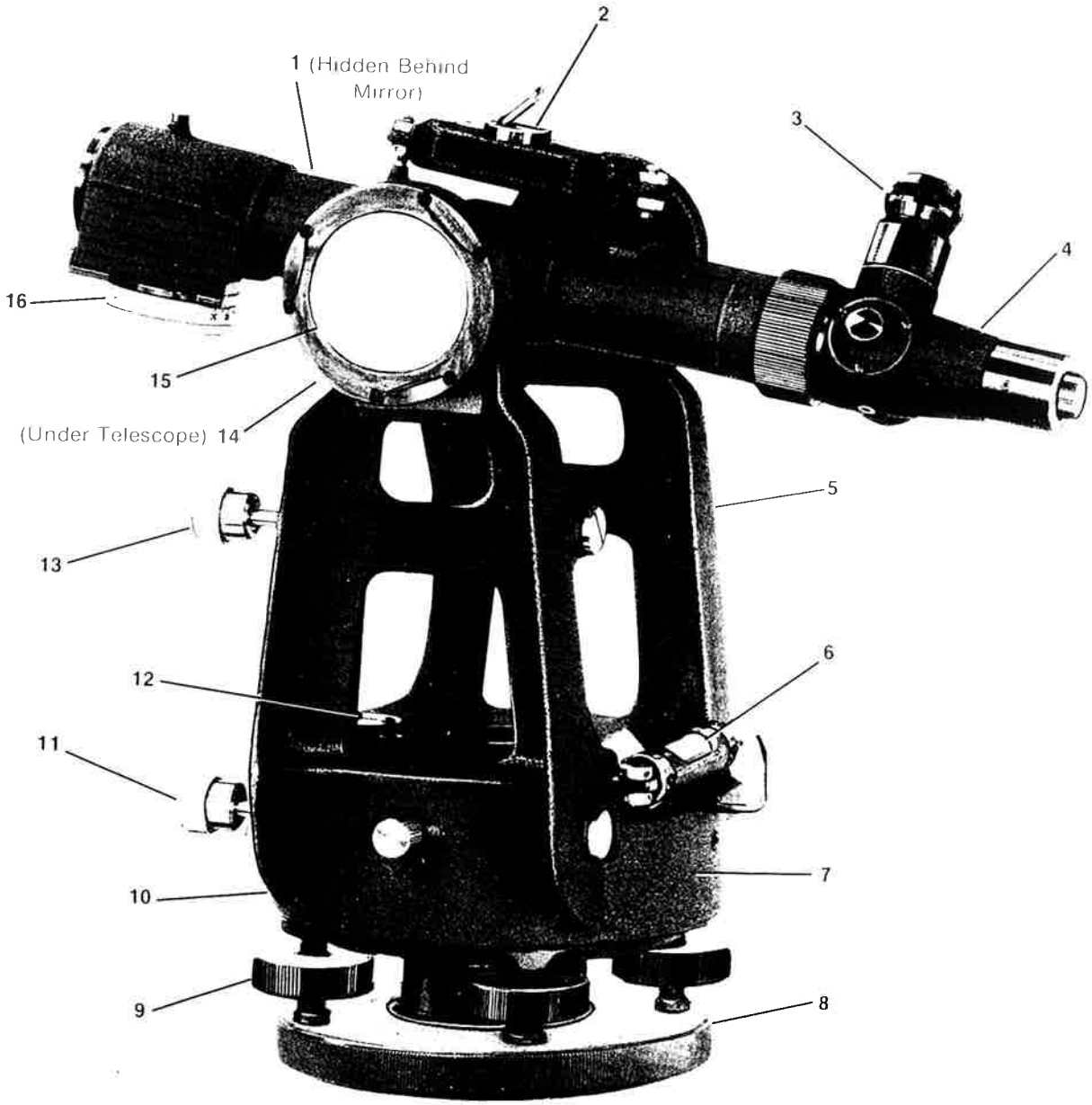
2. Remove the instrument from its carrying case by lifting the instrument by its standards. As soon as the instrument is clear of the carrying case, hold it upright, holding the standards with one hand and supporting the base with the other hand.

3. Make sure that both the azimuth clamp and the elevation clamp are loose.

4. Screw the instrument down in place on the instrument stand or support while holding the instrument standards with one hand. Be sure to use the knurled ring below the leveling screws, and not the leveling screws themselves, to screw the instrument onto the instrument stand or support.

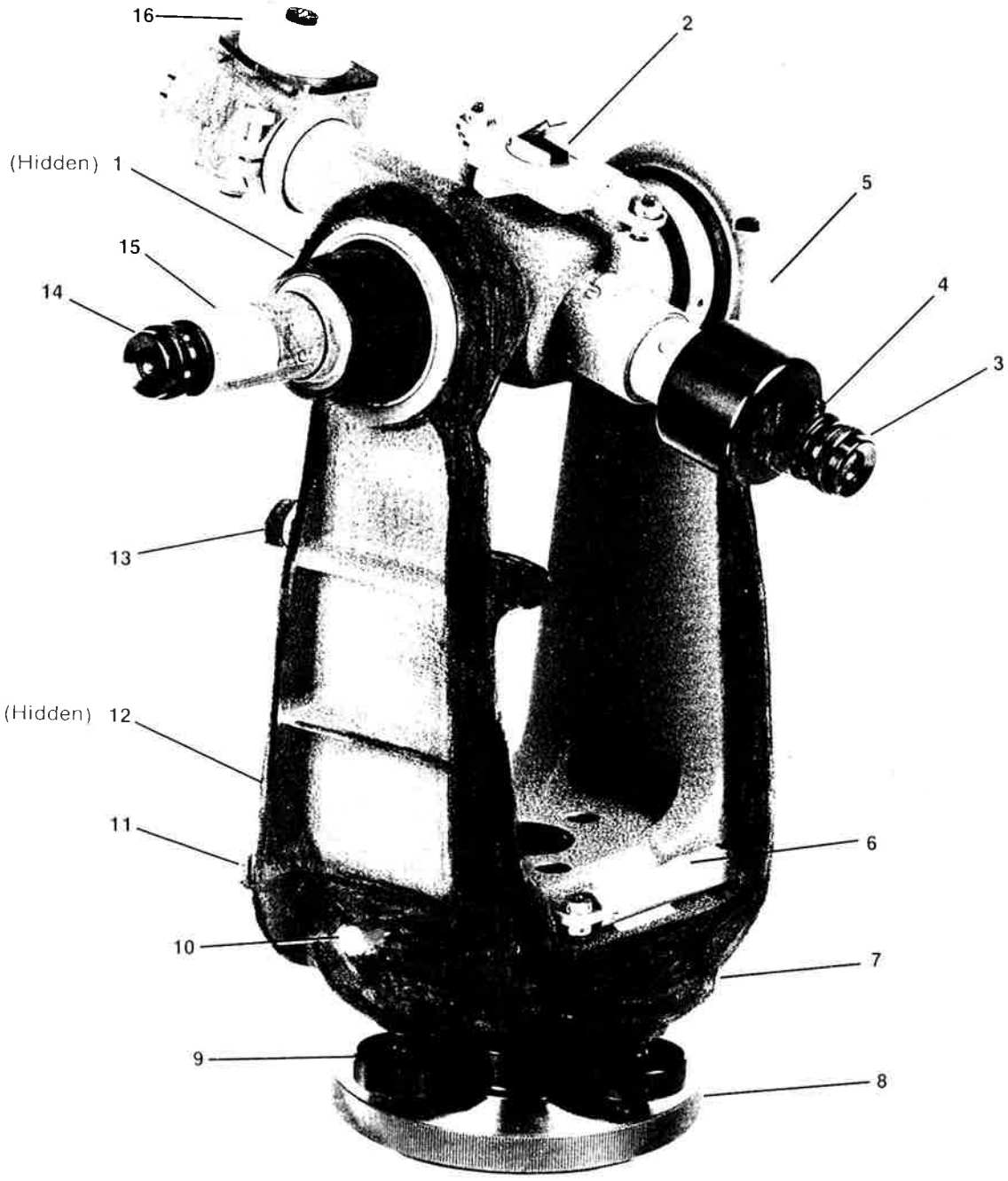
5. Check to see that rough alignment is good and that all clamps on the instrument stand or support are tight. If a lateral adjuster is used, see that the lateral adjuster is oriented so that the slide will be perpendicular to the line of sight when the setup is complete.

6. Slightly loosen two adjacent leveling screws to free the leveling head. Turn the leveling head so that a pair of opposite leveling screws is approximately in line with the line of sight to be established, or in line with the motion of the lateral adjuster or tooling bar carriage, if these items are used.



1. Elevation clamp
2. Telescope level
3. Eyepiece focusing ring
4. Auto-collimation eyepiece
5. Standards (alidade)
6. Plate level
7. Base
8. Leveling head
9. Leveling screws
10. Azimuth clamp
11. Azimuth tangent screw
12. Circular plate level
13. Elevation tangent screw
14. Focusing knob
15. Auto-reflection mirror
16. Optical micrometer scale

Figure 2-1. Jig Transit, Operating Elements



1. Elevation clamp
2. Telescope level
3. Eyepiece focusing ring
4. Auto-collimation eyepiece
5. Standards (alidade)
6. Plate level
7. Base
8. Leveling head
9. Leveling screws
10. Azimuth clamp
11. Azimuth tangent screw
12. Circular plate level
13. Elevation tangent screw
14. Focusing knob
15. Cross-axis telescope
16. Optical micrometer scale

Figure 2-2. Jig Transit Telescope Square, Operating Elements

Figure 2-3. Typical Instrument Stands

2-6. To Level the Instrument

Leveling of the instrument can be accomplished in either two or three steps. The bullseye (circular) level is used for rough leveling. If the instrument is equipped with a long plate level, the long plate level bubble may be used for further refinement. Final leveling is usually done with the telescope level because it is usually the most sensitive level on the instrument. To level the instrument:

1. Observe the circular level bubble. If the bubble is not centered, loosen slightly the leveling screw closest to the circular level bubble, while tightening the opposite leveling screw an equal amount. Always use opposite pairs of leveling screws simultaneously to retain a slight pressure as the leveling adjustment is made. Continue to adjust the leveling screws until the circular level bubble is centered in the bullseye.

NOTE: If the instrument is equipped with a long plate level, step 2 may be performed for leveling refinement; however, this step is not absolutely essential, and you may proceed directly to step 3.

2. When the circular level bubble is centered, turn the alidade until the long plate level is in line with a pair of opposite leveling screws. Center the long plate level bubble in the same manner as the circular level bubble. Then, turn the alidade until the long plate level is approximately in line with the other pair of leveling screws. Repeat the procedures of this step until the long plate level bubble centers in both positions of the alidade. Reverse the bubble by turning the instrument to check the final adjustment of the long plate.

2-7. To Aim at a Target

1. Free the azimuth clamp and the elevation clamp, and direct the telescope at a white or light-colored object.

2. Look through the telescope and adjust the eyepiece focusing ring until the reticle pattern is sharp.

3. If an optical micrometer is being used, set the optical micrometer at zero.

4. Sight over the telescope and point it at the target.

5. Correct the telescope aim so that the target can be seen in the telescope. It may be necessary to adjust the telescope focusing knob to recognize the target. When the target appears, focus precisely, set the azimuth and elevation clamps firmly, and aim the line of sight precisely by adjusting the azimuth and elevation tangent screws.

NOTE: The azimuth and elevation tangent screws are two-speed screws. Turning either tangent screw until the cross line of the reticle passes the target, then reversing the direction of turning, permits low-speed operation in both directions for a short distance.

NOTE: **Never** try the tightness of the azimuth clamp or the elevation clamp after aiming; tightening the clamps changes the aim slightly.

2-8. To Aim a Jig Transit with an Auto-Reflection Mirror at 90 Degrees To a Reference Line

1. Establish the reference line of sight using an Alignment Telescope, Line of Sight Telescope, or Tilting Level with suitable accessories.

2. Set up the Jig Transit so that its elevation axis is nearly on the reference line, with the auto-reflection mirror facing toward the reference instrument.

3. Focus the reference instrument on your reflection in the auto-reflection mirror of the Jig Transit.

4. Hold your finger where the reflected cross lines appear to fall. Have an assistant change the azimuth of the Jig Transit. As the azimuth of the Jig Transit is changed, the reflected cross lines will appear to move; follow them with your finger. Have your assistant continue turning the Jig Transit in azimuth until he sees your finger come to the center of the reference instrument.

5. Focus on the auto-reflection target (Figure 2-4), or use auto-collimation. Have your assistant turn the Jig Transit slowly with the azimuth tangent screw until the reflected vertical cross line (or your target) coincides with the vertical cross lines of the reference instrument.

6. The telescope of the Jig Transit will now sweep through a plane perpendicular to the reference line of sight.

2-9. To Aim a Jig Transit Telescope Square at 90 Degrees To a Reference Line

The Jig Transit Telescope Square has a hollow elevation axle that contains a telescope with fixed infinity focus. The line of sight through the elevation axle is parallel to the elevation axis; therefore, the cross-axis telescope needs only to be aimed at a collimator or any other instrument (focused at infinity) that establishes the reference direction. The line of sight of the main telescope will then sweep a plane at right angles to the reference direction. The operator of the instrument can set it himself without using an assistant.

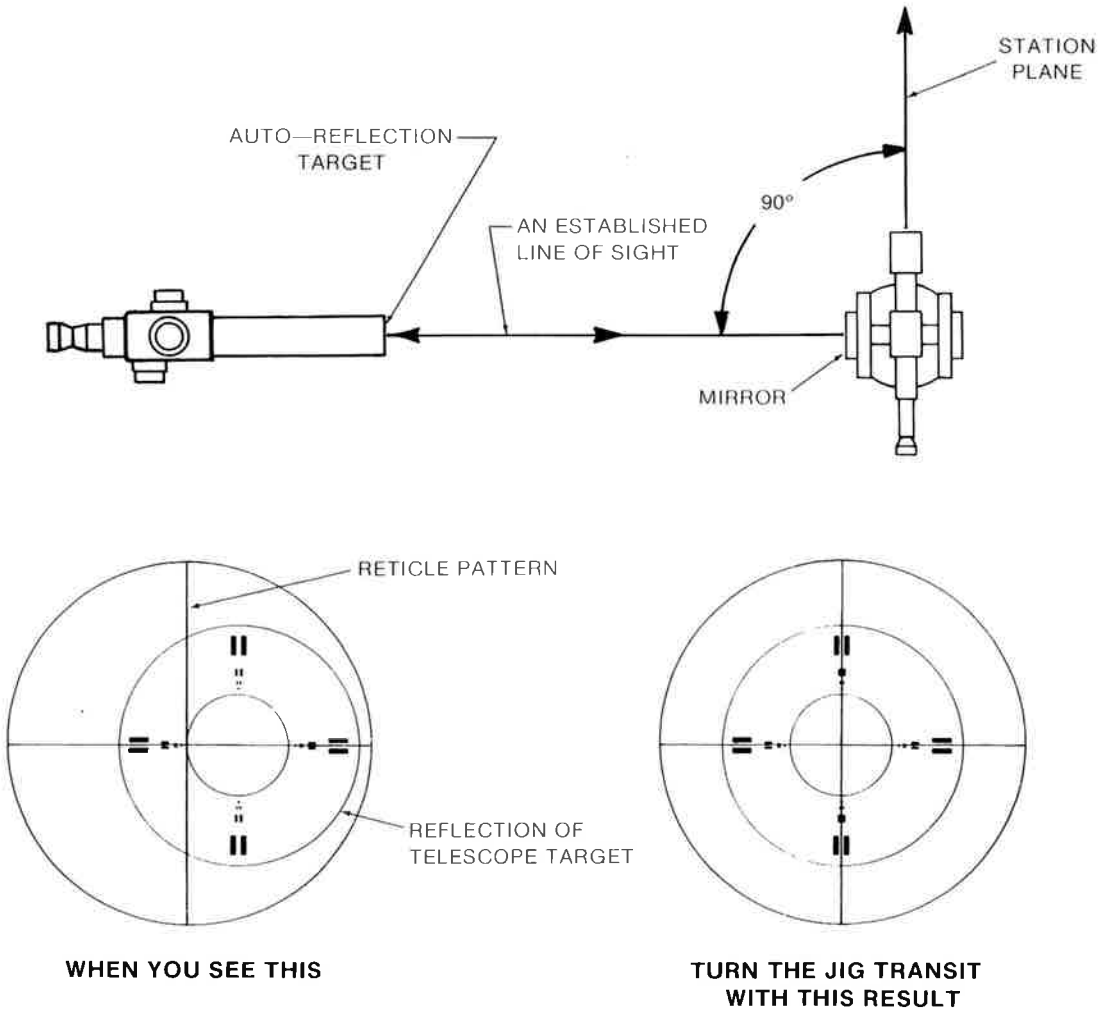


Figure 2-4. Auto-Reflection

2-10. To "Buck-In"

It is frequently necessary to place the Jig Transit in line with two targets or to satisfy two conditions simultaneously. Such a process is called "bucking-in". Usually, a 71 5085 Mechanical Lateral Adjuster is mounted on an instrument stand, and the Jig Transit is mounted on the Lateral Adjuster. With this setup:

1. Lock the head of the instrument stand so that the Lateral Adjuster ways are approximately perpendicular to the final direction of the line of sight.

2. Level the Jig Transit.

3. Sight the telescope on the far target. Use the azimuth tangent screw to align the cross line on the far target.

4. Sight the telescope on the near target. The near target will probably not be aligned with the vertical cross line.

5. Using only the Lateral Adjuster, move the Jig Transit as necessary to bring the vertical cross line on the near target.

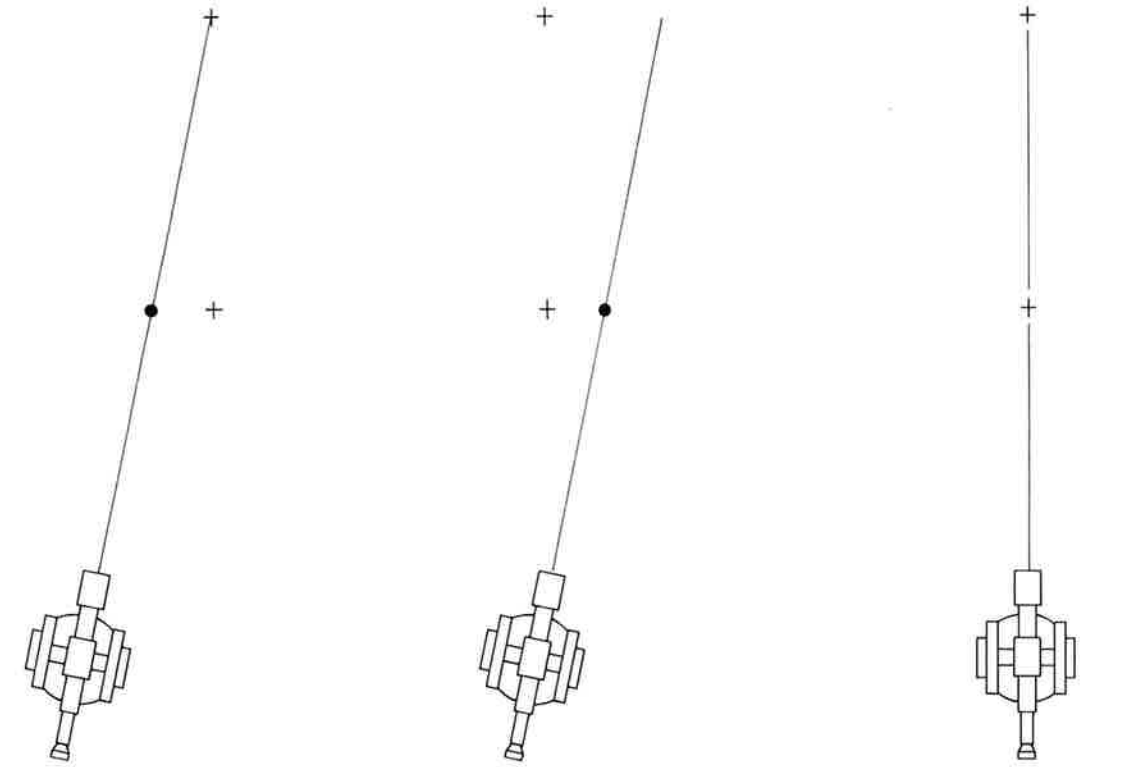
6. Repeat steps 3, 4, and 5 until the Jig Transit is nearly in line with both targets. (See Figure 2-5.)

7. Relevel the Jig Transit and perfect the alignment with the optical micrometer and the azimuth tangent screw.

2-11. To Sight Down Through the Base

This procedure is followed when metrological bars are used, or when it is necessary to set up directly over a point.

1. If the Jig Transit is to be positioned on a metrological bar, mount a 71 5642 Carriage on the metrological bar, mount the Jig Transit on the Carriage, and mount a suitable metrological bar scale at the setup point. If the Jig Transit is to be set up over a point other than on a metrological bar, mount the Jig Transit on a 71 5087 Precision Compound Lateral Adjuster that has been set up approximately over the desired point, and position a suitable target precisely on the point.



1. SIGHT FAR POINT AND CHECK NEAR POINT
2. WITH MECHANICAL LATERAL ADJUSTER MOVE SLIGHTLY BEYOND NEAR POINT
3. SIGHT FAR PONT AND CHECK NEAR POINT

Figure 2-5. Bucking-In

2. Level the Jig Transit.

3. Free the elevation clamp, and point the telescope through the hollow horizontal axle of the instrument at the target or metrological bar scale.

4. Focus on the target or metrological bar scale, lock the elevation clamp, and set the line of sight precisely on the target or the desired point on the metrological bar scale using the elevation tangent screw and the Lateral Adjuster or Carriage lead screw.

5. Turn the standards 180 degrees. If the telescope cross lines move off the target, note the amount and direction of the error. Adjust the vertical tangent screw as required to eliminate half the error, and adjust the Lateral Adjuster or Carriage lead screw to eliminate the remaining error. The Jig Transit should then remain level and centered on the desired point when its standards are rotated through 360 degrees.

2-12. To Collimate the Lines of Sight of Two Instruments

When two instruments are set at infinity focus and aimed at each other so that the reticles appear to coincide, the lines of sight are parallel, but not necessarily coincident. (See Figure 2-6A.) When both instruments are focused at some point between them (usually a target placed at the point temporarily), the reticle of each instrument can be seen on the reticle of the other when the target is removed. When the two instruments are aimed so that the reticles coincide, the lines of sight meet at a point, but are usually at an angle to each other. (See Figure 2-6B.) If the lines of sight of the two instruments are to coincide, the instruments must be aimed so that the reticles appear to coincide when focused at infinity and also when focused at a point between the two instruments. This is similar to bucking-in between a near and a far target. The reticle of each instrument must be illuminated for this procedure. Proceed as follows:

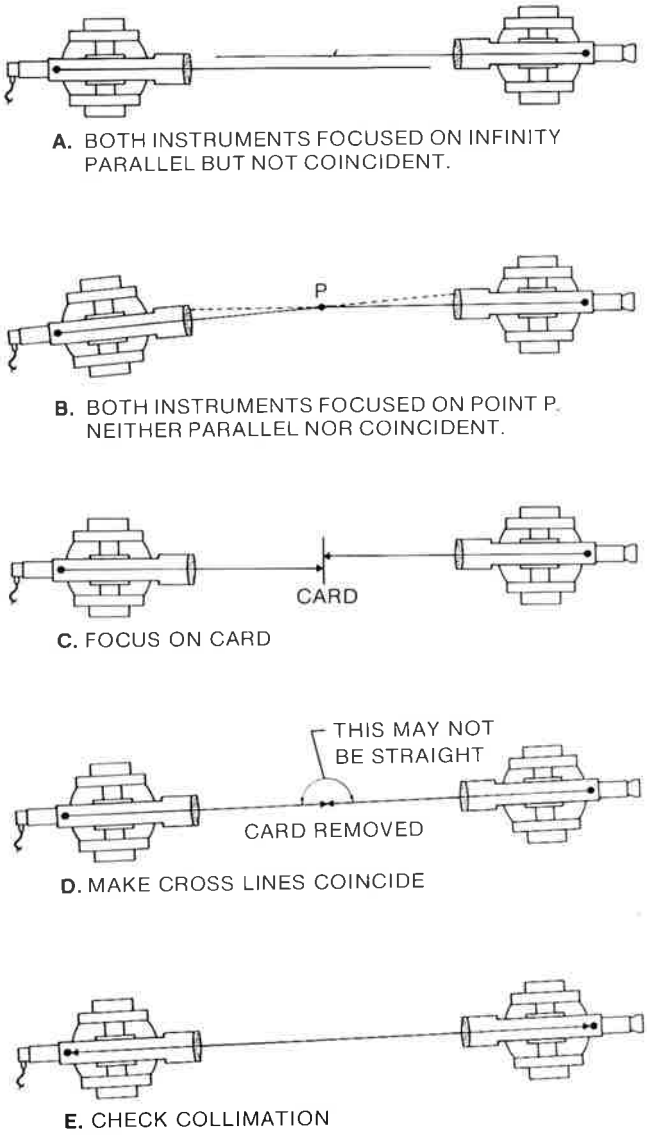
1. Assume that one instrument is aligned to a baseline, and a second instrument is to be made to coincide with it. Auto-collimate the second instrument to the baseline or the fixed instrument.

2. Mount a white card, with marks on each side for focusing, between the two instruments. (See Figure 2-6C.) Without changing the aim of either instrument, focus both instruments on the marks on the card.

3. Remove the card, look through the instruments and, if the cross lines do not coincide, take up the error with the lateral adjuster under the second instrument. (See Figure 2-6D.)

4. Now focus both instruments at infinity. If the reticle patterns do not coincide, take up the error with the tangent screw of the second instrument. (See Figure 2-6E.)

5. Repeat steps 2, 3, and 4 until the reticles coincide under both conditions.



A. BOTH INSTRUMENTS FOCUSED ON INFINITY PARALLEL BUT NOT COINCIDENT.

B. BOTH INSTRUMENTS FOCUSED ON POINT P. NEITHER PARALLEL NOR COINCIDENT.

C. FOCUS ON CARD

D. MAKE CROSS LINES COINCIDE

E. CHECK COLLIMATION

Figure 2-6. Steps in Collimating the Lines of Sight of Two Instruments

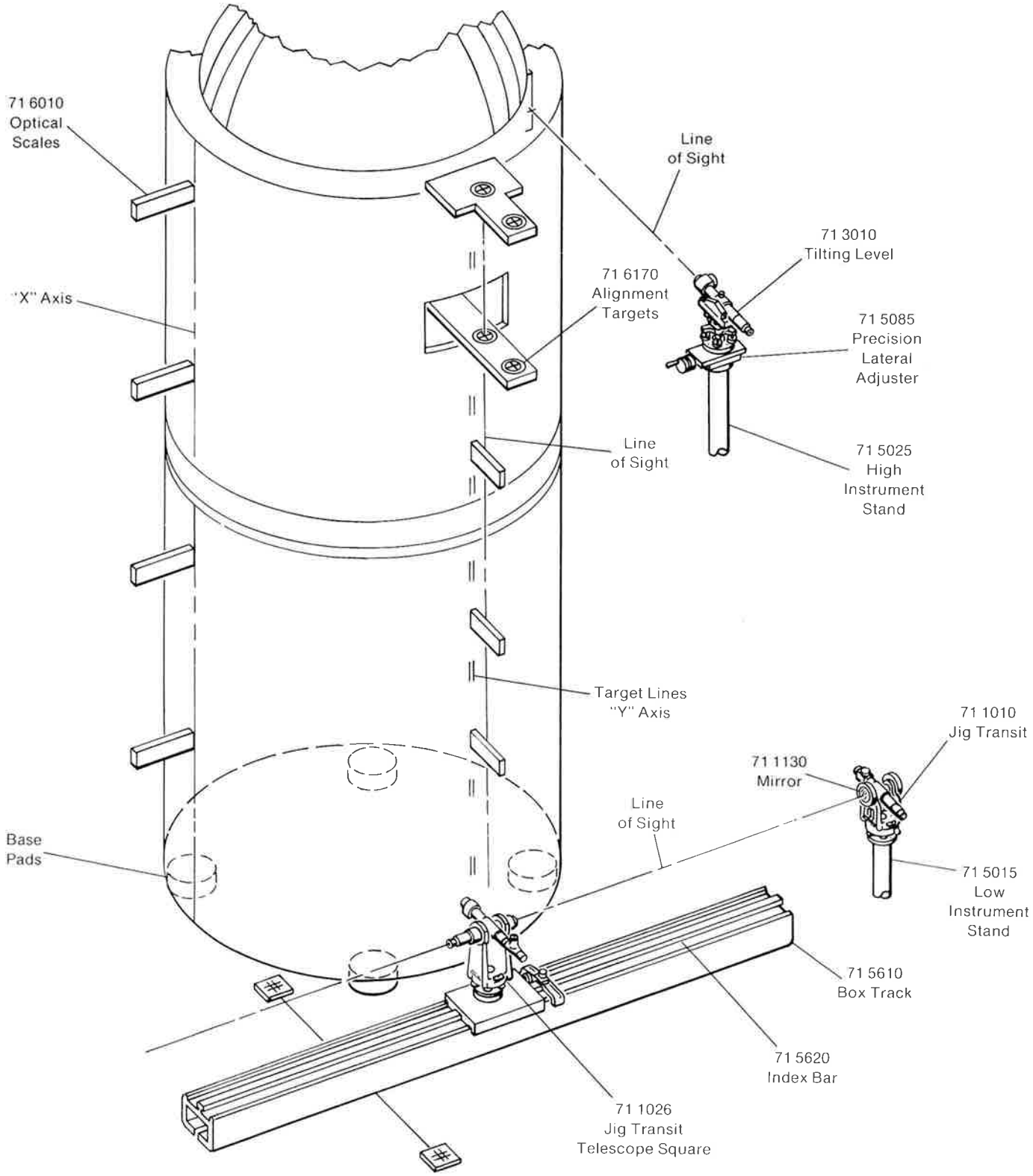


Figure 2-7. Checking Vertical Surface for Plumb

2-13. To Check a Vertical Surface For Plumb (See Figure 2-7.)

1. Set up the Jig Transit on an instrument stand or support that is positioned where the line of sight of the Jig Transit is just to one side of the vertical surface that is to be plumbed.

2. Place optical tooling scales horizontally against the vertical surface at desired points. (If the vertical surface is rigid, optical tooling scales at the bottom and top of the vertical surface will suffice.)

3. Adjust the Jig Transit for a precision plumb line as follows:

(a) Level the Jig Transit. Sight at the lower optical tooling scale and read the scale. Then, elevate the telescope of the Jig Transit and take a reading on the upper optical tooling scale.

(b) Plunge and reverse the telescope.

(c) Set the telescope cross lines on the lower optical tooling scale at the same reading as in step (a). Then, elevate the telescope and read the top optical tocling scale. If the Jig Transit is in perfect adjustment, the top scale reading will be the same as that obtained in step (a). If a slight difference is noted, set the optical micrometer at half the spread between the direct and reverse readings. This will be the true plumb position of the upper point.

4. Adjust the vertical surface until the correct readings are obtained on all optical tooling scales.

SECTION 3 — MAINTENANCE

3-1. CARE OF INSTRUMENT

The Jig Transit is a precision instrument which should be given reasonable care. Jarring and vibration may destroy adjustments. The following rules for care of the instrument are suggested:

1. Always support the instrument in its normal position during storage, use, and adjustment.

2. Never transport an instrument unless it is fully supported on resilient material.

3. Allow the instrument to adjust to surrounding air temperature before operating the instrument.

4. Install any accessories that are to be used with the instrument **before** making instrument adjustments.

5. When leveling the instrument, keep the instrument levels out of direct sun rays and away from any other sources of heat, such as electric lights. Even touching a level with the finger makes the leveling process unreliable.

6. When using the instrument, remember that a column of hot or cold air along the line of sight will destroy the accuracy of the reading.

7. Avoid even partial obstructions along the line of sight when using the instrument. Partial obstructions may make the line of sight unreliable.

8. Protect the instrument from dust as much as possible. Never wipe dust or dirt off a lens. Blow or brush dust and dirt off lightly. If the view through the instrument lenses dims, take the instrument to a competent instrument repair man for cleaning.

9. Lubrication is normally a shop operation; however, if necessary, the threads of the leveling screws may be lubricated with a small amount of fine instrument lubricant. Work the lubricant in by turning the leveling screws up and down throughout their range. Wipe off off excess lubricant with a clean, lint-free cloth.

3-2. TEST AND ADJUSTMENT

The Jig Transit should be tested frequently, but adjustments should be made only if three successive tests give the same error. Many Jig Transit adjustments affect other adjustments; however, minimum interference between adjustments is produced when adjustments are made in the order given in the following paragraphs. **If an adjustment does affect another, it is stated in the procedure.**

3-3. TEST AND ADJUSTMENT PROCEDURES

3-4. Object 1: To Center the Plate Level Bubble When the Azimuth Axis Is Vertical (In the Direction of Gravity)

1. Test 1. Level the instrument using the telescope level. (Refer to the Paragraph 2-6 headed "To Level the Instrument".) Check the bubbles of the accessory plate level and the circular plate level. The bubbles should be centered.

2. Adjustment 1.

(a) With the telescope level bubble centered, center the bubble of the accessory plate level and the circular plate level. The bubbles should be centered.

2. Adjustment 1.

(a) With the telescope level bubble centered, center the bubble of the accessory plate level, using the capstan nuts at one end of the level tube.

(b) Center the bubble of the circular plate level using the four level screws. The circular level mount rocks on a central support. Loosen one screw and tighten another; the bubble will move parallel to the pair used and toward the screw loosened.

(c) Repeat Test 1.

3-5. Object 2: To Rotate the Reticle Until the Vertical Cross Line Lies In a Plane Perpendicular to the Elevation Axis

NOTE: This adjustment destroys Adjustments 3, 5, 6, and 7 which follow.

1. Test 2. Aim at a target, then swing the line of sight up and down with the elevation tangent screw. The vertical cross line should remain on the target.

2. Adjustment 2.

(a) Expose the reticle adjusting screws by unscrewing the protective cover just in front of the eyepiece.

(b) Partly loosen two adjacent reticle adjusting screws.

(c) Tap the loosened reticle adjusting screws **gently** until the vertical cross line is rotated to its correct position.

(d) Tighten the two reticle adjusting screws with equal tension and without strain.

(e) Repeat Test 2.

3-6. Object 3: To Pass the Line of Sight Through the Elevation Axis

NOTE: This adjustment will affect Adjustment 2 **if tension is lost.** It will also destroy Adjustments 5, 6, 7, and 9 which follow.

1. **Test 3.**

(a) Aim at a distant target.

(b) Focus on and read a vertical optical tooling scale place as near to the instrument as possible.

(c) Reverse the telescope of the Jig Transit and again aim at the distant target.

(d) Focus on and read the near scale. The reading should be the same as that obtained in step (b).

2. **Adjustment 3.**

(a) Expose the reticle adjusting screws by unscrewing the protective cover just in front of the eyepiece.

(b) Loosen one of the side reticle adjusting screws **slightly.**

(c) Check the direction and amount of the error noted in Test 3. Using the top and bottom reticle adjusting screws together, adjust the reticle up or down in a direction opposite to the error direction and for a distance of about twice the amount of the error. **Never lose all adjusting screw tension.** Loosen one of the reticle adjusting screws while tightening the other an equal amount.

(d) Tighten the side reticle adjusting screw loosened in step (b).

(e) Repeat Test 3.

3-7. Object 4: To Make the Elevation Axis Perpendicular To the Azimuth Axis

NOTE: This adjustment may affect Adjustments 6 and 7 slightly

1. **Test 4.**

(a) Aim at a high target (elevation angle about 45 degrees). Then, aim down at a horizontal optical tooling scale (angle of depression about 45 degrees), and read the optical tooling scale.

(b) Reverse the telescope of the Jig Transit and repeat step (a). The scale reading should be the same as that obtained in step (a).

2. **Adjustment 4.**

(a) For Jig Transit: At the side of the standard which carries the elevation tangent screw, unscrew the accessory auto-reflection mirror, the weight, or the cap on the end of the axle. Remove the cover plate. This exposes two capstan nuts below the axle. A screw located above the axle controls the friction in the axle bearing. Eliminate one fourth of the error by loosening one capstan nut and tightening the other. **Repeat Test 4.**

(b) For Jig Transit Telescope Square: Using a suitable spanner, free the lock ring and rotate the eccentric sleeve until one fourth of the error is eliminated. (See Figure 3-1.) Tighten the lock ring. **Repeat Test 4.**

3-8. Object 5: To Make the Line of Sight Perpendicular To the Elevation Axis

NOTE: Two alternate tests and adjustments are given; either may be used. This adjustment may affect Adjustment 3.

1. **Test 5A.**

(a) Aim at a distant target at nearly the elevation of the instrument.

(b) Plunge the telescope and read a distant optical tooling scale in the opposite direction.

(c) Keeping the telescope plunged, reverse the instrument to aim back at the distant target used in step (a).

(d) Erect the telescope and read the same distant optical tooling scale. The reading should be the same as that obtained in step (b).

2. **Adjustment 5A.**

   (a) Expose the reticle adjusting screws by unscrewing the protective cover just in front of the eyepiece.

   (b) Loosen one of the side reticle adjusting screws **slightly.**

   (c) Adjust the reticle right or left to eliminate one fourth of the error, using the top and bottom reticle adjusting screws. Loosen one of the reticle adjusting screws and tighten the other screw an equal amount. **Never lose all tension.**

   (d) Tighten the reticle adjusting screw loosened in step (b).

   (e) Repeat Test 5A.

3. **Test 5B.**

   (a) Set one collimator in line with another collimator, and position the Jig Transit between the two collimators.

   (b) Aim at one collimator, and reverse the instrument to double-check. Then, plunge the telescope, and observe the other collimator. The vertical cross lines should coincide.

4. **Adjustment 5B.**

   (a) Expose the reticle adjusting screws by unscrewing the protective cover just in front of the eyepiece.

   (b) Loosen one of the side reticle adjusting screws **slightly.**

   (c) Adjust the reticle up or down to eliminate half the error, using the top and bottom reticle adjusting screws. Loosen one reticle adjusting screw while tightening the other screw an equal amount. **Never lose all tension.**

   (d) Tighten the reticle adjusting screw loosened in step (b).

   (e) Repeat Test 5B.

3-9. Object 6: To Pass the Line of Sight Through the Aximuth Axis

NOTE: This adjustment may affect Adjustments 4 and 5.

1. **Test 6.**

   (a) Aim at a distant target.

   (b) Focus on and read a horizontal optical tooling scale placed as near the instrument as possible.

   (c) Plunge and reverse the telescope and aim at a distant target.

   (d) Focus on the near optical tooling scale and read the scale. The reading should be the same as that obtained in step (b).

2. **Adjustment 6.**

   (a) Remove the two plug screws under the two standards. (See Figure 3-2.) Screw in the two special adjusting tools until they stop.

   (b) Loosen the three socket-head screws on the plate slightly.

   (c) Turn the special adjusting tools and slide the standards as required to eliminate half the error.

   (d) Tighten the three-socket head screws on the plate.

   (e) Repeat Test 6. If no further adjustment is required, remove the adjusting tools and install the plug screws.

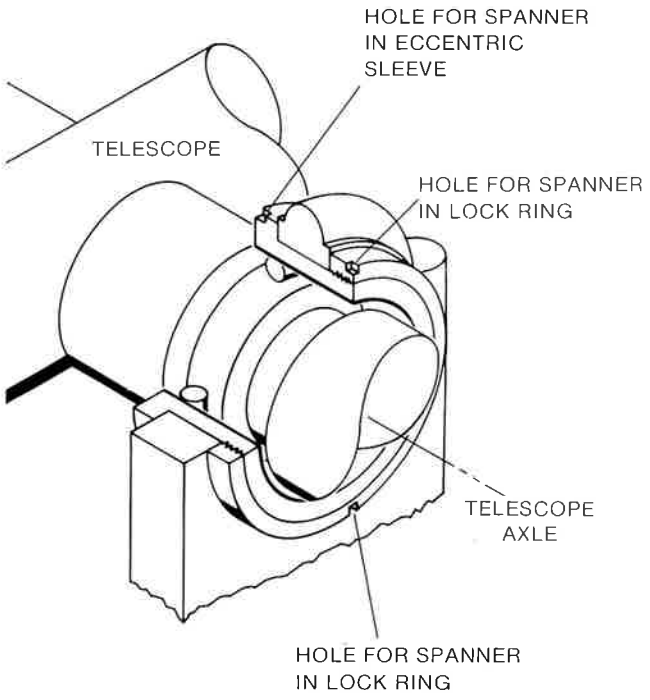


Figure 3-1. Telescope Axle Adjustment for Jig Transit Telescope Square

3-10. Object 7: To Intersect the Elevation Axis With the Azimuth Axis

NOTE: Adjustment 6 must be correct before starting Adjustment 7.

1. Test 7.

There are several methods for accomplishing this test, depending upon available equipment. This test requires a near and a distant target (preferably at infinity by collimation), placed above or below the Jig Transit. The best method is described; this method requires an auto-collimation eyepiece, an optical micrometer, and a 71 6250 Mirror Target.

(a) Mount the Jig Transit on an instrument stand or a trivet. Position the mirror target on the floor or table so that it is reasonably centered under the Jig Transit.

(b) Sight down through the hollow vertical axis and auto-collimate off the mirror target using both the leveling screws and the vertical tangent screw to bring the cross lines into coincidence.

(c) Rotate the instrument 90 degrees and check auto-collimation again. Eliminate any error by adjusting the vertical tangent screw in one direction and the two leveling screws for tilt 90 degrees from the telescope motion. **Do not adjust the leveling screws that are in line with the telescope motion.** It should now be possible to turn the telescope through 360 degrees without disturbing auto-collimation. The line of sight is now parallel to the vertical axis.

(d) Set the optical micrometer to zero, and focus onto the target on the mirror. **Do not disturb the setting of the vertical tangent screw.**

(e) Aim the telescope at the center of the target, using only the leveling screws.

(f) Rotate the instrument 180 degrees. The cross lines should remain on the target. If there is an error, measure the error distance with the optical micrometer.

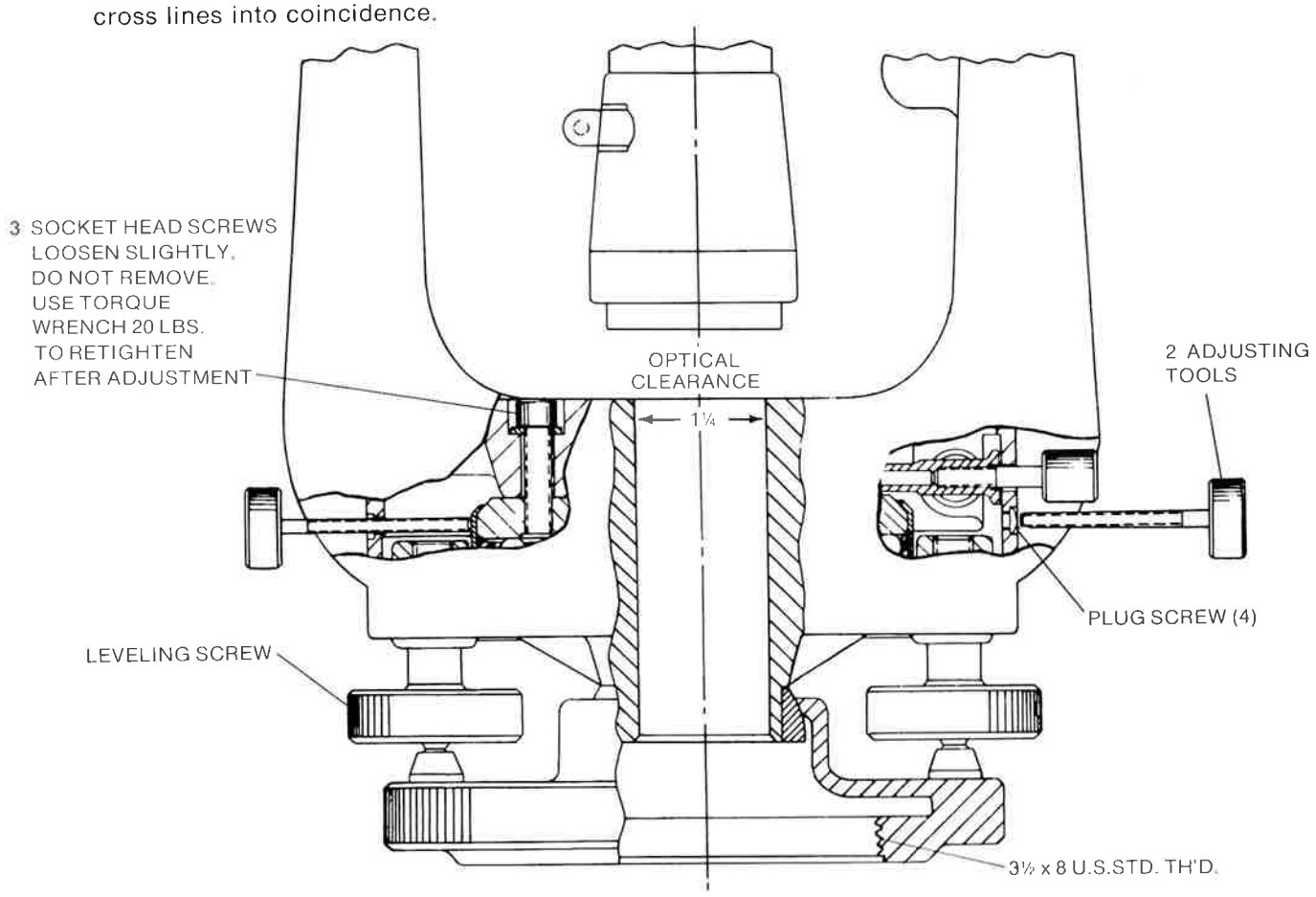


Figure 3-2. How Line of Sight and Elevation Axis Are Made To Intersect Azimuth Axis

2. **Adjustment 7.**
   (a) Set the optical micrometer to one-half the error measurement.

   (b) Remove the four plug screws (Figure 3-2).

   (c) Loosen the three socket-head screws on the plate slightly.

   (d) Screw in the two special adjusting tools, as required, until they stop. Slide the standards, by turning the special adjusting tools, until the cross lines are on the target center.

   (e) Tighten the three socket-head screws on the plate.

   (f) Repeat Test 7. If no further adjustment is required, remove the adjusting tools and install the plug screws.

3-11. Object 8: To Make the Reflecting Surface of the Auto-Reflection Mirror Perpendicular To the Elevation Axis

Two test methods are given; use either test, depending upon available equipment.

1. **Test 8A.**
   (a) Set up an auxiliary transit in the position shown in Figure 3-3. Aim the auxiliary transit at the reflection (in the auto-reflection mirror) of a precise point on the optical tooling scale.

   (b) Plunge the telescope of the Jig Transit on its elevation axis. The reflection of the point should remain on the cross lines of the auxiliary transit.

2. **Test 8B.**
   (a) Set a transit with an auto-collimating attachment as close to the auto-reflection mirror as practical, and auto-collimate off the surface of the auto-reflection mirror.

   (b) Plunge the telescope of the Jig Transit 180 degrees. The cross lines of the transit should remain aligned.

3. **Adjustment 8.**
   There are three spring clips on the face side of the auto-reflection mirror. Behind the center of each clip is a support that holds the mirror against the pressure of the spring clip. Two of the supports are capstan-head screws whose heads are behind the mirror mount; the other support is a fixed hidden point. If the auxiliary transit is placed close to the auto-reflection mirror, it is possible to adjust the mirror while observing the effect by looking into the auxiliary transit; otherwise, one operator must look into the transit and direct a second operator on how to move the auto-reflection mirror. The adjustment procedure is as follows:

   (a) Turn the telescope of the Jig Transit on its elevation axis so that one of the screws (A, Figure 3-4) is level with hidden point P in Figure 3-4.

   (b) Aim the vertical cross line of the auxiliary transit at a certain line on the optical tooling scale reflection in the auto-reflection mirror.

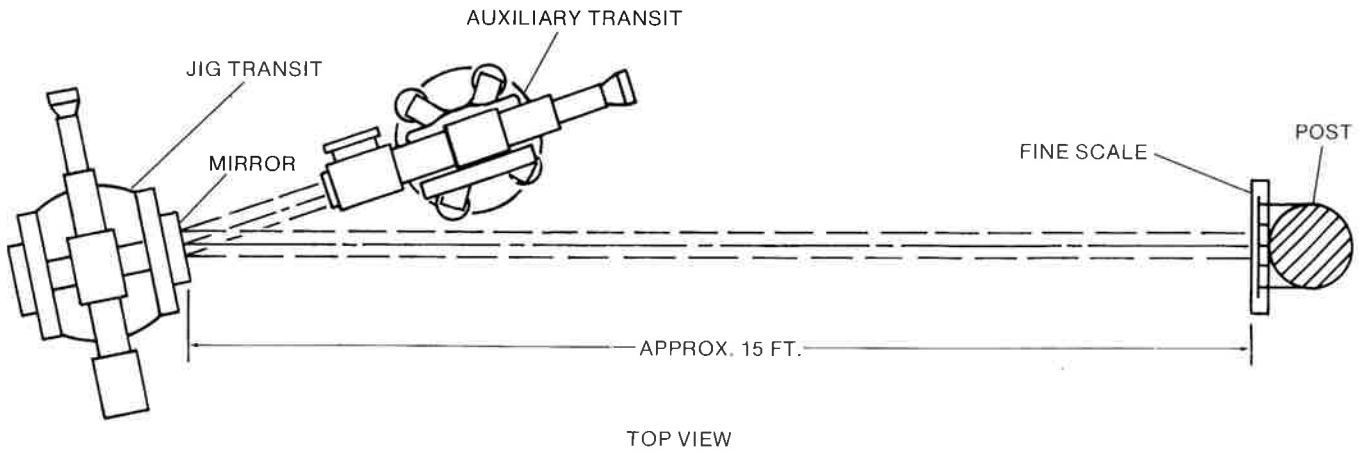


Figure 3-3. Jig Transit and Auxiliary Transit Arranged for Auto-Reflection Mirror Adjustment

(c) Reverse the telescope of the Jig Transit so that the arrangement shown in Figure 3-4 (2) results. Note the error in the scale reading of the auxiliary transit.

(d) Adjust screw (A, Figure 3-4) to eliminate one-half the error.

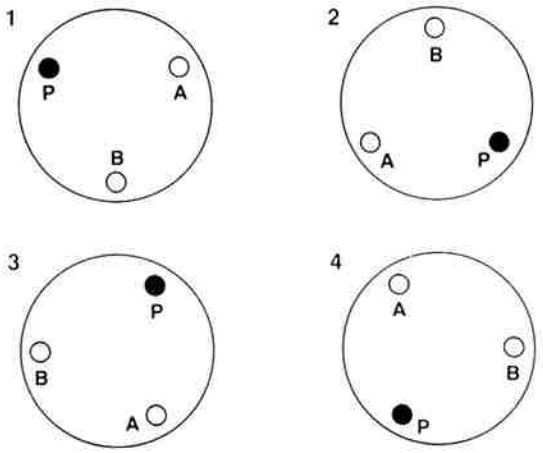
(e) Turn the telescope of the Jig Transit so that the arrangement shown in Figure 3-4 (3) results.

(f) Aim the vertical cross line of the auxiliary transit at a certain line on the optical tooling scale reflection in the auto-reflection mirror.

(g) Reverse the telescope of the Jig Transit so that the arrangement shown in Figure 3-4 (4) results. Note the error in the scale reading of the auxiliary transit.

(h) Adjust screw (B, Figure 3-4) to eliminate one-half the error.

(i) Repeat Test 8A or 8B.



POSITION 1. B AT BOTTOM. AIM AUXILIARY TRANSIT
2. B AT TOP. ADJUST SCREW A
3. B AT LEFT. AIM AUXILIARY TRANSIT.
4. B AT RIGHT. ADJUST SCREW B.

NOTE:
Screw positions are shown viewing face of mirror. Screws A and B are visible behind mirror. Support Point P is not visible.

Figure 3-4. Adjustment Positions of Auto-Reflection Mirror

3-12 Object 9: To Adjust the Reticle of the Cross-Axis Telescope of the 71 1026 Jig Transit Telescope Square So That Its Line of Sight Is Parallel To the Elevation Axis

1. **Test 9.**
   (a) Aim the cross-axis telescope at the infinity reticle of a collimator, or auto-collimate off a mirror.

   (b) Turn the main telescope 180 degrees in elevation. The aim of the cross-axis telescope should be undisturbed.

2. **Adjustment 9.** (See Figure 3-5.)
   (a) Unscrew the cover ring from the eyepiece end of the cross-axis telescope to expose four reticle adjusting screws.

   (b) To raise or lower the aim of the Line of Sight, loosen one of the side reticle adjusting screws **slightly**, and make the required adjustment by adjusting the top and bottom reticle adjusting screws equal amounts in opposite directions (tighten one, loosen the other) in small steps. **Never lose all tension.** To move the aim of the line of sight left or right, use the two side reticle adjusting screws in the same manner.

   (c) Repeat Test 9.

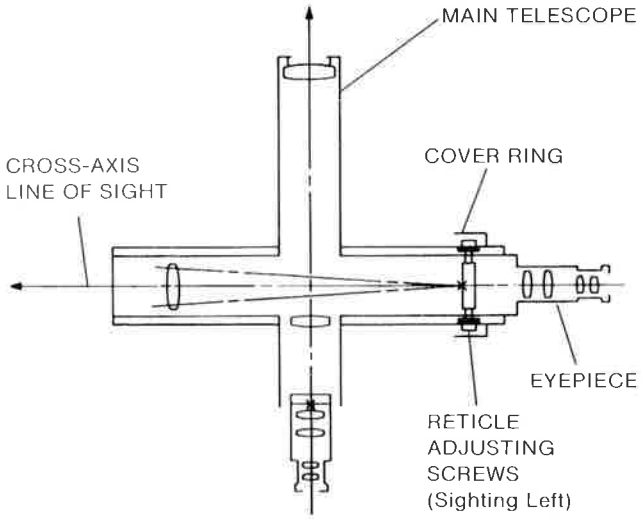


Figure 3-5. Schematic View of Cross-Axis Optical System in Jig Transit Telescope Square

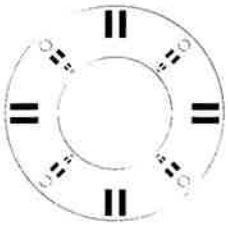
APPENDIX—ACCESSORIES

71 1111
Optical Micrometer

71 1113
Metric Optical Micrometer

71 1115
Optical Micrometer

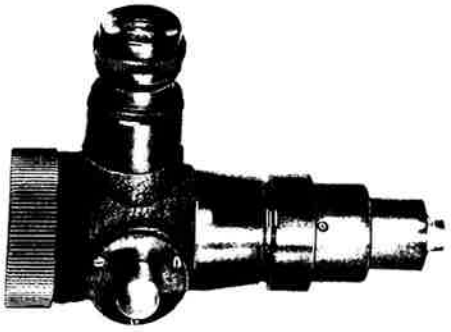
71 1130
Circular Auto-Reflection Mirror



71 1140
Auto-Reflection Target

71 1211
Auto-Collimation Conversion Unit

71 1231
Right-Angle Eyepiece

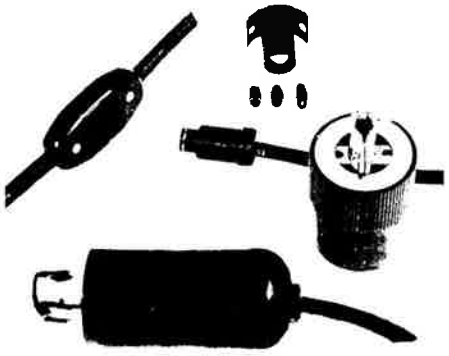


71 1241
Combination Auto-Collimation, Projection, Right-Angle Eyepiece

71 1260
Prismatic Eyepiece

71 3250
Coincidence Level

71 3260
Level Vial



71 5511
Auto-Collimation Illumination Unit

Figure A-1. Jig Transit Accessories

A-1. 71 1111 OPTICAL MICROMETER WITH VERNIER SCALE

Description

The 71 1111 Optical Micrometer with Vernier Scale can be installed on the objective end of the instrument telescope to enable measurement of horizontal or vertical displacement from the instrument line of sight. Its range is ±0.100 inch. Displacements can be read directly to 0.001 inch on a uniformly graduated red and black scale. Readings to 0.0001 inch can be made on the vernier scale. The Optical Micrometer operates by displacing the line of sight parallel to itself. (See Figure A-2.)

The Optical Micrometer has a dustproof cover glass, and a split clamp for mounting. It can be adjusted and calibrated without removal from the instrument.

Installation and Adjustment

1. Free the split-ring clamp screw of the Optical Micrometer.
2. Slide the Optical Micrometer onto the front end of the instrument telescope. Position the Optical Micrometer drum on top or underneath the telescope to measure horizontal displacements, or turned 90 degrees to measure vertical displacements.

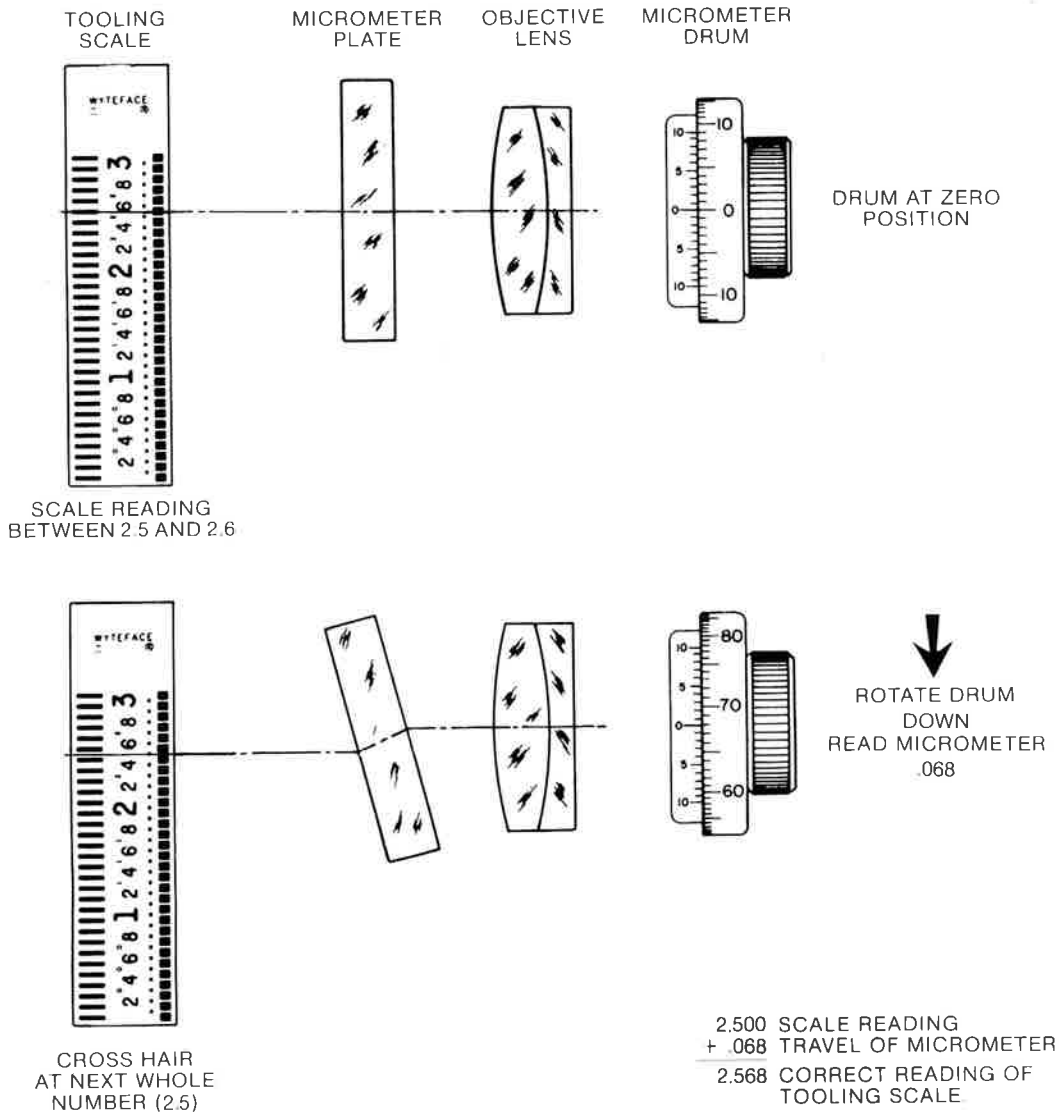


Figure A-2. Example of Optical Micrometer Use

3. Tighten the split-ring clamp screw slightly so that the Optical Micrometer will turn without play.

4. Aim at a target.

5. Turn the drum of the Optical Micrometer back and forth throughout its full range. Rotate the Optical Micrometer on the instrument telescope until the appropriate cross line remains on the target through the full range of drum rotation, and tighten the split-ring clamp screw.

6. It is suggested that the instrument be calibrated with the Optical Micrometer in place, and that the Optical Micrometer be left on the instrument during storage. This will minimize the need for repeated calibration.

Use

To use the Optical Micrometer to measure displacement from a reference line, proceed as follows:

1. Install and adjust the Optical Micrometer on the Jig Transit. Set the Optical Micrometer to zero.

2. Aim the Jig Transit line of sight at a reference target.

3. Position an optical tooling scale horizontally with its zero end against the object whose distance from the reference line is to be determined.

4. Sight at the optical tooling scale and note where the line of sight strikes the scale.

5. Turn the Optical Micrometer knob so that the line of sight is made to coincide with the next smaller valued 0.100 inch mark on the optical tooling scale. (See Figure A-2.)

6. Record the inch and tenth of inch values of this mark of the optical tooling scale. Add the number of thousandths of an inch read from the Optical Micrometer scale. If greater precision is required, use the readings from both the Optical Micrometer scale and the Optical Micrometer vernier. Units of 0.0001 inch can be read from the vernier.

A-2. 71 1113 METRIC OPTICAL MICROMETER WITH VERNIER SCALE

Description

The 71 1113 Metric Optical Micrometer with Vernier Scale is similar to the 71 1111 Optical Micrometer with Vernier Scale, except that it is calibrated in metric units. Its range is ±2.0 mm, the main scale reads directly to 0.02 mm, and the vernier scale reads to 0.0002 mm.

Installation and Adjustment

The installation and adjustment procedure is the same as that for the 71 1111 Optical Micrometer with Vernier Scale.

Use

Use of the 71 1113 Metric Optical Micrometer with Vernier Scale is basically similar to that described for the 71 1111 Optical Micrometer with Vernier Scale. Because the 71 1113 Metric Optical Micrometer with Vernier Scale is calibrated in metric units, it is normally used in conjunction with a 71 6041 WYTEFACE® Metric Optical Alignment Scale, and all displacement measurements are made in units of mm rather than inches.

A-3. 71 1115 OPTICAL MICROMETER

Description

The 71 1115 Optical Micrometer is similar to the 71 1111 Optical Micrometer with Vernier Scale, except that it has an auto-reflection target photo-etched on its cover glass.

Installation and Adjustment

The installation and adjustment procedure is the same as that for the 71 1111 Optical Micrometer with Vernier Scale.

Use

To use the 71 1115 Optical Micrometer to measure displacement from a reference line of sight, use the same procedure as described for the 71 1111 Optical Micrometer with Vernier Scale. The auto-reflection target facilitates auto-reflection, whereby a mirror is set perpendicular to the instrument line of sight or, conversely, the instrument line of sight is set perpendicular to the mirror. For auto-reflection, proceed as follows:

1. Install and adjust the Optical Micrometer on the Jig Transit. Set up the instrument so that its line of sight strikes the surface of the auto-reflection mirror.

2. Focus the instrument and aim at the reflection of the auto-reflection target in the mirror. (See Figure A-3.)

3. Adjust the auto-reflection mirror (or the Jig Transit) so that the target reflection coincides with the reticle pattern. The mirror surface is then perpendicular to the line of sight of the Jig Transit.

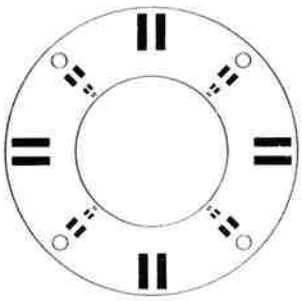
A-4. 71 1140 WYTEFACE® AUTO-REFLECTION TARGET (ALUMINUM)

Description

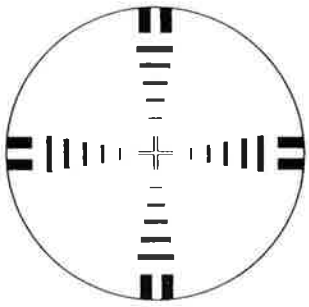
The 71 1140 WYTEFACE® Auto-Reflection Target is designed for installation on the objective end of the telescope of the Jig Transit or on the Optical Micrometer. It provides a point of reference on the line of sight for auto-reflection.

Installation and Adjustment

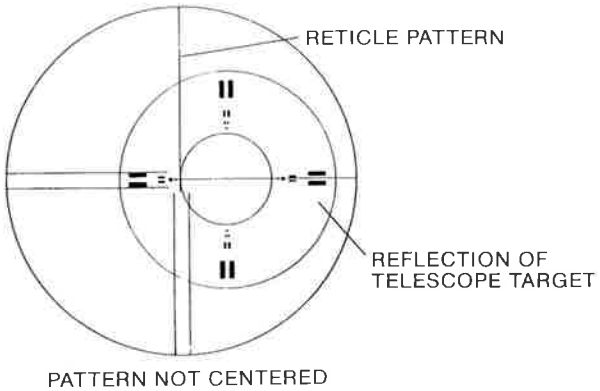
The 71 1140 WYTEFACE Auto-Reflection Target is provided with a spring-fit mounting ring. It can be mounted directly on the mounting lip at the objective end of the telescope barrel of the Jig Transit, or on the mounting lip on the Optical Micrometer. It has two sets of paired-line targets oriented approximately 45° from each other. The first set consists of the finer pairs for close-in sights, and the second set consists of widely spaced pairs for long sights. After installation, the 71 1140 WYTEFACE Auto-Reflection Target must be rotated so that the appropriate set of paired lines is oriented to the instrument reticle lines. This can be done approximately by "eyeballing" at the time of mounting, and refined by observing the reflected image of the 71 1140 WYTEFACE Auto-Reflection Target pattern in a mirror placed perpendicular to the line of sight of the instrument. When changing from the short range pattern to the long range pattern, the entire 71 1140 WYTEFACE Auto-Reflection Target must be rotated approximately 45° and re-oriented to the instrument reticle.

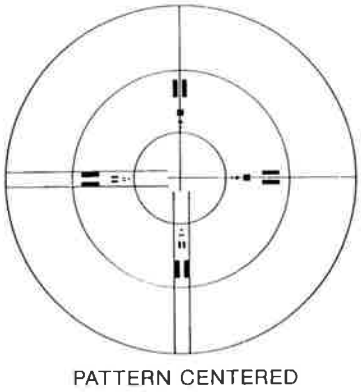


A. Slip-on auto-reflection target.



B. Built-in auto-reflection target.





C. What the observer sees.

Figure A-3. Auto-Reflection

Use

To use the 71 1140 WYTEFACE® Auto-Reflection Target for auto-reflection, install it on the instrument or optical micrometer, adjust it, and follow the same procedure as described for the 71 1115 Optical Micrometer.

A-5. 71 1211 AUTO-COLLIMATION CONVERSION UNIT

Description

The 71 1211 Auto-Collimation Conversion Unit can be used to convert the Jig Transit Telescope into an auto-collimating telescope. It is supplied complete with a lightplug assembly, cord, switch and fixed 6-volt transformer. It operates directly from 110 volts AC, 50-60 Hz. The Auto-Collimation Conversion Unit consists of two major parts: the beam splitter with its mount, and the illumination unit. The illumination unit may be ordered separately for replacement as 71 5511 Auto-Collimation Illumination Unit. (See Paragraph A-11.)

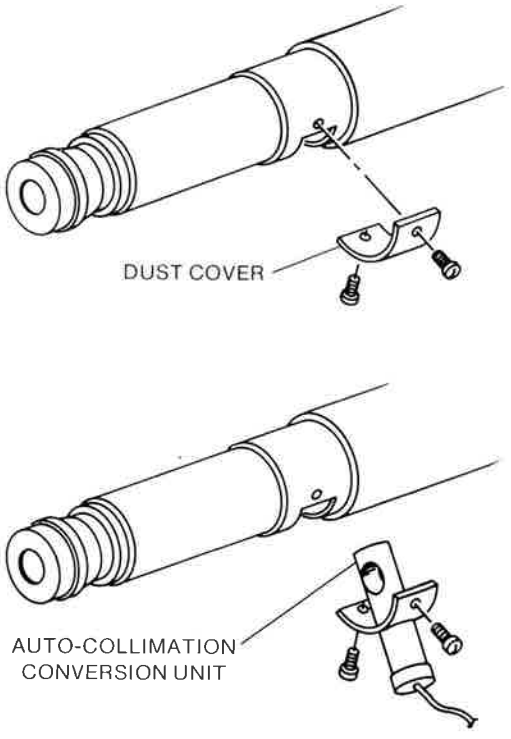


Figure A-4. Installation Location for 71 1211 Auto-Collimation Conversion Unit

Installation

To install the 71 1211 Auto-Collimation Conversion Unit on the Jig Transit, proceed as follows:

1. Locate the dust cover plate on the underside of the telescope tube just forward of the eyepiece. (See Figure A-4.)

2. Remove the two dust cover plate attaching screws, then remove the dust cover plate. The same two screws are used to mount the Auto-Collimation Conversion Unit.

3. Insert the Auto-Collimation Conversion Unit into the opening in the telescope tube. Note that the mounting holes are off-center so that the Unit can be mounted only in its proper orientation. The Unit should be mounted with its wide edge forward of the holes. When the Unit has been properly positioned, Insert the mounting screws and snug the screws tight.

4. The 71 5511 Auto-Collimation Illumination Unit is provided with an on-line 6-volt transformer with a 3-prong, twist-lock male connector. (This is in accordance with AIA requirements.) Plug the male connector into a suitable 110 volt AC outlet or extension cord connected to such an outlet. If a 3-prong, twist-lock outlet or extension cord is not available, the unmounted female connector supplied with the Auto-Collimation Conversion Unit can be used to fabricate an extension cord or short pig-tail to adapt to the available AC outlet or extension cord.

5. Turn on the switch and check the light in the Auto-Collimation Illumination Unit. It is used to illuminate the cross lines of the telescope.

Use

The auto-collimation process can be used to position a part perpendicular to the line of sight of the telescope. With the Auto-Collimation Conversion Unit installed, mount an optically flat target mirror on the part that is to be positioned so that the reflective surface of the mirror is approximately centered on the line of sight of the telescope. When the telescope is aimed at the mirror and focused, it serves as a telescopic sight and both the illuminated cross lines and the reflection of those cross lines in the mirror can be seen through the telescope. By adjusting the part so that the reflection of the cross lines coincides with the actual cross lines of the reticle, both the mirror and the part are perpendicular to the line of sight of the telescope. (See Figure A-5.)

A-6. 71 1231 RIGHT-ANGLE EYEPIECE

Description

The 71 1231 Right-Angle Eyepiece can be used in place of the standard eyepiece of the Jig Transit Telescope for very low setups or when working close to walls, columns, or other obstructions. The Right-Angle Eyepiece also makes it possible to use the Jig Transit for zenith sights. It maintains a fully erect image, and can be rotated through 360 degrees for sighting from any angle perpendicular to the line of sight.

Installation and Adjustment

Unscrew the standard eyepiece from the Jig Transit telescope and install the Right-Angle Eyepiece on the telescope. Observe the reticle; if the reticle cannot be brought into sharp focus using the Eyepiece focusing ring, the following adjustment is required:

1. Set the Right-Angle Eyepiece at the middle of its total movement.
2. Remove the eyepiece and adapter from the Eyepiece assembly. (See Figure A-6.) Loosen setscrew "A" with a 0.023 inch socket wrench.
3. Move the lens mount in or out in small increments, installing the eyepiece and adapter and checking the focus after each adjustment, until the reticle can be focused sharply with the Eyepiece focusing ring.
4. Remove the eyepiece and adapter and tighten setscrew "A".
5. Recheck reticle focusing. **If necessary, repeat steps 1 through 4.**

Use

Except for the fact that the eyepiece is displaced 90 degrees relative to the instrument line of sight, the Right-Angle Eyepiece is focused and used in the same manner as the standard eyepiece. Merely position the eyepiece for most convenient sighting.

A-7. 71 1241 COMBINATION AUTO-COLLIMATION, PROJECTION, RIGHT-ANGLE EYEPIECE

Description

The 71 1241 Combination Auto-Collimation, Projection, Right-Angle Eyepiece is interchangeable with the standard eyepiece of the Jig Transit telescope. It can be converted in the field as required to form a straight through vision system, or a right-angle vision system. The unit includes a variable output transformer for use with 110 volts AC, 50-60 Hz.

Installation and Adjustment

Unscrew the standard eyepiece from the Jig Transit telescope, and screw on the Combination Auto-Collimation, Projection, Right-Angle Eyepiece in its place. Observe the reticle through the Eyepiece; if the reticle cannot be brought into sharp focus using the Eyepiece focusing ring, adjust the Eyepiece as follows:

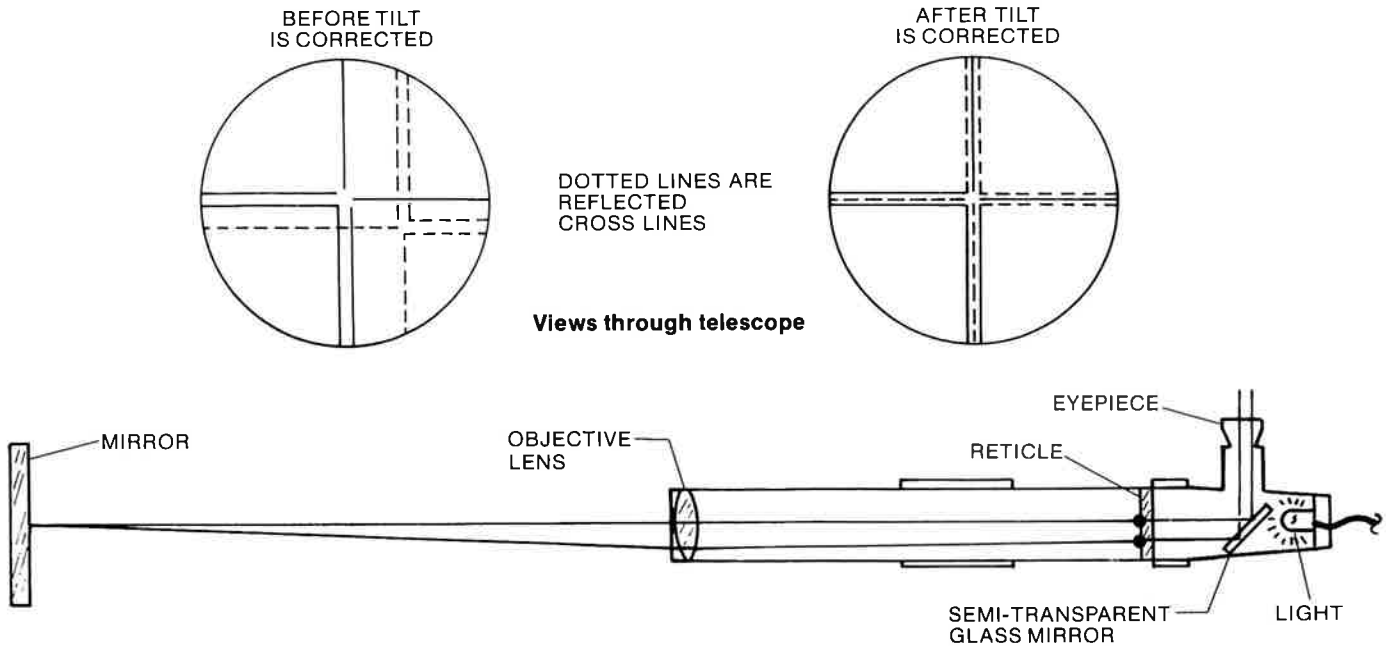


Figure A-5. Auto-Collimation

1. Set the Eyepiece to the approximate center of its movement. Then, unscrew the entire unit.
2. Loosen setscrew "A" (Figure A-7) with a 0.035 inch hexagon key.
3. Move the lens mount in or out in small increments. Check the reticle focusing after each incremental adjustment.
4. When the reticle can be focused sharply with the Eyepiece focusing ring, tighten setscrew "A".
5. Focus the telescope at infinity.
6. Hold a piece of white paper approximately two feet from the end of the telescope.
7. Connect the projection unit to the transformer, switch on AC power, and observe the projected filament on the white paper. If the filament does not appear sharp, loosen the four projection unit adjusting screws and move the lamp forward or backward until the filament appears sharp.
8. Adjust the lamp with the four projection unit adjusting screws until the filament appears centered in the projected circle of the field.
9. Refocus the telescope until the reticle appears sharp on the white paper. The projected circle should be bright and evenly illuminated. If a shadow appears in the field, the lamp (filament) is not centered properly; repeat step 8.

Use

1. To use the Combination Auto-Collimation, Projection, Right-Angle Eyepiece for right-angle viewing, merely position the Eyepiece for most convenient viewing, and focus and use the Eyepiece in the same manner as the standard eyepiece.

2. To use the Combination Auto-Collimation, Projection, Right-Angle Eyepiece for straight-through viewing, interchange the projection unit and the eyepiece/eyepiece mount assembly. Then, focus and use the Eyepiece in the same manner as the standard eyepiece.

3. To use the Combination Auto-Collimation, Projection, Right-Angle Eyepiece, for auto-collimation, connect the projection unit to its transformer, switch on AC power, and push the prism slide assembly to the right. The auto-collimation process is the same as that described for the 71 1211 Auto-Collimation Conversion Unit.

4. To use the Combination Auto-Collimation, Projection, Right-Angle Eyepiece as a projection eyepiece, connect the projection unit to its transformer, switch on AC power and push the prism slide assembly to the left.

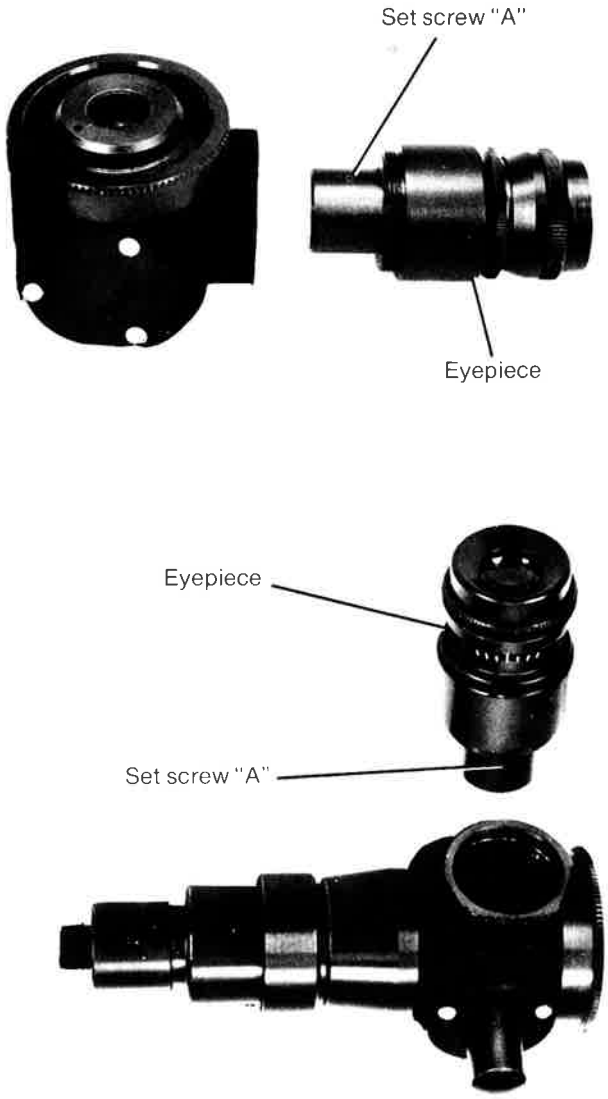


Figure A-7. 71 1241 Combination Auto-Collimation, Projection, Right-Angle Eyepiece

A-8. 71 1260 PRISMATIC EYEPIECE

Description

The 71 1260 Prismatic Eyepiece is used as an attachment on the standard eyepiece of the Jig Transit for very low setups, or when working close to walls, columns, or other obstructions. It may be rotated through 360 degrees and gives an erect but reversed image.

Installation
To install the 71 1260 Prismatic Eyepiece, unscrew the end ring of the standard eyepiece, and screw on the Prismatic Eyepiece in its place. No adjustments are required.

Use
To use the Prismatic Eyepiece, merely rotate it to the position that enables the most convenient viewing, and sight through the Prismatic Eyepiece. Note that the Prismatic Eyepiece will give a reversed image.

A-9. 71 3250 COINCIDENCE LEVEL

Description
The 71 3250 Coincidence Level can be used on the Jig Transit as either the plate level or the telescope level. Its sensitivity is 20 seconds of arc per 2 mm movement. The Coincidence Level offers the advantage of more precise indication.

Installation
Remove the mounting hardware for the level to be replaced, and remove this level from the Jig Transit. Install the Coincidence Level in its place, using the same mounting hardware.

Use
To use the Coincidence Level for leveling of the Jig Transit, adjust the mirror on the Coincidence Level so that the two ends of the level bubble are visible in the mirror. Then, level the instrument, following the normal instrument leveling procedure (Paragraphs 2-6, Section 2), until the ends of the bubble, as viewed in the mirror, coincide. This process is illustrated in Figure A-8. When the two ends of the bubble coincide, the bubble is centered.

A-10. 71 3260 LEVEL VIAL

Description
The 71 3260 Level Vial can be used on the Jig Transit as either the plate level or the telescope level. (It is supplied on the standard instrument as the telescope level.) It has a sensitivity of 20 seconds of arc per 2 mm movement.

Installation
Remove the mounting hardware for the level to be replaced, and remove this level from the Jig Transit. Install the Level Vial in its place, using the same mounting hardware.

Use
To level the instrument to which the Level Vial is attached, use the normal instrument leveling procedure (Paragraphs 2-6, Section 2). When the Level Vial bubble is centered, the instrument is level.

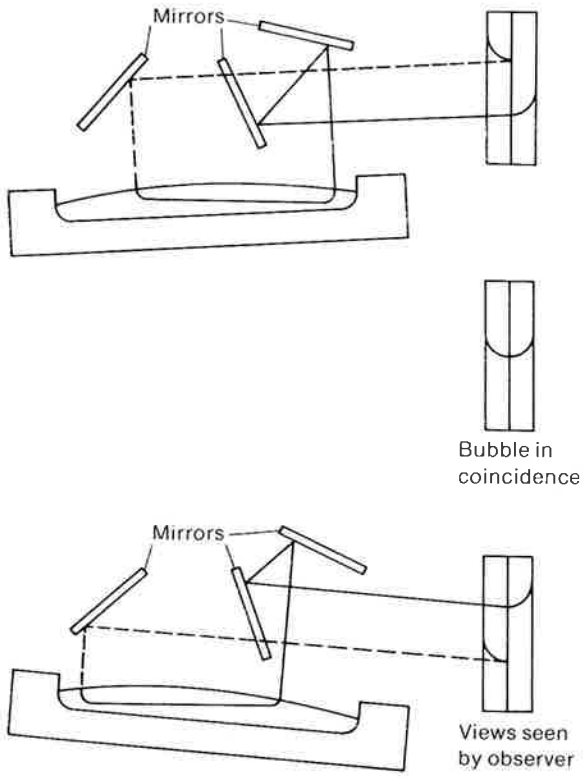


Figure A-8. Coincidence Level

A-11. 71 5511 AUTO-COLLIMATION ILLUMINATION UNIT

The 71 5511 Auto-Collimation Illumination Unit is part of the 71 1211 Auto-Collimation Conversion Unit, although it may be ordered separately for replacement purposes. It consists of a transformer, cord, switch, and light plug assembly. It is designed for operation from 110 volts AC, 50-60 Hz, and may be used with all auto-collimation illumination attachments. Installation and use are described in connection with the 71 1211 Auto-Collimation Conversion Unit.

A-12. 71 1130 CIRCULAR AUTO-REFLECTION MIRROR

Description
The 71 1130 Circular Auto-Reflection Mirror is installed on the elevation axle of the 71 1010 Jig Transit when the Jig Transit is to be used for establishing a plane perpendicular to a line of sight. The 2-5/16 inch diameter mirror is optically flat to within 1/4

wavelength of light. It can be mounted on either end of the Jig Transit elevation axle, and it can be adjusted to square with the elevation axle by means of two adjusting screws.

Installation and Adjustment

To install the Circular Auto-Reflection Mirror, unscrew the axle cap from the desired end of the elevation axle of the Jig Transit, and screw the Circular Auto-Reflection Mirror onto the axle end. Following installation, check and adjust the Circular Auto-Reflection Mirror in accordance with Paragraph 3-11, Test and Adjustment Procedures, in Section 3 of this manual.

Use

Use of the Circular Auto-Reflection Mirror is covered in Paragraph 2-9, "To Aim a Jig Transit with an Auto-Reflection Mirror at 90 Degrees to a Reference Line", in Section 2 of this manual.

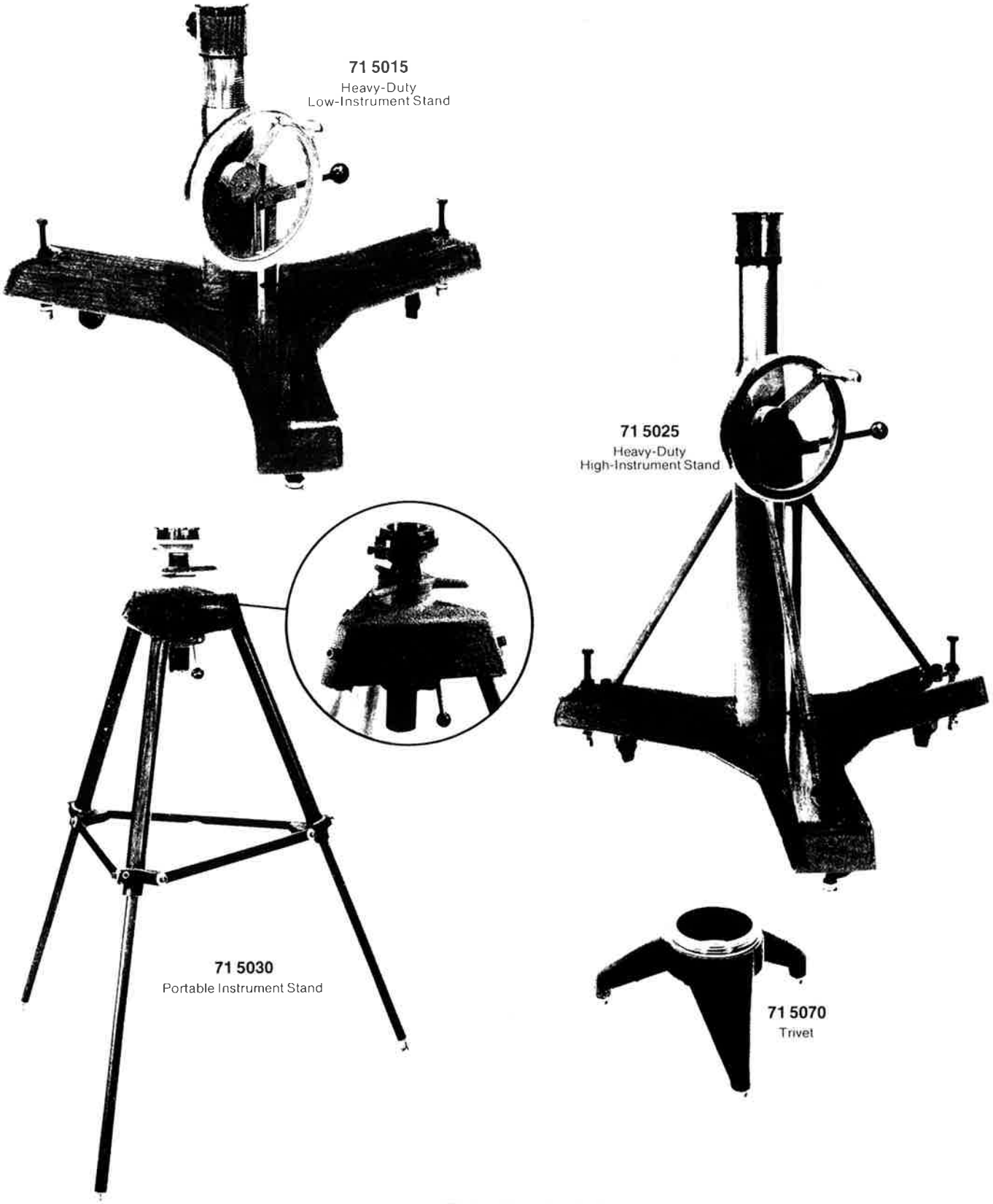


Figure A-9. Typical Instrument Stands

INSTRUMENT STANDS

A-13. 71 5025 HEAVY DUTY HIGH INSTRUMENT STAND

The 71 5025 Heavy Duty High Instrument Stand provides an exceptionally rigid support for optical tooling and other instruments. It is easily positioned by rolling on retractable rubber covered casters. A quick release mechanism places the stand on three adjusting bolts with swivel pad shoes. The bolts permit leveling of the stand. Range of tilt 5° approx.

The center column is height adjustable by cranking a large diameter hand wheel which operates a fine drive worm and pinion. A precision rack is ground directly into the column. Range 33 in., adjustment from 40 to 73 in. between shoes and instrument base interface. A clamp lock holds the column to any desired height. Capacity, 150 lbs.

The column head is rotatable through 360° with a locking clamp to hold it in position. U.S. Standard 3½ x 8 thread is provided for instrument attachment. The column is hollow for downward sighting, with a clear aperture of 1¼ in. diameter. The column head is provided with a rubber shock bumper for instrument protection in the event the elevation clamp is released under load. A shock resistant plastic thread cap is provided.

Floor space required, 3 ft. 6 in. x 3 ft. 6 in. Net weight 230 lbs. approx. Shipping weight, 274 lbs. approx. Cube, 45 cu. ft.

A-14. 71 5015 HEAVY DUTY LOW INSTRUMENT STAND

Same as 71 5025 except range is 17 in., adjustment from 24 to 41 in. Floor space required, 3 ft. 6 in. x 3 ft. 6 in. Net weight, 190 lbs. approx. Shipping weight, 230 lbs. approx. Cube, 45 cu. ft.

A-15. 71 5030 PORTABLE INSTRUMENT STAND

The 71 5030 Portable Instrument Stand provides a firm, rigid support for optical tooling, surveying and other optical metrological instruments. Triangular bracing of the legs assures stability. The legs are removable and telescope for compact storage and easy transporting of the stand from one location to another. Stability is not sacrificed despite the compactness and light weight *(approx. 28 lbs.)* of the stand.

The height of stand is adjustable from 31 to 51½ in. with its adjustable center column and telescoping legs. The star adjusting wheel at the head end permits fine adjustment of the column height within a range of 3 in. A positive hand clamp prevents accidental height changes.

The column swivel head can be rotated through 360° and locked in any position. It has a mounting ring at the top with U.S. Standard 3½ x 8 thread for attaching brackets or instruments. Column and swivel head are hollow to provide a 1⅛ in. diameter clear aperture for downward sighting. A removable plastic cap protects mounting ring threads when stand is not in use.

The leg attachment screws are permanently fastened to the head. These screws and the leg clamp screws are fastened with an Allen wrench which comes attached to the tripod head by a spring clip.

The upper legs of the stand are made of aluminum tubing; the lower legs with stainless steel insert to prevent fretting and wear.

The swivel pad feet on the lower legs facilitate set-ups on hard surfaces. The swivel pad feet can be unscrewed and replaced with the stainless steel points furnished with stand.

A-16. 71 5070 TRIVET

The 71 5070 trivet is a special device for supporting a jig transit, transit, or level near the floor or at any position where the line of sight is low. It is very rigid in construction and is supported by removable, hardened steel points. If desired, the steel points may be removed and the trivet bolted directly to a jig or fixture having 5/16 x 18 male thread. The trivet has a U.S. Standard 3½ x 8 thread head; its height is 5⅝ in. and it covers a radius of 4⅞ in. Mounting hole sizes are 5/16 x 18 thread. Weight 6 lbs. approx.

A-17. INSTRUMENT STAND ACCESSORIES

***71 5048 Extension Piece**—This 5 in. extension piece increases the maximum height of instrument stands. It is fitted with a U.S. Standard 3½ x 8 male thread at one end and a 3½ x 8 female thread at the other end. The use of the extension piece does not affect the range of adjustment of the stands. Two or more extension pieces can be used to increase height still further. Weight 5 lbs. approx.

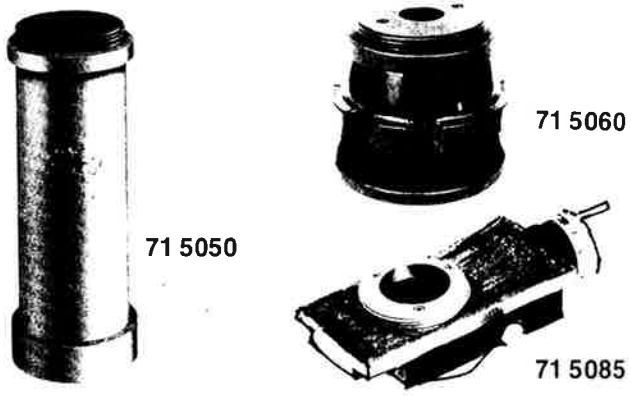


Figure A-10. Typical Instrument Accessories

*To order only

71 5050 Extension Piece—Same as 71 5048 except 10 in. size. Weight 10 lbs. approx.

71 5052 Extension Piece—Same as 71 5048 except 20 in. size. Weight 18 lbs. approx.

71 5060 Precision Lift (For Instrument Stands)—The Precision Lift ensures precise vertical control of the horizontal crosshair of a previously levelled instrument. Mounted on an instrument stand, the Precision Lift provides up to ¾ in. of vertical motion. It is especially valuable for "bucking in" on targets in the horizontal plane—where there must be fine vertical adjustment of the levelled instrument.

The Precision Lift has a U.S. Standard 3½ x 8 female thread for mounting to any standard tripod, trivet, or instrument stand.

The Precision Lift has a U.S. Standard 3½ x 8 male thread for instrument mounting. A 1 3/16 in. diameter hole through the vertical centerline provides for vertical plumbing with the mounted instrument. Smooth green finish. Weight 8¼ lbs. approx.

71 5085 Precision Mechanical Lateral Adjuster—A precision lathe cross compound made of stress relieved Meehanite. For "bucking" jig transits or other optical tooling instruments into line. The graduated micrometer drum reads to 0.001 in., numbered every .010 in., range 0.1 in. It is operated by hand crank. Slide travel 2⅜ in. Clear aperture for downward sighting 2¼ in. diam., near center of travel, 1¾ in. diam., at end. U.S. Standard 3½ x 8 threads, male top, female bottom. Weight 11 lbs. approx.

71 5087 Precision Compound Mechanical Lateral Adjuster— Same as 71 5085 except provides for adjustments in two planes.