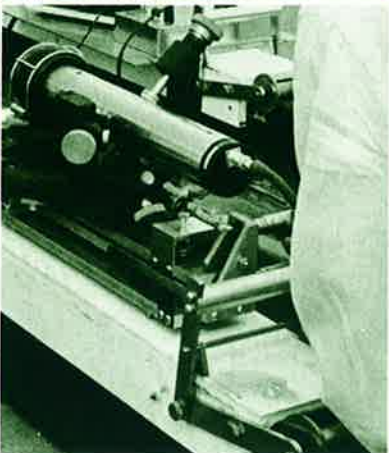
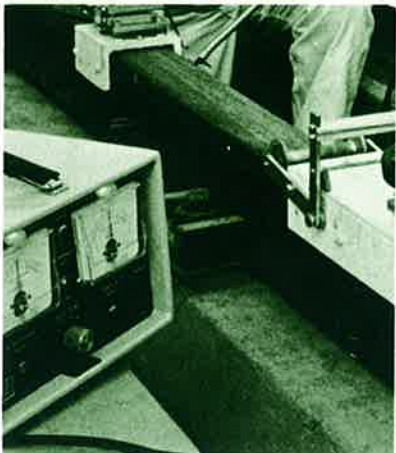
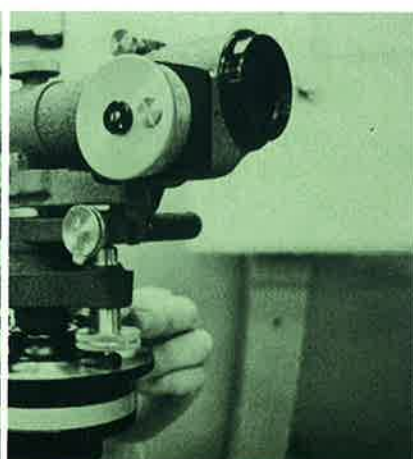


OPTICAL ALIGNMENT EQUIPMENT

 **CUBIC PRECISION**

A member of the Cubic Corporation family of companies

 **Electro-Optical Products**
750 Huyler Street, Teterboro, NJ 07608





Additional catalogs covering the K&E product line are available from Keuffel & Esser Company, Morristown, N.J. or from the nearest K&E Branch or Dealer.

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STABILENE® Stable Base Materials
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Drafting Machines and Drafting Room Furniture
Optical Alignment Equipment
Electronic Distance Measuring Equipment
Field Equipment

Established in 1867, K&E first published a catalog in 1868.

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Optical Alignment

K&E creates, designs, and manufactures optical, mechanical, and electro-optical systems and components for the precise measurement of lengths and angles. Drawing on more than 100 years of experience and leadership in optical metrology, K&E offers broad facilities and outstanding scientific and engineering personnel capable of handling optical alignment projects, from consultation or basic research to design, development, and quantity production. K&E is a world leader in the applied science of optical metrology and alignment. Laser instruments, alignment telescopes, jig transits, collimators, metrological bar systems, and accessories manufactured by K&E achieve

consistent linear distance measuring accuracies to within .001 in. over short and long ranges. K&E optical instruments, components, and techniques are invaluable aids in missile launching and tracking systems, orientation of microwave antennas, alignment of atomic particle accelerators, and airframe and missile assembly. K&E alignment products have been widely used in the erection, alignment, and testing of large equipment such as ship propulsion shafts, long bed lathes, turbines and compressors, and paper processing machinery. Almost any application where extremely accurate positioning is mandatory calls for optical alignment.



K&E Optical Alignment Equipment— designed for precision and speed

The flexibility, economy, and versatility of K&E optical alignment equipment make it possible to perform the simplest as well as the most complex alignment operations.

K&E instruments set up an optical three-dimensional pattern which makes it possible to achieve highly accurate dimensional data of any point in space. Conventional mechanical measuring techniques simply cannot achieve the accuracies obtained through optical alignment.



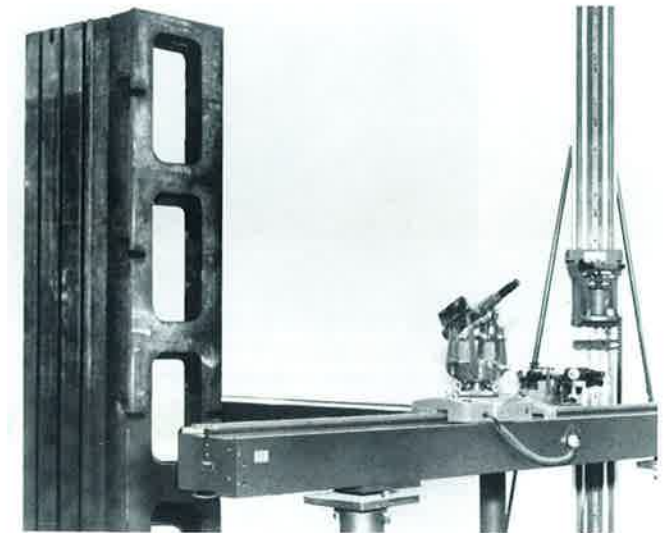
K&E Tilting Level checks ways of 30-foot horizontal milling machine for both twist and sag within .002 inches



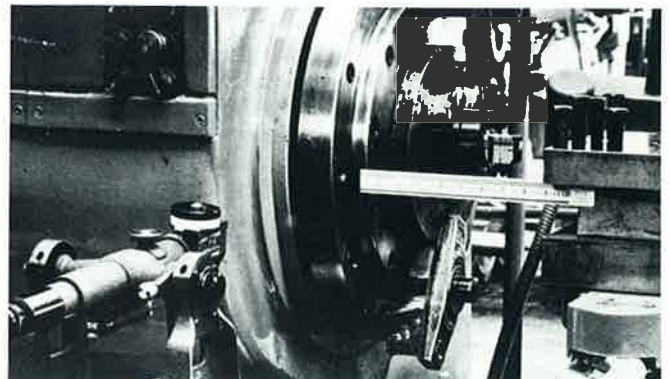
Inspecting critical alignment of rollers on a paper machine with a K&E Jig Transit. In many cases, present-day tolerances would be impossible without optical devices.



Aligning main propulsion shaft bearings on a large naval vessel with a K&E Alignment Telescope and accessory equipment. Portability eliminates the need for building accurate devices into each setup at critical points.

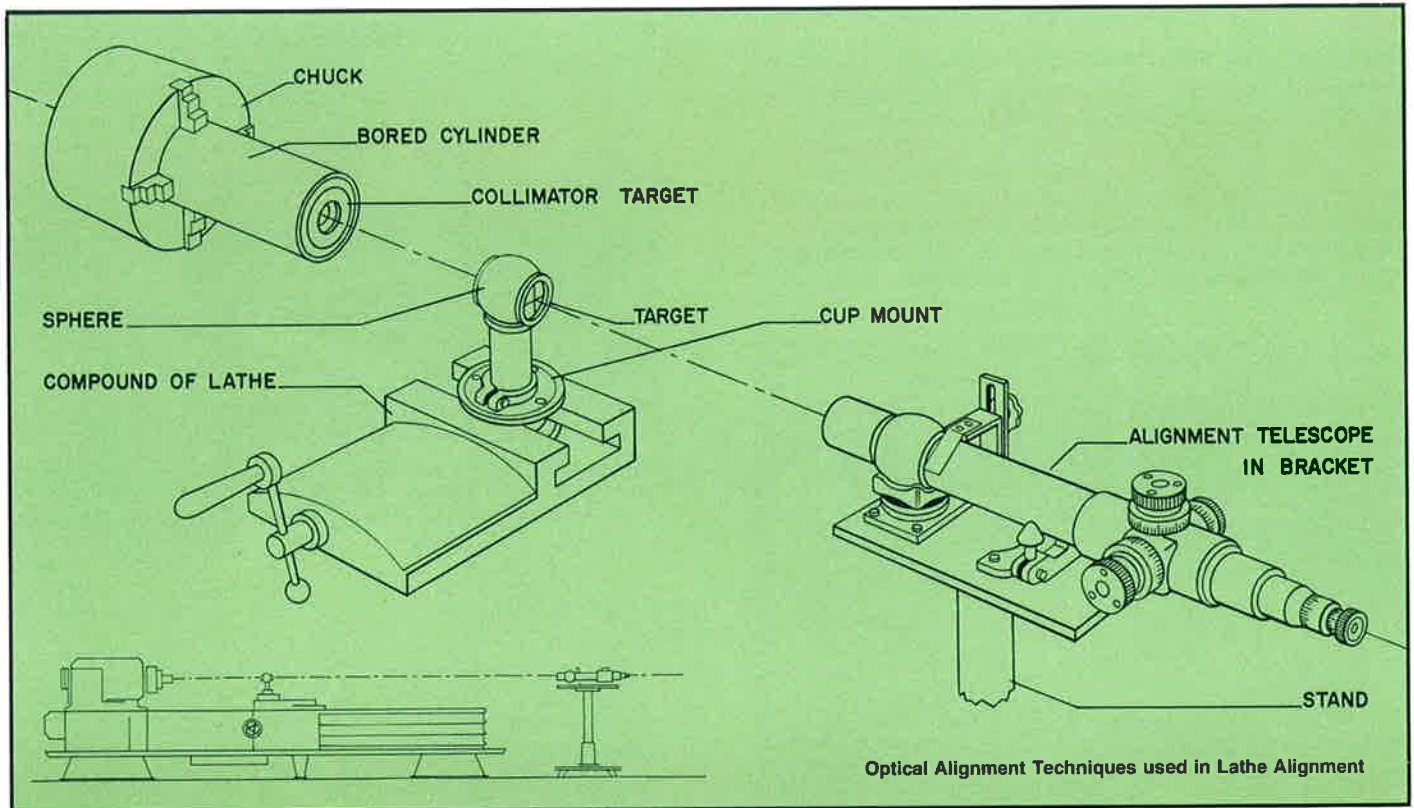


K&E Jig Transit and Alignment Telescope with Optical Square mounted to tooling bars and K&E Tilting Level check x,y,z dimensions of machine tool casting



Turret cross-slide ways are checked with jig transit, displacement scale, and cube mirror target mounted on headstock spindle

Optical Alignment



FOUR FUNDAMENTAL QUESTIONS

In the erection of industrial equipment, or in the alignment of precision systems, four basic questions must be answered in order to insure proper equipment operation. These four fundamental questions are:

Is it straight? ... Is it flat? ...

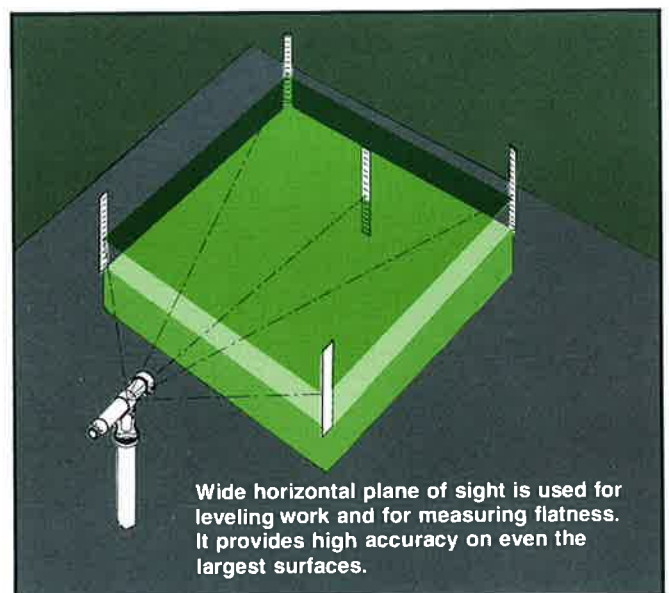
Is it plumb? ... Is it square?

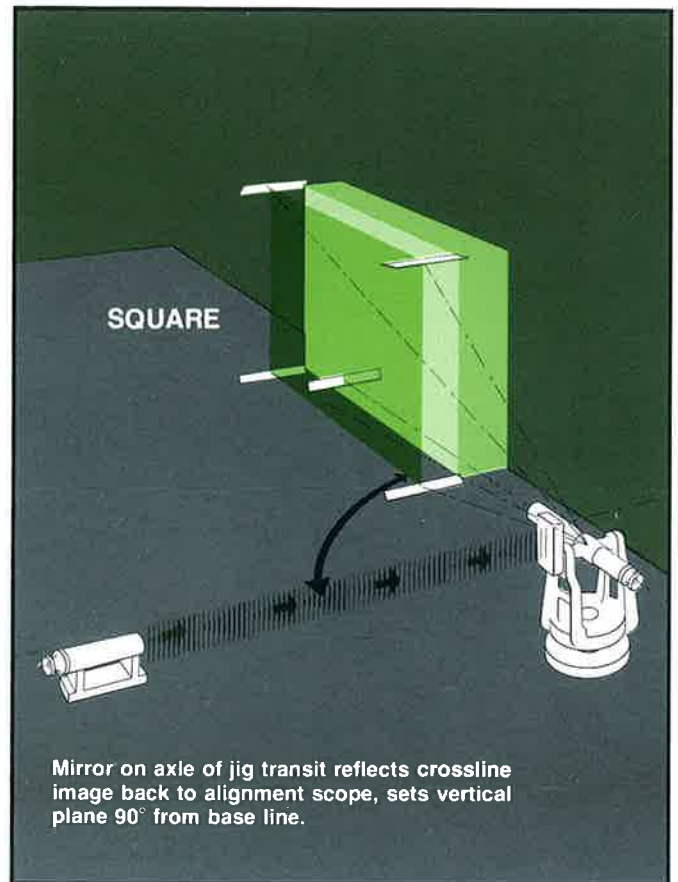
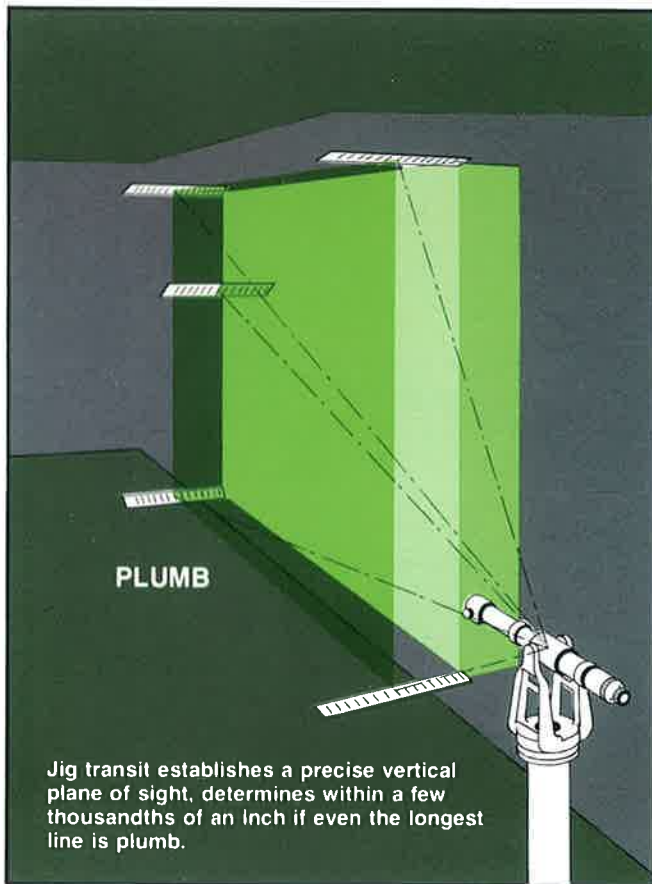
A number of techniques have been developed to make these measurements. However, many of them result in inaccuracies so great that the efficient and precise operation of the equipment involved is seriously endangered.

The science of optical metrology and alignment, utilizing K&E equipment and techniques, makes it possible to achieve the highest degree of accuracy in answering these four important questions. It is no longer necessary to extrapolate readings, or to make constant adjustments and calculations. In optical alignment, direct precision measurements are made rapidly and consistently.

Is it straight? ... In aligning several points, a tight wire is often used as a reference line. This technique has numerous drawbacks resulting in considerable inaccuracy. First of all, wire has weight, which causes it to sag; over long distances this sag can become considerable. In addition, wire vibrates, can bend or kink, and when stretched in the area to be measured, equipment cannot be moved around for fear of disturbing the wire reference line.

In optical alignment technique, the line of sight of a K&E alignment telescope is used as a reference line, instead of the tight wire. The invisible line of sight reference has no weight, cannot sag, kink, or be disturbed, nor is it a safety hazard. It constitutes a precise, unvarying reference, determining straightness to within thousandths of an inch.





Is it flat? . . . In order to determine flatness for leveling operations, a shop level and a straightedge may be employed. However, over large horizontal areas, the shop level must be moved from part to part. Consequently, one can only tell the degree of flatness of each individual surface upon which the level is placed. Whether the whole area to be covered is flat is still in doubt. Obviously, flatness over a considerable area must be assured in the erection of large machinery, such as paper processing equipment. Shop level techniques simply do not offer the degree of precision required.

Optical alignment methods overcome these disadvantages and assure levelness to within a few thousandths of an inch, regardless of how large an area is to be covered. This high degree of levelness is accomplished by sweeping the telescope back and forth from right to left, so that the line of sight mentioned above becomes an invisible, horizontal plane of sight, giving a precise horizontal reference plane.

Is it plumb? . . . A plumb bob may be used to establish a single vertical reference line. Of course, as vertical distances increase, the plumb bob system becomes cumbersome and inaccurate. For one thing, it takes a long time for the plumb bob to steady itself. Also, it can easily be swayed by vibration, air currents, and other disturbances which are bound to be encountered.

In the optical alignment method, a jig transit is used to erect a vertical reference plane. The degree of parallelism between this vertical plane of sight and any other surface can then be determined by measuring the offset between the two planes. As a result, measurements can be made to within .001 in., and even very large vertical areas can be made perfectly plumb.

Is it square? . . . Perfect squareness implies that one plane forms a 90° angle with another intersecting plane. When a steel square is used to test for this condition, the results can be very misleading. Such measurements rely upon the trueness of the steel square, which can vary from square to square and with time. In addition, steel squares have a definite limit in their physical dimensions and consequently the testing of very large surfaces becomes inaccurate, slow, and cumbersome. Optical alignment overcomes all these disadvantages and offers a quick and precise method for determining squareness.

One method is to use two telescopes, each creating its own line of sight reference. One telescope carries a precision-mounted mirror on its axle; the second telescope is aimed at the mirror, so that its line of sight is reflected back on itself. Once this condition has been achieved, the two lines of sight are precisely at right angles, and the squareness of the two planes can be established with a great degree of precision.

Optical Alignment

METHODS OF ALIGNMENT

COLLIMATION...Parallel light rays are said to be "collimated." When any telescope is "focused at infinity," it focuses collimated light rays on the reticle. Conversely, when the reticle of such an instrument is illuminated, it projects collimated rays.

When collimated rays are viewed with a second telescope set at infinity focus, an image of the illuminated cross lines appears on its reticle. When the second telescope is aimed so that the cross line image coincides with the actual cross lines, the lines of sight of the two telescopes are parallel.

As shown by the illustration, although they are parallel, they do not necessarily coincide.

AUTO-REFLECTION...When precise angular accuracy is necessary, an optically flat target-mirror is mounted on the part to be positioned so that its reflecting surface is parallel to the proper reference plane on the part and where it will be in the line of sight of the alignment telescope. The part is positioned by tilting the part until the cross lines in the alignment telescope appear to coincide with the image of a target mounted on the end of the telescope, or on the inside surface of the objective, reflected back through the telescope from the target-mirror.

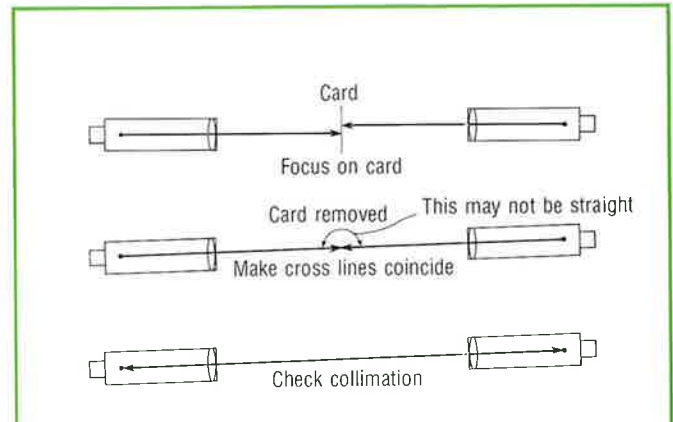
When several points must be set at some distance off the line of sight, an optical plane must be established at a known station at right angles to the line of sight. This is accomplished by auto-reflection with a jig transit or a device based on a pentaprism, called an optical square.

AUTO-COLLIMATION...Auto-collimation is similar to auto-reflection but more accurate. In auto-reflection the line of sight is aimed at the reflection of a target. In auto-collimation the line of sight is aimed at the reflection of the cross lines of the telescope itself. To use an instrument in this way, it is necessary only to direct a small amount of light on the cross lines. The telescope is focused at infinity so that its reflection is really a collimator. And, since the telescope is focused at infinity, the cross lines of the collimator are in focus. When the mirror is adjusted so that the reflection of the cross lines falls on the cross lines themselves, its surface must be perpendicular to the line of sight. When a target is used in auto-reflection, there is always the possibility that it may not be exactly centered on the line of sight and thus may introduce a slight error. Moreover, as auto-reflection is used to establish a series of parallel planes, a slight error may be introduced if there is any curvature in the line of sight of the sighting telescope when it is focused at different distances. In auto-collimation, the sighting telescope is always focused at infinity and therefore there can be no curvature in the line of sight due to focusing.

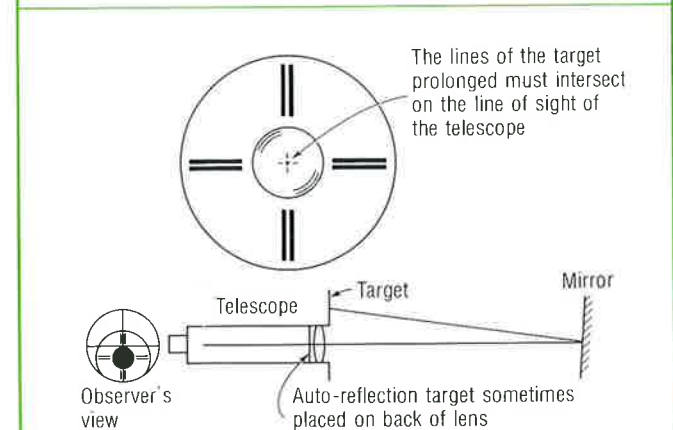
71 1001 Optical Alignment Equipment Operating Manuals—Set of four operating manuals with illustrations and complete instructions for the use, care and adjustment of K&E optical alignment equipment. A comprehensive glossary of Optical Alignment Terms for easy and convenient referral is also included.

The set includes the following:

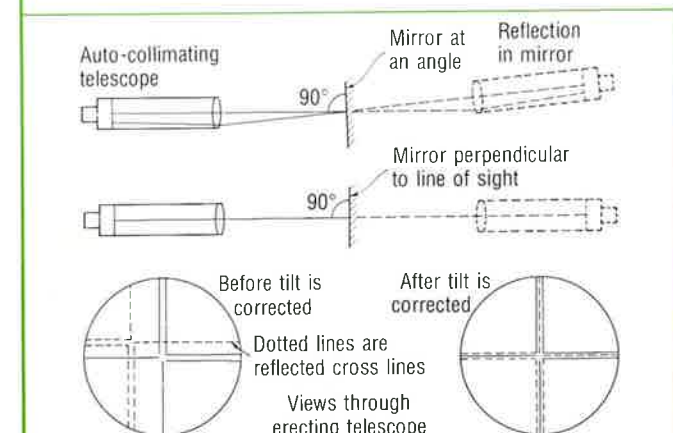
1. Manual for Alignment Telescope, Bright Line Telescope, Line of Sight Telescope and Alignment Collimator, Straightness of Line of Sight Collimator.
2. Manual for PARAGON® Tilting Level, PARAGON Leveling Kit.
3. Manual for PARAGON Jig Transit, PARAGON Jig Transit Telescope Square.
4. Manual for Alignment/Auto-Collimating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



Collimation: Placing two telescopes on line with each other. They are placed parallel by collimation and on the same line by first focusing on a card and then aiming at the other cross lines.



Auto-reflection: The same principle as auto-collimation.



Auto-collimation: The line of sight and its reflection. The reflected cross lines are inverted because the reflected erect virtual image is inverted when imaged by the lens. Both real and reflected cross lines will be again inverted by an erecting eyepiece.

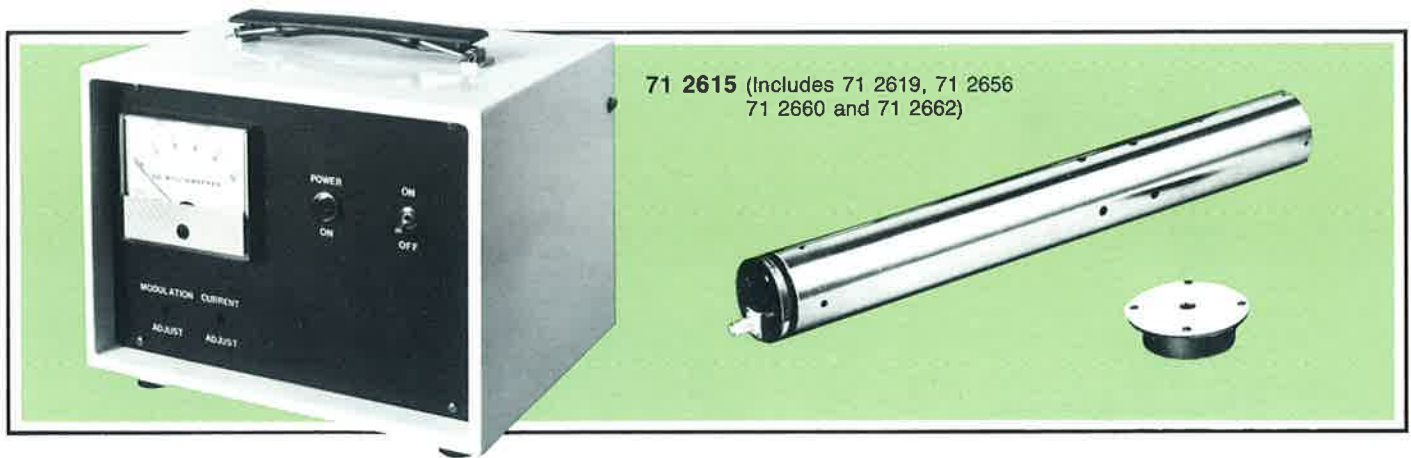
Laser Alignment Instrument

K&E Alignment/Auto-Collimating Laser (71 2615) combines faster set-up and operation with precision and accuracy to provide greater cost savings than ever before possible with conventional optical methods.

The K&E Laser projects a low power visible beam along an optically straight path over long distances. It is only necessary to zero in the red beam onto the center of a photoelectric target. Displacement of a work piece can be measured to within $\pm .001$ in. from the center of the beam.



Laser Alignment Instrument



71 2615 (Includes 71 2619, 71 2656
71 2660 and 71 2662)

The K&E Laser Alignment Instrument is used for establishing both reference lines of sight and for auto-collimating. A minimum of controls and switches makes it convenient and easy to use.

The laser instrument is completely compatible with standard K&E optical alignment accessories. For example, with an optical square, planing prism, or optical micrometer, the same laser instrument can generate auxiliary planes parallel or perpendicular to the basic line of sight.

- The laser beam is produced by a helium-neon, continuous-wave plasma tube that is basically similar to the neon tube commonly found in store signs. The beam produced by the laser instrument is, of course, more specialized. It is coherent—that is, composed of only one color or wavelength, and all the waves are in phase with each other.
- The laser gas tube is also specially designed and fabricated. It incorporates double-wall construction and utilizes a cold cathode which generates practically no heat. This prevents thermal distortion and produces *maximum reading stability*.
- Protecting the laser tube is a fully-closed, precision-ground steel barrel. This eliminates the possibility of instrument contamination by humidity, dirt, or harmful fumes which are often present in a shop or lab. This makes the K&E laser instrument exceptionally durable ... even in tough environments.

71 2615 Laser Alignment Instrument—Multi-function laser system to establish reference line of sight up to 300 feet; and, when used with quad cell detectors, detects linear displacement in x or y motion to $\pm .001$ inches. For auto-collimation, it detects angular displacement in x or y to ± 3 arc seconds over an operational range of 0 to 150 feet.

Included:

1. Laser instrument which projects a low power, coherent red beam. Built-in internal quad cell for auto-collimating applications (must be connected with 71 2623 read-out unit for angular displacement detection).

2. Power supply unit (71 2619).
3. Interconnect cable to connect laser unit and power supply.
4. Laser beam finder screen (71 2662) used for acquisition of return signal.
5. 10 ft. cable to connect laser unit to read-out unit (71 2623).
6. Calibration plate (71 2656).
7. Calibration wedge (71 2660).

SPECIFICATIONS

LASER INSTRUMENT: Fully closed, tool steel, chrome-plated, Rockwell C55.

Outside Diameter: NAS standard 2.2498 in., plus .0000 in., minus .0003 in., per foot.

Overall Length: 18½ in.

WEIGHT: 9 lbs. 12 oz.

RANGE: Alignment applications, 0-300 ft.; Auto-collimating applications, 0-150 ft.

POWER SUPPLY: Case, 10 x 8 x 8 in.

LASER OUTPUT: Power: Maximum uniphase power output 0.7 milliwatts, TEM₀₀ mode. Power stability within 10% during four-hour period. Power output amplitude modulated at 10 Hz.

Light Source: Helium-neon laser, 632.8 nm.

Beam Diameter: 7/16 in.

Beam Displacement: Centered to within ± 001 in. relative to mechanical axis of laser instrument.

Beam Parallelism: Axis is parallel to mechanical axis of laser instrument to within ± 4 arc seconds.

Alignment Stability: Less than $\pm .0005$ in. drift during a one-hour period in a 2 ft. enclosed air path.

Warm-up Time: 60 minutes from cold start, none thereafter.

POWER INPUT: Standard 110/115 VAC 60 Hz line power. Automatic voltage regulation and adjustments for current control and modulation control. Optional 220 VAC, 50 Hz.

CONNECTION: Coaxial cable connects single wire from power supply to laser instrument.

Manufactured in conformance with radiation safety data requirements. Specifications subject to change without notice.

The following warning Logotype appears on all Alignment Auto-Collimating Lasers (71 2615) manufactured after Aug. 2, 1976 in compliance with DHEW radiation performance standards 21 CFR Chapter 1, Subchapter J for a Class II laser product.

CAUTION



Laser Radiation—

Do not stare into beam

Output: < 1.0 mW
Wave Length: 632.8 nm
Class II Laser Product

Laser Accessories



71 1112 Optical Micrometer with Vernier Scale (Two-Plane)—The micrometer measures horizontal or vertical displacement from a line of sight. Its range is ± 0.100 inch. Has uniformly graduated, red and black main scale reading directly to ± 0.001 inch. Vernier scale reads to 0.0001 inch. Has dustproof cover glass and split clamp for mounting. Can be adjusted and calibrated without removal from instrument. Specially made for use with the Auto-Collimating Alignment Laser but will fit all standard $2\frac{1}{4}$ inch diameter instrument barrels. Weight, 1 lb., 10 oz.

***71 2619 Power Supply**—Operates on standard 110/115 VAC, 60 Hz or optional 220 VAC, 50 Hz, 60 cps line power. One supplied with 71 2615. Single wire, 6 ft. long, connects unit to laser instrument. Overall dimensions, 10 x 8 x 8 in. Weight, 12 lb., 8 oz.

71 2623 Digital Readout w/Auto-Gain Control—For use with both auto-collimating and alignment procedures. Unit has two digital meters that measure horizontal and vertical displacement in thousandths of an inch. Terminals for connecting for detector targets and recorder or servo-controlled device are provided on rear panel. Auto-gain feature maintains digital meter stability (damping) for long shots when outside turbulence would otherwise cause continuous reading fluctuations.

SPECIFICATIONS

READ-OUT UNIT: Two digital meters read "left-right" and "up-down" respectively in thousandths of an inch. Reading indicating a left or down direction is preceded by a negative (-) sign.

Range: .050 inch displacement in each direction.

Damping Time Constant: Fast (Auto-gain on) 6 to 8 seconds to rest position; slow (Auto-gain off) 12 to 14 seconds to rest position.

Terminals: Four provided at rear panel for connecting detector targets. Detector targets selection one at a time by depressing appropriate "channel" button on front panel.

Output Jacks: Provided on rear panel for connecting strip-chart recorder or servo-controlled device.

Output Voltage: 2 millivolts 1.0001 meter change, within 600 ohms output impedance.

BCD Jacks: Two Cannon 37-pin "D" subminiature connectors are provided for BCD output for peripheral equipment.

Fuse: 1/8 amp slow blow

Input Voltage: 110/115 Vac, 60 Hz, Automatic voltage regulated (optional 220 Vac 50 Hz).

Dimensions: 10 x 8 x 8 in.

Weight: Approx. 6 lbs., 4 oz.

71 2627 Pig Tail Quad Cell Detector Target Assembly—A circular photoelectric cell used for alignment applications with the 71 2615 Auto-Collimating Laser. The photoelectric cell is divided into four equal quadrants, each of which emits an electric current in proportion to the amount of laser light falling on it. Misalignment of the laser beam off-center on the quad cell generates an imbalanced current in favor of the segment receiving the most laser light. The unit is electrically connected to the Readout Unit, which contains two meters. The imbalanced electrical current from the quad cell causes the appropriate meter to indicate numerically the direction taken by the laser beam on the cell.

The quad cell will fit standard optical alignment hardware. The pig tail is approx. 9 in. long and is easily adapted to the 10 ft. connection cable provided.

SPECIFICATIONS

Detector Target: Tool steel, chrome-plated, Rockwell C55. Dust cap and hood provided for mechanical protection of target.

Outside Diameter: NAS standard 2.2498 in. + .0 in. - .0005 in.

Overall Length: $1\frac{1}{8}$ in.

Sensing Element: Axis centered to outside diameter within $\pm .001$ in. Center lies in plane 1.000 in. $\pm .003$ in. in front of rear indexing surface.

Sensitivity: Photo-electric sensors detect displacement to within .001 in.

Weight: 1 lb., 4 oz.

*To order only.

Laser Accessories



71 2629

71 2629 See-Thru Detector Target—Permits alignment of several stations simultaneously at different positions along a laser line of sight. The see-through capability of the target permits the use of up to four units at one time. The target connects to the read-out unit.

The sensing element is concentric within ± 0.001 in. of the outside diameter of the target and lies in a plane within ± 0.003 in. of the rear interface surface. The one-inch mounting ring is stainless steel, Type 303, with an outside diameter precision ground to a NAS standard of 2.2498 in. $+0, -0.0003$ inch/ft. Weight, 2 lbs. 4 oz.

***71 2630 Replacement Laser Plasma Tube**—Used as replacement tube for 71 2615.

***71 2643 Connector Cable**—Length, 50 ft. Used to interconnect Read-Out Unit 71 2623 to Detector Targets 71 2627 and 71 2629. The cable is a six-conductor, specially shielded mylar covered wire. Weight, 1 lb. 8 oz.

***71 2645 Connector Cable**—Same as 71 2643 but length, 100 ft. Weight, 2 lb. 4 oz.

***71 2647 Connector Cable**—Same as 71 2643 but length, 150 ft. Weight, 3 lb. 5 oz.

***71 2649 Connector Cable**—Same as 71 2643 but length, 200 ft. Weight, 4 lb.

***71 2642 Connector Cable**—Length, 50 ft. Used to interconnect Read-Out Unit 71 2621 and 71 2623 to old style Quad Cell Detector Target. Weight, 1 lb. 8 oz.

***71 2644 Connector Cable**—Same as 71 2642 but length, 100 ft. Weight, 2 lb. 4 oz.

***71 2646 Connector Cable**—Same as 71 2642 but length, 200 ft. Weight, 4 lbs.



71 2656

***71 2656 Calibration Plate**—Used for calibrating Read-Out unit (71 2623) for alignment applications by fitting to surface of detector target. The plate introduces .010 in. linear displacement of the laser beam. Weight, 4 oz.

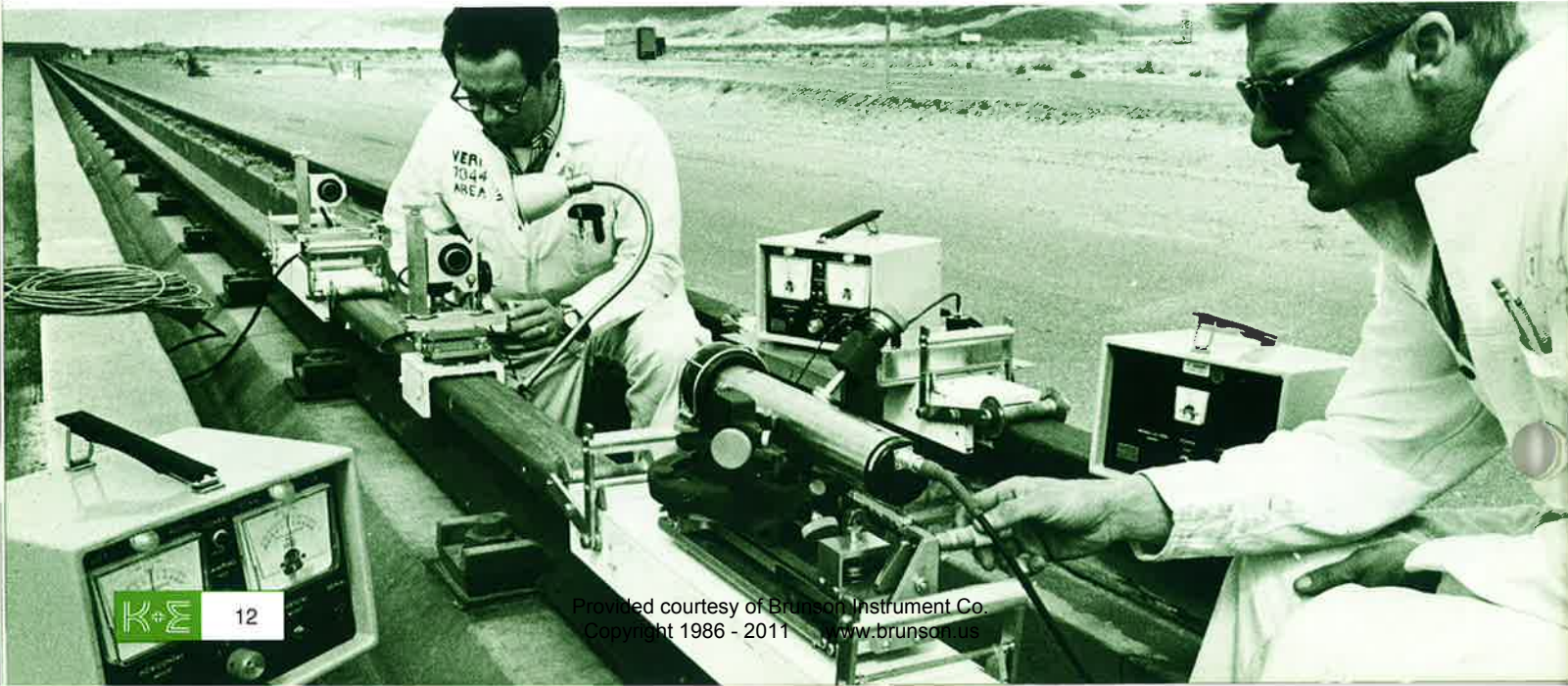
***71 2660 Calibration Wedge**—Used for calibrating Read-Out unit (71 2623) for auto-collimating applications by placing over objective end of instrument. The wedge introduces 5 second (nominal) angular displacement of the reflected laser beam. Weight, 1 lb. 2 oz.



71 2662

***71 2662 Laser Beam Finder Screen**—Used to assist in acquiring the reflected laser beam by positioning over objective end of the Auto-Collimating Alignment Laser. The screen guides the reflected beam into the center of the objective lens for making auto-collimation readings. Weight, 4 oz.

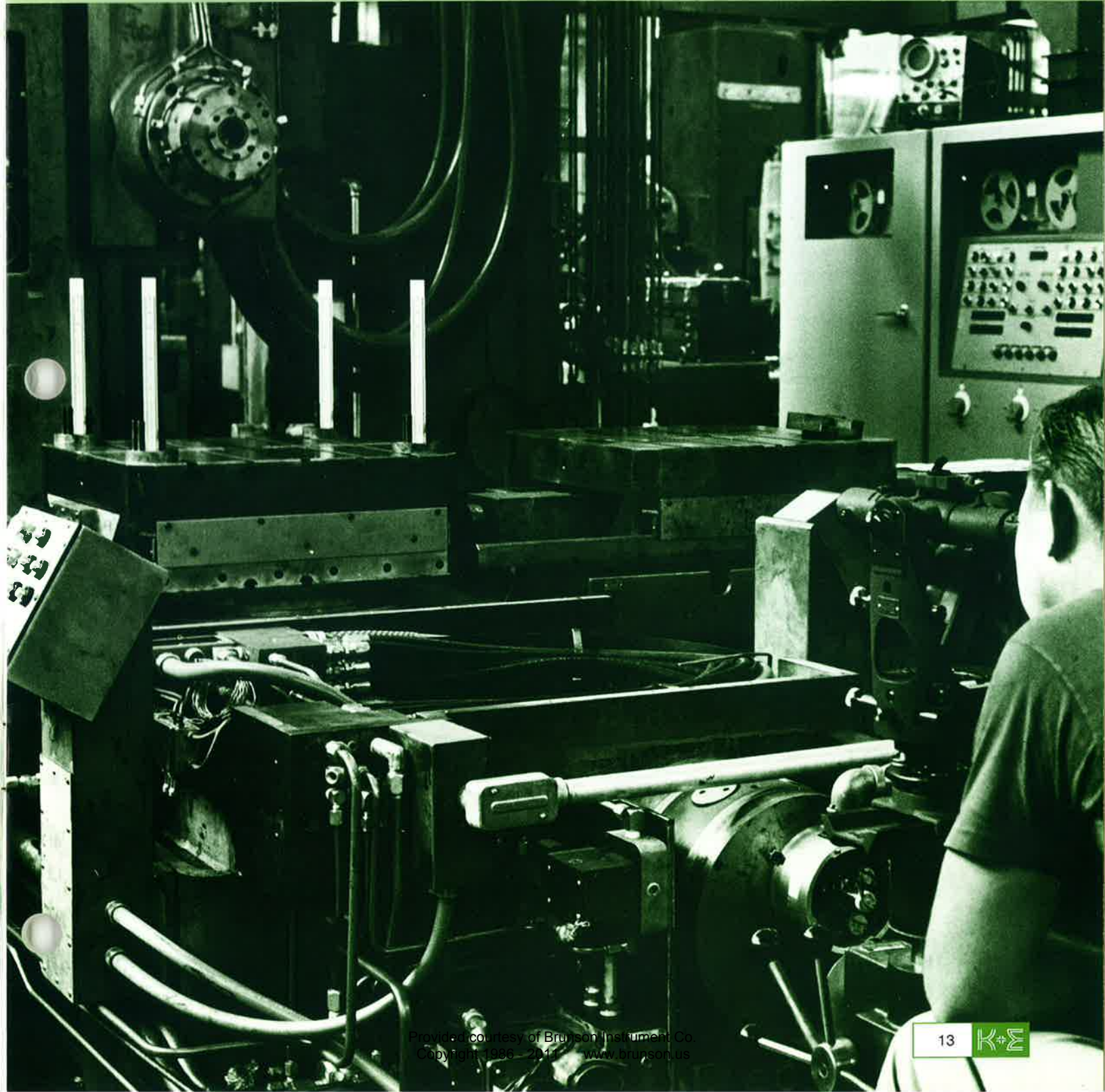
*To order only



PARAGON[®] Jig Transits

The PARAGON Jig Transit is an exceptionally versatile instrument, specifically designed to produce the highest accuracy in optical tooling and alignment work. The transit's azimuth center is hollow and the line of sight is centered

with this axis so that it is possible to sight vertically down through the instrument base. This technique is used on a K&E optical tooling bar, or to set the instrument up over a station point.



PARAGON® Jig Transits



71 1010

71 3260 is standard on 71 1010.

71 1010 PARAGON Jig Transit—Establishes precise vertical planes and plumb lines. When equipped with a right-angle eyepiece, zenith sights or upward plumb lines can be established. Two-speed tangent screws on both the azimuth and elevation axles ease leveling and auto-collimation. The instrument comes equipped with a standard Level Vial 71 3260 attached to the telescope and a circular vial on the plate. The eyepiece is easily converted in the field for auto-collimation.

An all-purpose glass reticle with cross-pattern of single lines top and right, paired lines bottom and left, is employed.

The 71 1010 Jig Transit complete with the most required accessories now can be ordered as a complete unit under one Product Number.

71 1012 PARAGON Jig Transit 71 1010 complete with 71 1111 Optical Micrometer

71 1013 PARAGON Jig Transit 71 1010 complete with 71 1111 Optical Micrometer and 71 3250 Coincidence Level mounted on telescope.

71 1014 PARAGON Jig Transit 71 1010 complete with 71 1111 Optical Micrometer and 71 3250 Coincidence Level mounted on telescope and with 71 1130 Circular Auto-Reflection Mirror.

SPECIFICATIONS

TELESCOPE: 11¼ in. long, with fully erecting achromatic K&E optical system.

Magnification: Varies automatically from 20x at 8 in. to 30x at infinity.

Focusing Range: 8 in. to infinity.

Resolving Power: 4 seconds of arc (according to the Bureau of Standards test procedure).

Field of View: 55 minutes at infinity, 6.4 mm at near distance.

Effective Aperture: 30 mm.

Optics: Fully coated optics used throughout.

Eyepiece: Erecting, achromatic. Removable blank provided for auto-collimation conversion unit. Right-angle eyepiece and complete projection accessories available.

Reticle: All-purpose, double glass, dustproof; cross-pattern with single lines top and right, paired lines bottom and left.

TELESCOPE AXLE: Bronze, with steel journals sweated on. Provided with threaded ends and stop shoulders to accommodate auto-reflection mirrors.

STANDARDS: Reinforced, ribbed, U-type bronze one-piece casting. Bearings V-type, bronze, adjustable for centering line of sight on the azimuth axis in the horizontal and vertical planes.

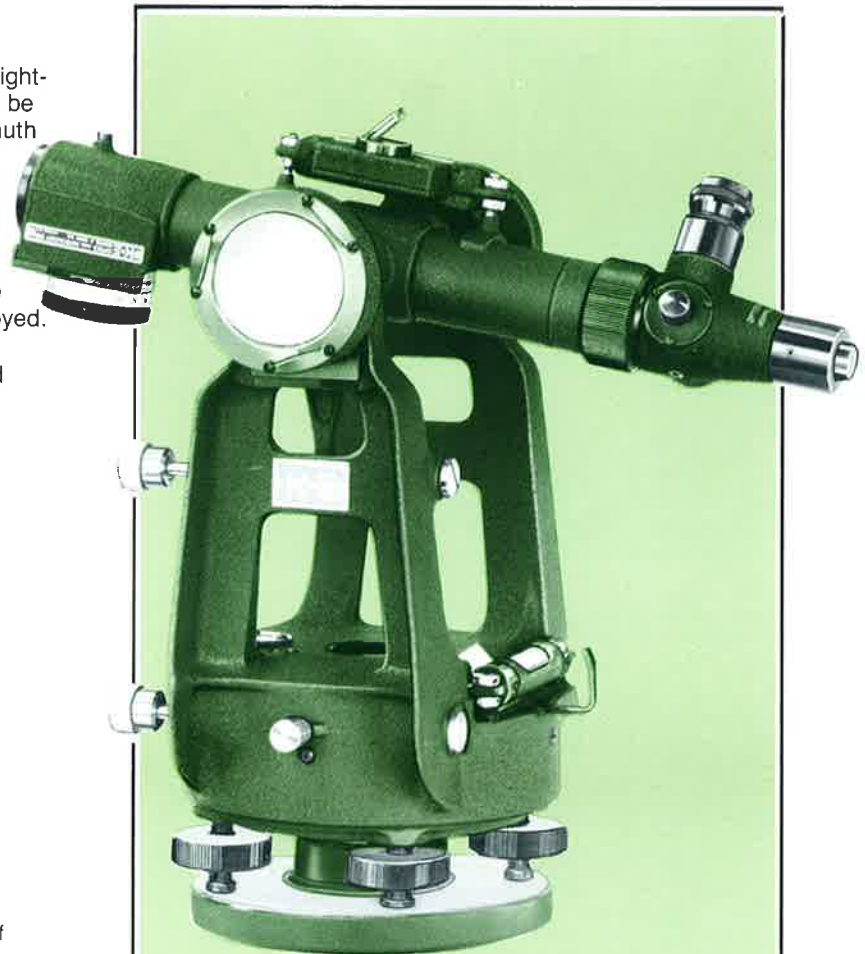
HEIGHT: 10¾ in. from bottom of base to center of telescope axis.

LOWER PART: Hollow azimuth axle with 1⅜ inches diameter optical clearance.

CENTER: Cylindrical, with high precision thrust ball bearing. Mounted in retaining ring between two precision optically flat steel plates. Enclosed with protective dust cover ring.

LEVELS: Telescope – Sensitivity of 20 seconds of arc per 2 mm movement. Two 7/32 in. diam. holes, spaced 3/2 in. on centers, are provided for mounting. Provisions for alternately mounting Level 71 3250 on the telescope.

Plate – Circular, sensitivity 5 minutes per 2 mm movement. Provisions for mounting Levels 71 3250 or 71 3260 parallel to telescope axle.



71 1010
with 71 1111 Optical
Micrometer, 71 1241
Combination Right
Angle Auto-Collimation/
Projection Eyepiece,
71 1130 Circular
Mirror and 71 3250
Coincidence Level.



**Reticle
Pattern**

SCREWS: Leveling – Four, with precision-generated threads, fully enclosed to exclude dust and retain lubricant.

Tangent – Two-speed, fine motion, for both azimuth and elevation motions.

WEIGHT OF INSTRUMENT: 26½ lbs. approx.

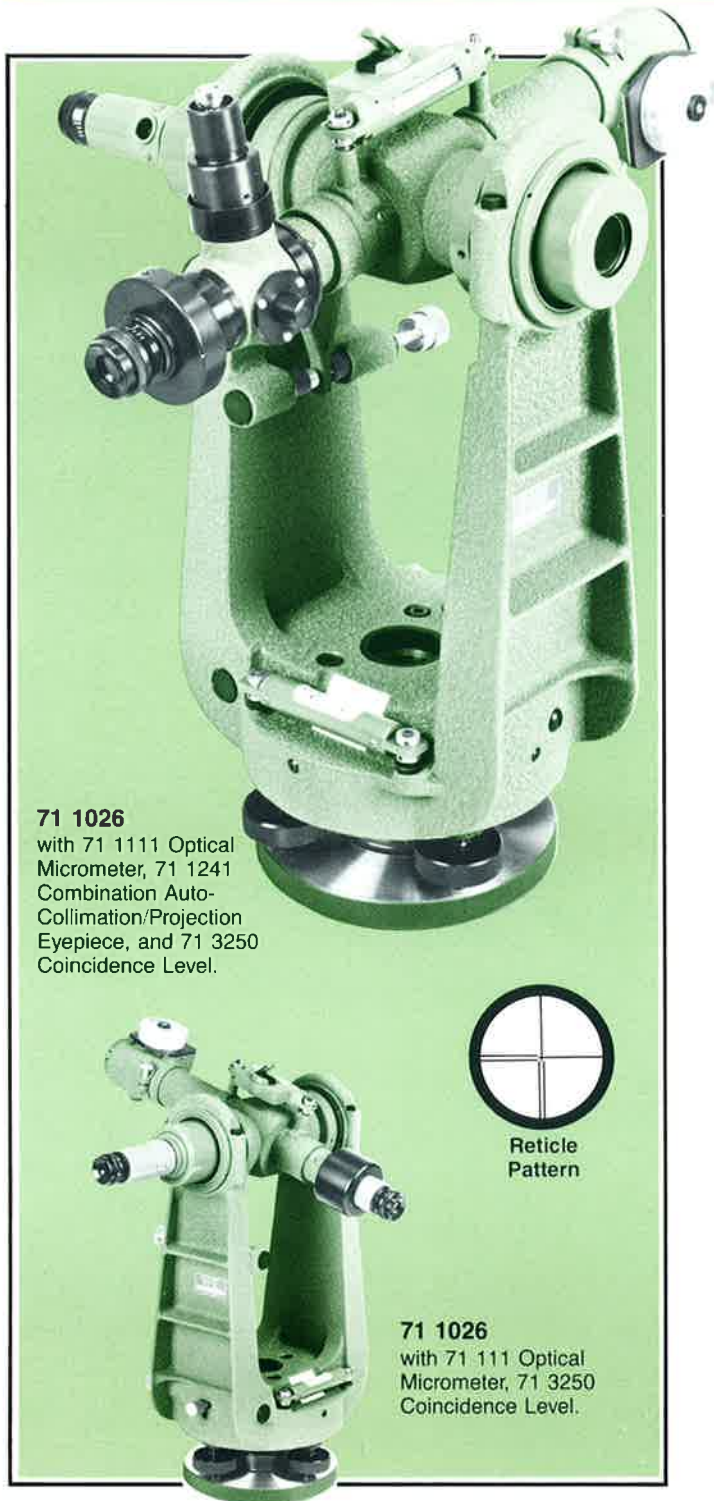
TRIPOD PLATE: Threaded, 3½ x 8, U.S. Standard.

FINISH: Two-tone green.

INSTRUMENT CARRYING CASE: High impact plastic with foam rubber inserts and four large rubber supports, adjusting tools.

STANDARD EQUIPMENT: Basic Jig Transit with circular plate level, 71 3260 Telescope Level Vial and instrument carrying case.

PARAGON® Jig Transit Telescope Square



71 1026
with 71 1111 Optical
Micrometer, 71 1241
Combination Auto-
Collimation/Projection
Eyepiece, and 71 3250
Coincidence Level.

71 1026
with 71 111 Optical
Micrometer, 71 3250
Coincidence Level.



Reticle
Pattern

The hollow horizontal axle is supplied with an infinity-focus telescope at one end and an objective lens at the other end. This permits convenient and economical one-man operation, eliminating the need for a second man behind the line of sight telescope. The cross-axis telescope may be equipped with a 71 1211 Auto-Collimation Unit. When equipped with this accessory, the optical reference line can be maintained by a mirror in place of the line of sight telescope. Alternately, the cross-axis telescope may be equipped with the 71 1231 Right-Angle Eyepiece or the 71 1241 Combination Auto-Collimation, Projection Eyepiece.

SPECIFICATIONS

MAIN TELESCOPE:

Same specifications as for 71 1010.

CROSS-AXIS TELESCOPE:

Length: 13 in. long with fully achromatic K&E optical system.

Magnification: 28x at infinity.

Focus: Fixed at infinity.

Resolving Power: 4 seconds of arc (according to the Bureau of Standards Test Procedure).

Field of View: 50.5 minutes at infinity.

Effective Aperture: 21 mm.

Eyepiece: Achromatic. Removable blank provided for auto-collimation conversion unit.

Reticle: All-purpose, double-glass, dustproof; cross-pattern with single lines in two quadrants — paired lines in the remaining two quadrants. The reticle is aligned so that it is in a horizontal/vertical position when the main telescope is level.

TELESCOPE AXLE: Hollow and equipped with cross-axis telescope. Bronze, with steel journals sweated on.

STANDARDS: Reinforced, ribbed, U-type bronze one-piece casting. Hardened ball bearings, bronze adjustable for centering line of sight on the azimuth axis in the horizontal and vertical planes.

HEIGHT: 13½ inches from bottom of base to center of telescope axis.

LOWER PART: Hollow azimuth axle with 1⅜ inches diameter optical clearance.

CENTER: Cylindrical, with high precision thrust ball bearing. Mounted in retaining ring between two precision optically flat steel plates. Enclosed with protective dust cover ring.

LEVELS: Telescope — Sensitivity of 20 seconds of arc per 2 mm movement. Two 7/32 in. diam. holes, spaced 3½ in. on centers, are provided for mounting. Provisions for alternately mounting level 71 3250 on the telescope.

Plate — Circular, sensitivity 5 minutes per 2 mm movement. Provisions for mounting Levels 71 3250 or 71 3260 parallel to telescope axle.

SCREWS: Leveling — Four, with precision-generated threads, fully enclosed to exclude dust and retain lubricant.

Tangent — Two-speed, fine motion, for both azimuth and elevation motions.

TRIPOD PLATE: Threaded, 3½ x 8, U.S. Standard.

FINISH: Two-tone green.

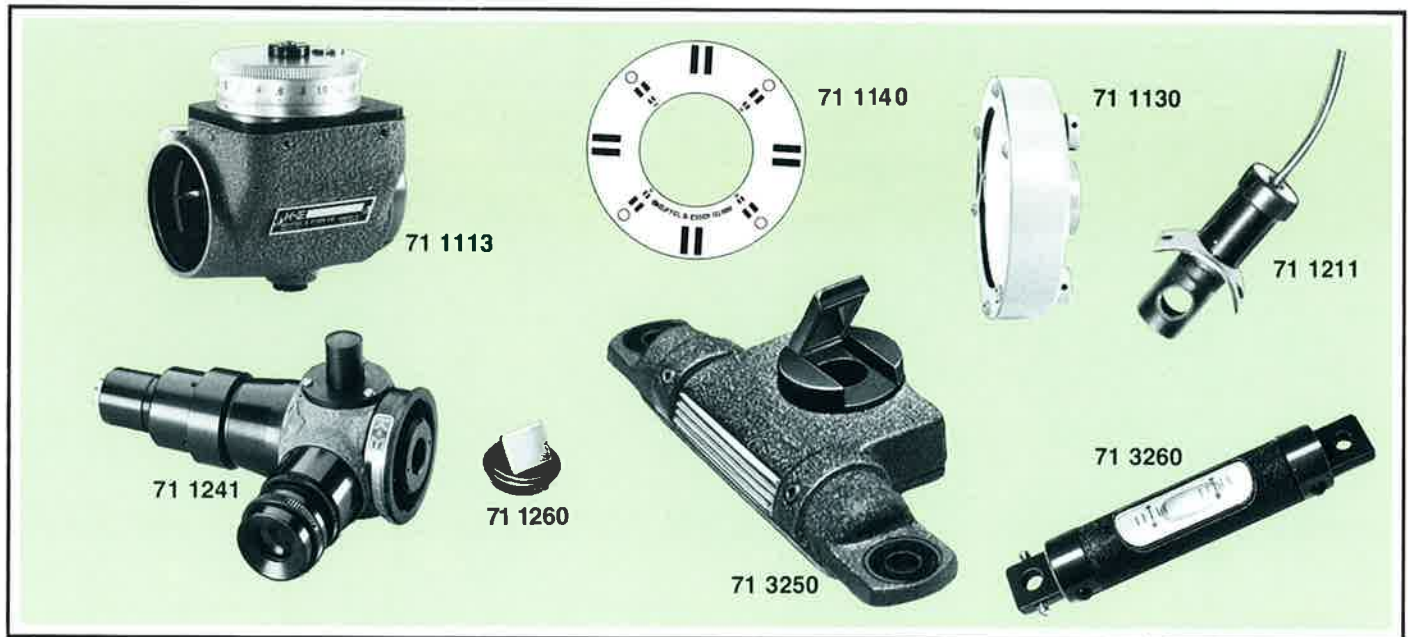
WEIGHT: Approximately 37 lbs.

INSTRUMENT CARRYING CASE: High impact plastic with foam rubber inserts and four large rubber supports.

STANDARD EQUIPMENT: Basic Jig Transit with circular plate level, 71 3260 Telescope Level Vial and instrument carrying case.

71 1026 PARAGON Jig Transit Telescope Square (with Horizontal Axis Telescope) — Used to establish precise vertical planes and plumb lines. With a right-angle eyepiece, zenith sights or upward plumb lines can be established. The instrument is equipped with Level Vial 71 3260 attached to the telescope.

Jig Transit Accessories



For 71 1010 Jig Transit and 71 1026 Jig Transit Telescope Square.

71 1111 Optical Micrometer with Vernier Scale – The micrometer measures horizontal or vertical displacement from a line of sight. Its range is ± 0.100 inch. Has uniformly graduated, red and black main scale reading directly to 0.001 inch. Vernier scale reads to 0.0001 inch. Has dustproof cover glass and split clamp for mounting. Can be adjusted and calibrated without removal from instrument telescope.

Ⓜ **71 1113 Metric Optical Micrometer with Vernier Scale** – Same as 71 1111 except its range is ± 2.0 mm and the main scale reads directly to 0.02mm. The vernier scale reads to 0.0002mm. In addition to Jig Transits, micrometer can also be used with 71 3010 PARAGON Tilting Level. Used in conjunction with WYTEFACE Metric Optical Alignment Scale 71 6041.

* **71 1115 Optical Micrometer** – Same as 71 1111 except with auto-reflection target photo-etched on micrometer cover glass.

71 1140 WYTEFACE[®] Auto-Reflection Target (Aluminum) – This target, when mounted on the objective end of all jig transit telescopes or on an optical micrometer, will provide a point of reference on the line of sight for auto-reflection.

71 1211 Auto-Collimation Conversion Unit – The unit converts a jig transit telescope, line of sight telescope, and tilting level telescope into auto-collimating telescopes. The unit comes complete with a light plug assembly, cord, switch, and fixed 6-volt transformer.

71 1231 Right-Angle Eyepiece – The eyepiece is used in place of the standard eyepiece for very low setups or when working close to walls, columns, or other obstructions. The eyepiece makes it possible to use the instrument for zenith sights. The right-angle eyepiece maintains a fully erect image and can be rotated through 360° for sighting from any perpendicular angle.

71 1241 Combination Auto-Collimation, Projection, Right-Angle Eyepiece – This combination eyepiece is interchangeable with the standard eyepiece of the K&E telescope such as on jig transits, line of sight telescopes and tilting levels. The eyepiece unit can be converted in the field as required to form a straight-through vision system or a right-angle system. The complete unit includes a variable output transformer for use with 110 volts AC, 50-60 cycles.

*(Sold separately).

* **71 1260 Prismatic Eyepiece** – The prismatic eyepiece is used in very low setups, or when working close to walls, columns, or similar obstructions. It may be rotated through 360°, giving an erect but reversed image.

71 3250 Coincidence Level – This level can be used for either the plate level or the telescope level on jig transits. It can also be attached to any fixture, gauge, or machine bracket. Two 7/32 in. diam. holes, spaced 3½ in. on centers, are provided for mounting. The level vial has a sensitivity of 20 seconds per 2 mm movement.

71 3260 Level Vial—This level can be used for either the plate level or the telescope level of jig transits. It can also be attached to any fixture, gauge, or machine bracket. Two 7/32 in. diam. holes, spaced 3½ in. on centers, are provided for mounting. The level vial has a sensitivity of 20 seconds of arc per 2 mm movement. (Standard with 71 1010).

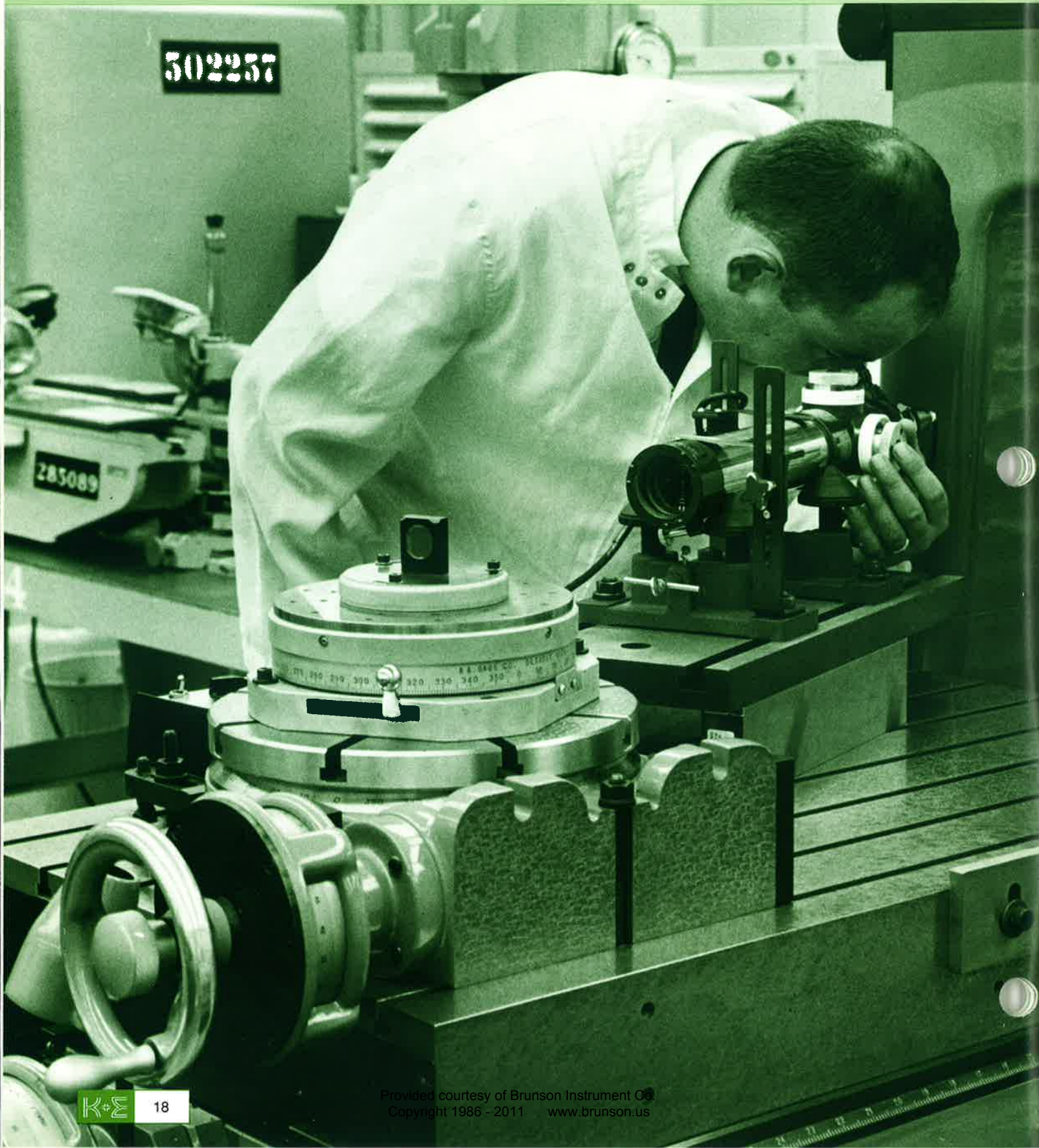
For 71 1010 Jig Transit

71 1130 Circular Auto-Reflection Mirror – A circular front surface mirror, 2⁵/₁₆ in. in diameter, is used for establishing a plane perpendicular to a line of sight. The mirror is optically flat to within ¼ wave length of light. It can be mounted on either end of the axle of a jig transit telescope and can be adjusted to square with the axle by means of two adjusting screws.

* To order only.

Ⓜ Metric

Alignment & Line of Sight Telescopes





71 2022 Alignment Telescope – This telescope establishes precise reference lines of sight. Its focusing range is from zero to infinity. Magnification varies automatically from 4x at zero focus to 46x at infinity focus. It has an effective aperture of 42 mm. Resolving power is 3.4 seconds of arc (according to the Bureau of Standards test procedure). The image is especially bright and clear, with excellent definition; coated optics are used throughout. An all-purpose double glass reticle gives a cross-pattern with single lines top and right, paired lines bottom and left. The telescope barrel is made of through hardened stabilized tool steel with a hard chrome surface. The telescope conforms to A.I.A. specifications, including accuracy, concentricity of line of sight, and barrel diameter.

Instrument has built-in auto-reflection target and auto-collimation illumination unit.

SPECIFICATIONS

MAGNIFICATION: Varies automatically from 4x at zero focus to 46x at infinity.

FOCUSING RANGE: Zero to infinity.

RESOLVING POWER: 3.4 seconds of arc (according to Bureau of Standards test procedure).

FIELD OF VIEW: 37 minutes at infinity, 42 mm at zero focus.

EFFECTIVE APERTURE: 42 mm.

OPTICS: Fully coated optics used throughout.

RETICLE: All-purpose, double glass, dustproof; cross-pattern with single lines top and right, paired lines bottom and left.

EYEPIECE: Fully erect image; diopter scale. Right-angle eyepiece and complete projection accessories available.

OPTICAL MICROMETER: Built-in horizontal and vertical optical micrometers: $\pm .050$ in, displacement. Direct reading to .001 in. Micrometer accuracy $\pm .0002$ in. over full range. Scale graduations are red and black to indicate direction of displacement.

FOCUSING KNOB: Drum graduated to show focusing distance in feet.

TELESCOPE BARREL: Made of through hardened stabilized tool steel with a hard chrome surface.

BARREL DIAMETER: 2.2498 in. ($+0, - .0003$) (A.I.A. specifications), Barrel length $9\frac{3}{16}$ in.

OVERALL LENGTH: $17\frac{3}{4}$ in.

WEIGHT: Approx. 11½ lbs.

Ⓜ **71 2024 Alignment Telescope, Metric**—Specifications are similar to 71 2022 with the following exceptions:

OPTICAL MICROMETER: Built-in horizontal and vertical optical micrometers: ± 1.2 mm displacement. Direct reading to .02 mm. Micrometer accuracy $\pm .005$ mm over full range. Scale graduations are red and black to indicate direction of displacement.

BARREL DIAMETER: 2.2498 in. ($+0, - .0003$)(A.I.A. specifications), 57.14492 mm ($\pm 0, - .0076$ mm) (A.I.A. specifications). Barrel length 23.3 cm.

OVERALL LENGTH: 45.1 cm.

WEIGHT: Approx. 5.2272 kg.

***71 2030 Bright Line Alignment Telescope**—Same as 71 2022 but instrument has a right angle eyepiece with a two-reticle system that consists of a dark field, bright line reticle and a bright field, dark line reticle. It does not include the built-in auto-reflection target. A "straight through" type eyepiece is available on special order only. Auto-collimation illumination unit included with instrument.

[†]To order only Ⓜ Metric

Line of Sight Telescope



71 2062 Line of Sight Telescope – The line of sight telescope provides precise, optical reference lines. It conforms to A.I.A. specifications, including accuracy, concentricity of line of sight and outside barrel diameter. In addition, it receives all standard spherical adapters and optical squares.

The telescope is especially bright, with excellent definition. It is used as a line of sight or boresight telescope, and in optical tooling bar applications as a basic reference line of sight telescope.

The instrument is furnished with a built-in auto-reflection target and auto-collimation illumination unit.

SPECIFICATIONS

MAGNIFICATION: Varies automatically from 23x at 7 in. to 35x at infinity.

FOCUSING RANGE: 7 in. to infinity.

FOCUSING KNOB: 6½ in. from end of eyepiece.

RESOLVING POWER: 3.5 seconds of arc (according to Bureau of Standards test procedure).

FIELD OF VIEW: 47 minutes at infinity; 7.4 mm at near distance.

EFFECTIVE APERTURE: 38 mm.

OPTICS: Fully coated optics used throughout.

RETICLE: All-purpose, double glass, dustproof; cross-pattern with single lines top and right, paired lines bottom and left.

EYEPIECE: Erecting, achromatic. Right-angle eyepiece and complete projection accessories available.

TELESCOPE BARREL: Made of through hardened stabilized tool steel with a hard chrome surface.

BARREL DIAMETER: 2.2498 in. (+0, - .0003) (A.I.A. specification). Ground barrel, length 9³/₁₆ in.

OVERALL LENGTH: 13¼ in.

WEIGHT: Approx. 5 lbs. 11 oz.

Accessories

FOR LINE OF SIGHT TELESCOPES (71 2062)

71 1211 Auto-Collimation Conversion Unit; see page 17.

71 1231 Right Angle Eyepiece; see page 17.

71 1241 Combination Auto-Collimation, Projection Eyepiece; see page 17.

FOR ALIGNMENT TELESCOPES (71 2022, 71 2024, 71 2030)

71 2230 Right-Angle Eyepiece – This right-angle eyepiece is used in place of the standard eyepiece on any K&E alignment telescope. With the eyepiece, it is possible to use the telescope at floor level, against a wall or other obstruction. This eyepiece maintains an erect image and can be rotated through 360° for sighting from any angle perpendicular to the line of sight.



Accessories

FOR ALIGNMENT TELESCOPES *(continued)*

71 2240 Combination Auto-Collimation, Projection, and Right-Angle Eyepiece – This unit is used in place of the standard eyepiece on a K&E alignment telescope. It consists of a right-angle eyepiece plus an illumination unit which can be used either to project an image of the reticle onto a target or for auto-collimation. The unit includes a variable transformer for use with 110 volts AC, 50-60 cycles. The eyepiece unit can be converted in the field as required, to form a straight-through vision system or a right-angle system.

71 2302 Angle Reading Attachment – This attachment fits over the objective end of a standard 71 2022 telescope and converts it into an angle reading type telescope. With the angle reading attachment in place, the micrometers read directly to one second of arc over a range of 50 seconds at infinity only. Maximum usable distance for auto-collimation, approximately 30 ft. Infinity setting on focusing knob approx. 17 ft.

For Both LINE OF SIGHT & ALIGNMENT TELESCOPES

71 2410 Optical Square – The optical square is mounted on an alignment telescope or an alignment collimator with an outside diameter of 2.2498 in. (conforming to A.I.A. specification). It establishes a plane perpendicular to the basic line of sight at right angles to it, with an accuracy of within one second of 90°. No adjustments are needed to set the right angle. The basic line of sight can be checked while the optical square is attached to the telescope, since the square has both a front and a side aperture. The optical system is mounted in a spherical housing of 3.500 in. diam. with the vertex of the right angle at the center of the sphere. Weight 5 lbs. approx.

71 2412 Double Sphere Optical Square – This instrument is similar to the Optical Square 71 2410, except that a second sphere is located 2.250 in. behind the sphere with the prism. With the rear sphere placed in a cup mount, the optical square can be rotated and provides a clear right-angle view through a full 360°. Weight 6 lbs. approx.

71 3205 Cross Level—This level establishes the reticle crosslines of the alignment telescopes and alignment collimators vertically and horizontally. The cross level is positioned by means of a stud fitting into a hole in the barrel of the instrument tube. When the level bubble is centered, the crosslines of the instrument will be vertical and horizontal. The level vial has a sensitivity of 90 seconds of arc per 2 mm movement. Weight ¼ lb. approx.

71 3220 Coincidence Striding Level—This level is used for establishing a level line of sight with any alignment telescope or alignment collimator with a 2¼ in. diam. ground barrel. It is placed directly on the barrel of the telescope or collimator. It has Coincidence Level 71 3250 (see page 17) in a modified base. Sensitivity 20 seconds per 2 mm movement. Weight ½ lb. approx.



71 5100

71 5103

71 5100 Spherical Adapter (with Collet); see page 28.

71 5103 Spherical Adapter (without Collet); see page 28.

71 5511 Auto-Collimation Illumination Unit; see page 30.



71 2240

71 2302

71 2410

71 2412

71 3205

71 3220

PARAGON[®] Tilting Level



71 3010 PARAGON Tilting Level – The tilting level is specifically designed to establish a plane in space, level to 1 second of arc. When using this instrument with Optical Micrometer 71 1111, 71 1113 or 71 1115 and the optical alignment scale (see page 34), displacements accurate to thousandths of an inch can be determined at distances up to 100 ft. from the instrument. This provides means of leveling with ease all types of machinery and equipment, such as machine tools, turbine foundations, and paper machine bed plates, to accuracies difficult to achieve by conventional mechanical methods.

The telescope incorporates a new optical design which provides a minimum focus of 4 in. and variable magnification. The straight eyepiece is interchangeable with K&E eyepieces 71 1231 & 71 1241; see page 17. The tilting screw is of the new, two-speed screw design.

For rough leveling it has a circular level, sensitivity 10 minutes per 2 mm movement. For precise leveling it has a coincidence-type level with $2\frac{1}{2} \times$ magnification.

Four-screw leveling with the tilt (elevation) axis coincident with the azimuth axis eliminates errors due to changing the height of the instrument, which frequently occurs with the three-screw leveling instruments and those with a tilt axis not coincident with the azimuth axis.

SPECIFICATIONS

TELESCOPE: 11 $\frac{1}{4}$ in. long, with fully erecting achromatic K&E optical system.

Magnification: Varies automatically from 20x at near distance to 30x at infinity.

Focusing Range: 4 in. to infinity.

Resolving Power: 4 seconds of arc (according to the Bureau of Standards test procedure).

Field of View: 55 minutes at infinity, 5.2 mm at near distance.

Effective Aperture: 30 mm.

Optics: Fully coated optics used throughout.

Reticle: All-purpose, double-glass, dustproof; cross-pattern with single lines top and right, paired lines bottom and left.

Eyepiece: Erecting, achromatic. Removable blank provided for auto-collimation conversion unit. Right-angle eyepiece and complete projection accessories available.

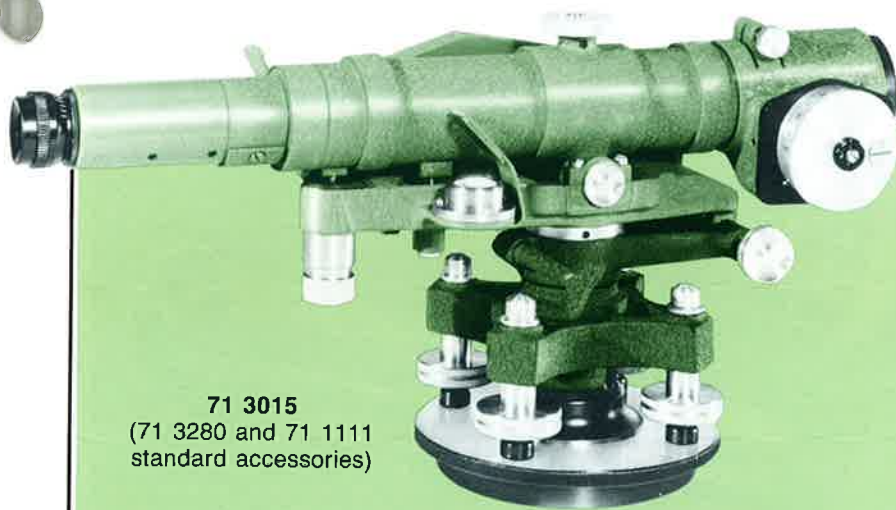
LEVELS: Circular Vial — Sensitivity 10 minutes per 2 mm movement.

Level Vial — Sensitivity 20 seconds per 2 mm movement; coincidence reading type, permitting both ends of bubble to be observed simultaneously; magnification $2\frac{1}{2} \times$. Right angle mirror for level vial housing.

TRIPOD PLATE: Threaded, 3 $\frac{1}{2}$ x 8, U.S. Standard.

WEIGHT: Approximately 11 lbs.

CARRYING CASE: Sturdy, woodgrain Formica, with foam rubber inserts and four large rubber supports; adjusting pin, center key, webbed strap.



71 3015
(71 3280 and 71 1111
standard accessories)



71 6010



71 6065



71 1260



71 3270



71 3015
Leveling Kit

LEVELING KIT

71 3015 PARAGON® Leveling Kit – This kit, in a compact carrying case, provides the basic equipment required for precise optical leveling and alignment. It contains:

- 71 3010 PARAGON Tilting Level
- 71 1111 Optical Micrometer
- 71 6010 WYTEFACE® 10 in. Optical Alignment Scale
- Right-Angle Mirror for level vial housing
- 71 3270 Scale Level
- 71 6065 Scale Holding Magnet
- 71 1260 Prismatic Eyepiece

Space is provided for an extra Scale 71 6010 and Scale Holding Magnet 71 6065.

Kits with metric components are available on special order.

ACCESSORIES for Tilting Level 71 3010

- 71 1111 Optical Micrometer; see page 17.
- *71 1113 Metric Optical Micrometer; see page 17.
- *71 1115 Optical Micrometer; see page 17.
- 71 1211 Auto-Collimation Conversion Unit; see page 17.
- 71 1231 Right-Angle Eyepiece; see page 17.
- 71 1241 Combination Auto-Collimation, Projection, Right-Angle Eyepiece; see page 17.
- *71 1260 Prismatic Eyepiece; see page 17.
- 71 5511 Replacement Auto-Collimation Illumination Unit; see page 30.

*To order only ® Metric

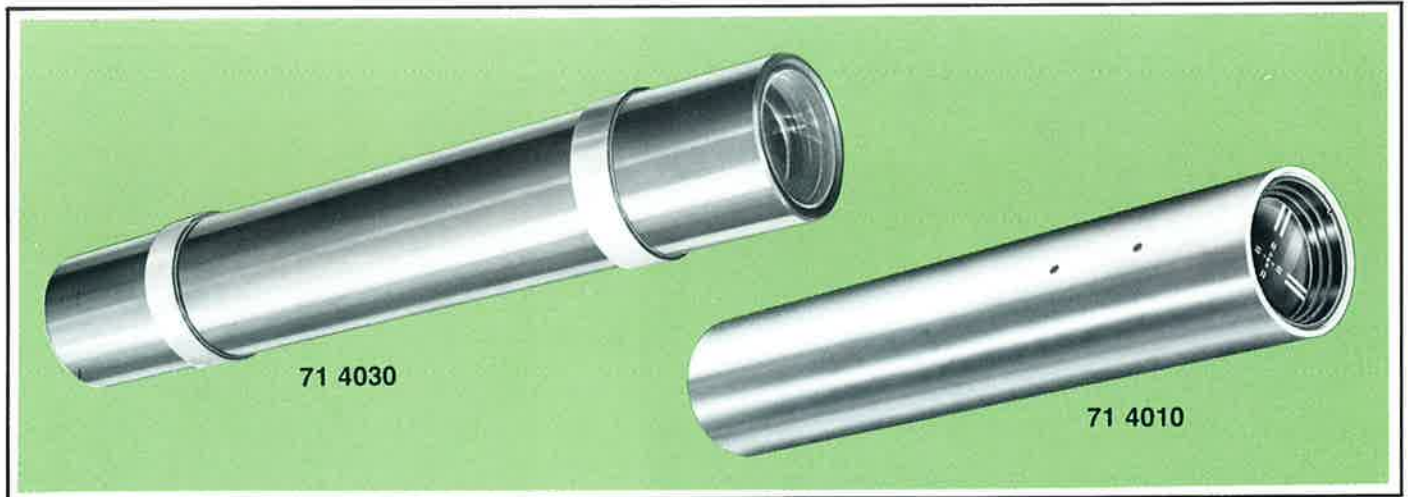
COINCIDENCE LEVEL



71 3280

***71 3280 Coincidence Level**—A coincidence-type level with 2½x magnification permits leveling to within 1 arc second. Coincidence viewed through window in end of housing. Back plate to facilitate mounting to any instrument or part to be precisely leveled. Weight 3 lbs. approx. (Standard with 71 3010, 71 3015).

Collimators



71 4030 Straightness of Line of Sight Collimator – This instrument is used in testing and adjusting all optical metrological and surveying instruments. It checks the straightness of the line of sight of any sighting telescope from minimum focus to 100 ft. The collimator contains seven reticles positioned to simulate distances of 0, 4, 10, 25, 50, 100 ft., and infinity. Weight 12½ lbs. approx.

SPECIAL COLLIMATORS

K&E can furnish special collimators to order for testing and adjusting optical metrological and surveying instruments. These collimators can be made with various combinations of reticles positioned to simulate desired distances from zero to infinity.

71 4010 Alignment Collimator – The alignment collimator is used to establish positions in reference to a line of sight and for checking and adjusting optical alignment and surveying instruments. It can also be used as an auto-collimator when provided with Auto-Collimation Eyepiece 71 4111. The collimator barrel is machined from through hardened stabilized steel with a hard chrome surface. Ground barrel length is approximately 12 in., barrel diameter is 2.2498 in. (A.I.A. specification). The infinity target is graduated every 30 seconds with a total of 18 minutes of arc in four directions from zero. A paired-line target is centered on the collimator objective lens. Lamp housing 71 5520 for target illumination can be screwed into the rear of the barrel. Weight 5 lbs. approx.



71 4210 Visual Auto-Collimator – Best described as the basic unit for auto-collimation in the K&E line. It is designed to measure angles of deviation about an axis perpendicular to the line of sight. The micrometer reads to 0.2 second of arc and is estimated to 0.1 second of arc. Used for checking surface plates and beds, angles on polygons, and other highly accurate angle measurements.

SPECIFICATIONS

Range: ± 5 minutes. **Graduations:** to 0.2 second of arc. **Working distance:** 0 to 50 ft. at full range. **Magnification:** 53x. **Field of View:** 22 minutes. **Objective Aperture:** 50 mm. **Effective Focal Length:** 900 mm. **Overall Length:** 19½ in. **Weight:** 17½ lbs.

Accessories

ACCESSORIES for 71 4030 Collimator

71 3230 Coincidence Striding Level – The striding level establishes the Collimator 71 4030 in a level position. A coincidence-type reading, is accurate to within 1 second of arc. A spring clip prevents the striding level from falling off the collimator barrel. Weight 7 lbs, approx.

ACCESSORIES for 71 4010 Collimator

71 4111 Auto-Collimation Eyepiece – This eyepiece is used to convert the 71 4010 to an auto-collimator. After removing the back plate, the eyepiece can be attached by screwing it into the end of the alignment collimator, making it a 30x infinity focus telescope. It is provided with a plug-in type illumination unit, 110 volts AC, 50-60 cycles.

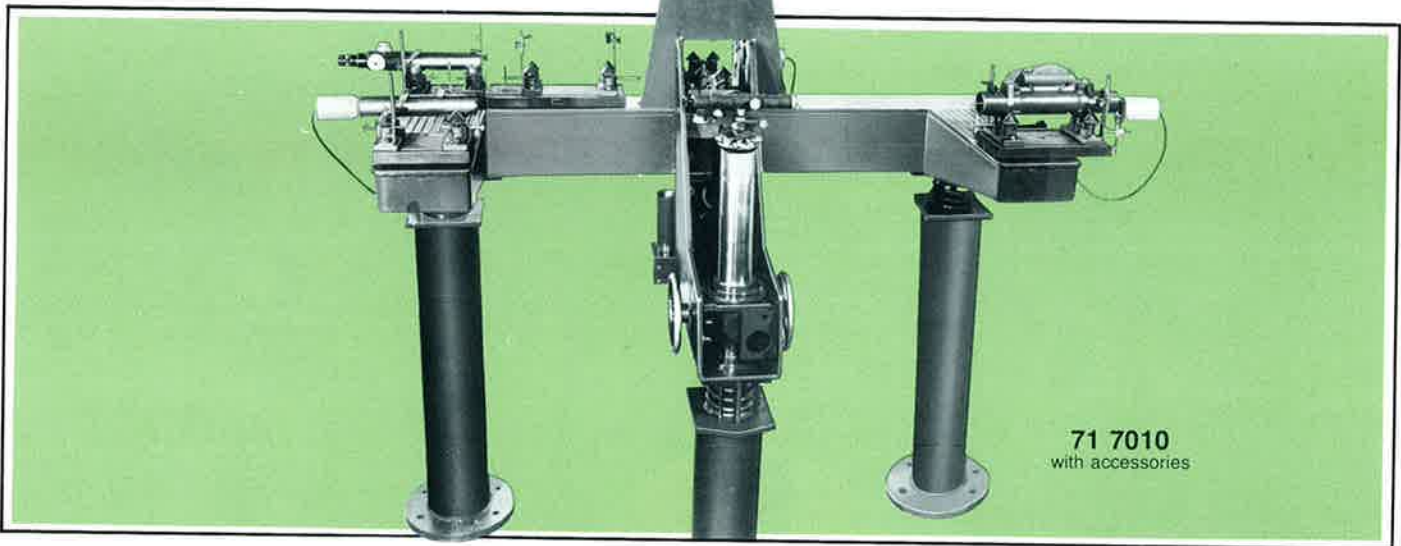
*71 3205 Cross Level; see page 21.

71 3220 Coincidence Striding Level; see page 21.

71 5520 Lamp Housing; see page 30.



Collimator Test Stand



***71 7010 Collimator Test Stand**—The collimator test stand facilitates making the tests and adjustments required for all optical metrological instruments, theodolites, transits, transit-type instruments, levels, etc. The entire unit measures approximately 80 in. in length and 39 in. in width. It employs welded steel construction with three-point support for maximum stability. The test section is a one-piece unit mounted on vibration dampers which virtually eliminate any vibrations that might interfere with the tests. With suitable brackets and accessories, the test stand will accommodate any instrument; see pages 28, 29 & 30 for brackets. Weight 3,000 lbs. approx. Includes six 71 5192 Cone Assemblies, one 71 5201 T-Slotted Base Plate and two 14 in. T-Slotted Base Plates.

ACCESSORIES 71 4010 Alignment Collimator; see page 24

71 4030 Straightness of Line of Sight Collimator; see page 24.

71 4111 Auto-Collimation Eyepiece; see above.

71 5520 Lamp Housing; see page 30.

71 3230 Coincidence Striding Level; see above.

71 5060 Precision Lift; see page 27.

71 5085 Precision Mechanical Lateral Adjuster; see page 27.

71 5087 Precision Compound Mechanical Lateral Adjuster; see page 27.

71 5192 Cone Assembly; see page 30.

71 5201 T-Slotted Base Plate; see page 30.

***71 7020 Wedge Assembly** — This instrument is attached to Test Stand 71 7010 for checking the right angle of optical squares and jig transits with axle mirrors. It is direct reading to 1 second of arc and can be estimated to ¼ second of arc. Now with fixed cable. Weight 6 lbs. approx.



* To order only

Instrument Stands



71 5025 Heavy Duty High Instrument Stand — Provides exceptionally rigid support for Optical Tooling and other instruments. Easily positioned by rolling on retractable rubber covered casters. Quick release mechanism places stand on three adjusting bolts with swivel pad shoes. Bolts permit leveling of stand. Range of tilt 5° approx.

Center column is height adjustable by cranking large diameter hand wheel which operates fine drive worm and pinion. Range 33 in., adjustment from 40 to 73 in. between shoes and instrument base interface. Clamp lock to hold any desired height. Capacity, 150 lbs.

Column head rotatable 360° with locking clamp. U.S. Standard 3½ x 8 in. thread for instrument attachment. Column hollow for downward sighting, clear aperture 1¼ in. diameter. Provided with rubber shock bumper for instrument protection if elevation clamp is released under load. Shock resistant plastic thread cap provided.

Floor space required, 3 ft. 6 in. x 3 ft. 6 in. Net weight, 180 lbs. approx. Shipping weight, 260 lbs. approx. Cube, 45 cu. ft.

71 5015 Heavy Duty Low Instrument Stand — Same as 71 5025 except range is 17 in., adjustment from 24 in. to 41 in. Floor space required, 3 ft. 6 in. x 3 ft. 6 in. Net weight, 155 lbs. approx. Shipping weight, 235 lbs. approx. Cube, 45 cu. ft.

71 5030 Portable Instrument Stand — This stand provides a firm, rigid support for optical tooling, surveying and other optical metrological instruments. Triangular bracing of the legs assures stability. 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.

Height of stand is adjustable from 31 to 51½ in. with the 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 1½ in. diameter clear aperture for downward sighting. A removable plastic cap protects mounting ring 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.

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

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.

71 5070 Trivet — The 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 standard 3½ x 8 thread head; its height is 5 5/8 in. and it covers a radius of 4 7/8 in. Mounting hole sizes are 5/16 x 18 thread. Weight 6 lbs. approx.

ACCESSORIES



***71 5048 Extension Piece**—This 5 in. extension piece increases the maximum height of K&E instrument stands. It is fitted with a 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.

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) — 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 3½ x 8 female thread for mounting to any standard tripod, trivet, or instrument stand.

The Lift has a 3½ x 8 Standard 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. Operated by hand crank. Graduated micrometer drum reads to 0.001 in., numbered every .010, range 0.1 in. Slide travel 2 3/8 in. Clear aperture for downward sighting 2¼ in. diam., near center of travel, 1¼ in. diam., at end. Male and female threads, 3½ x 8 in., 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.

*To order only

Bracket and Support Equipment



71 5100 Spherical Adapter (with Collet) – This adapter is a hardened steel sphere ground to 3½ in. diam., and conforming to A.I.A. specifications. It has a collet for clamping the adapter on any point along the barrel of an alignment telescope, alignment collimator, or any other tube 2¼ in. in diameter. Target Stop Ring 71 5101 is used to position a target in the center of the sphere. Weight 3 lbs. approx.

71 5101 Target Stop Ring – The ring is used with Spherical Adapter 71 5100 to position the pattern surface of an alignment target precisely in the center of the sphere. A 2 x 24 thread is provided in the bore of the ring to hold Lamp Housing 71 5520. Weight ¼ lb. approx.

71 5102 Spanner Wrench – This wrench tightens the tension of the Spherical Adapter 71 5100 collet and the Target Stop Ring 71 5101.

71 5103 Spherical Adapter (without collet) – This adapter is a through hardened steel sphere, 3½ in. in diameter, conforming to A.I.A. specifications. It is designed to accommodate any target or tube with an outside diameter of 2¼ in. Three tapped holes with set screws are provided in the sphere to secure Lamp Housing 71 5520 or any of the 2¼ in. diam. targets. A fourth hole, with set screw, is provided for securing the sphere to the alignment telescope or alignment collimator. Weight 2¾ lbs. approx.

71 5140 Adjustable Cup Mount – This cup mount, which conforms to A.I.A. specifications, is a permanent positioning support for any 3½ in. diam. sphere, such as Spherical Adapters 71 5100 and 71 5103, or for any telescope, collimator, or tube equipped with sphere.

The base is cast iron with three bolt holes for mounting. The cup is adjustable in height through 1¼ in. and can be clamped in any position. Its supporting surface has three equally spaced lands for precise positioning. The vertical column of the cup mount is hollow to permit downward sighting through it. Weight 3¾ lbs. approx.

71 5142 Clamp for Cup Mount 71 5140 – This clamp holds a standard 3½ in. diam. sphere securely to the Cup Mount 71 5140 in any position. The open construction of the clamp permits measurements to be made directly to the surface of the sphere. Weight ¼ lb. approx.

71 5144 Adapter with 3½ x 8 Thread – The adapter is used with the Adjustable Cup Mount 71 5140 or any other cup mount conforming to A.I.A. specifications. It is provided with three tapped holes 5/16 in. x 18 threads for mounting the adjustable cup mount. The adapter can be mounted on any standard instrument stand, tripod, or trivet, with a 3½ x 8 U.S. Standard male thread. Weight 1¼ lbs. approx.

71 5146 Mounting Ring with 3½ x 8 Male Thread – The ring has a U.S. Standard 3½ x 8 male thread for mounting standard surveying or optical alignment instruments. It has three mounting holes for fastening the ring to any flat surface. Weight ¼ lb.

71 9026 Adapter Plate – for adapting instruments having 5/8 x 11 threads to fit optical tooling stands and other 3½ x 8 threaded supports.

71 5150 Universal Alignment Telescope Bracket – This bracket supports the optical square combined with an alignment telescope, or an alignment telescope equipped with a sphere. The bracket is specifically designed to simplify the process of “bucking-in” an alignment telescope. The cup mount can be removed and a cone screw-type mount substituted. The range of vertical adjustment is 2 $\frac{3}{8}$ in.

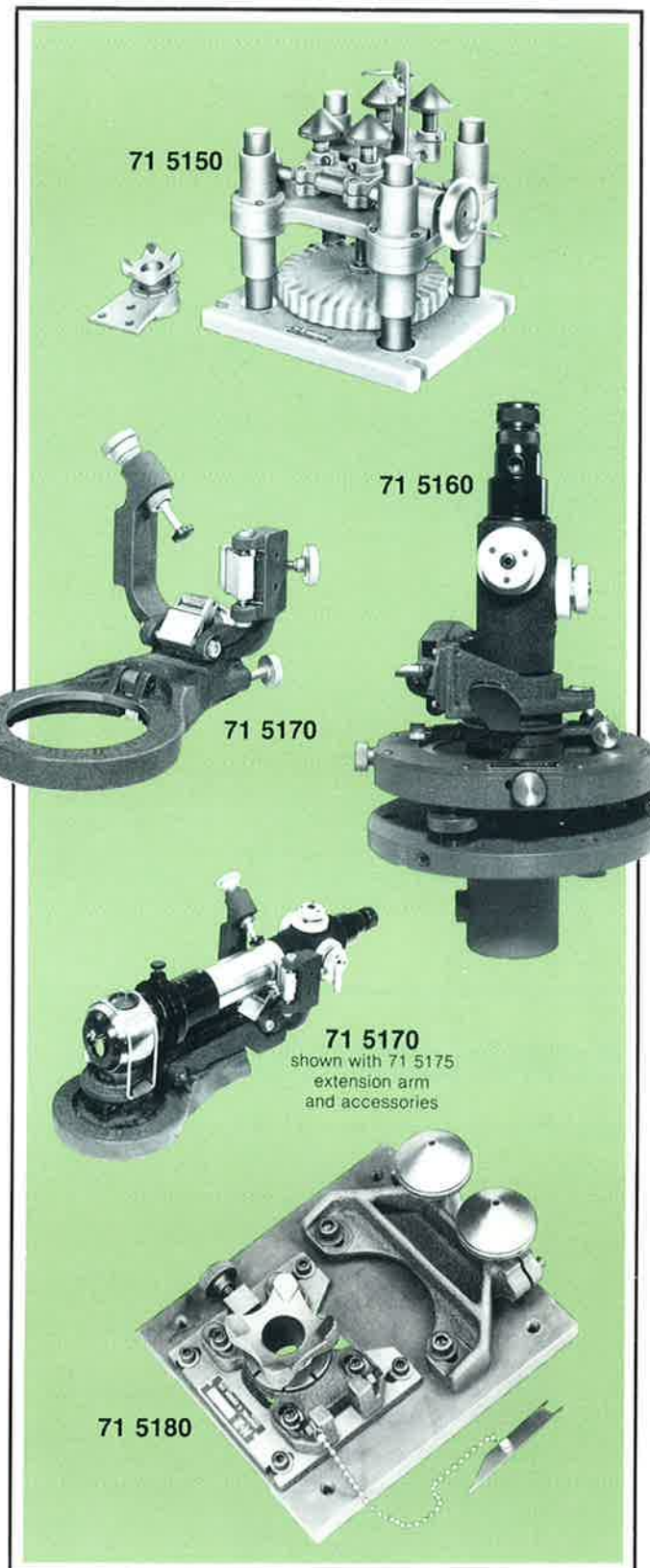
The cross slide supports the telescope and has an adjustment range of 2 $\frac{7}{8}$ in. A 3 $\frac{1}{2}$ x 8 thread is provided in the base plate for mounting the bracket to an instrument stand, such as 71 5025. The overall size of the bracket is 10 in. x 12 in. x 10 in. Weight 41 lbs. approx.

71 5160 Plumb Aligner Bracket – This bracket is used with the alignment telescope for making precise vertical sights, either upward or downward. It consists of a clamp and level vial assembly, a bearing plate, and a leveling plate with three mounting holes permitting the complete unit to be mounted at a predetermined location. The bracket is equipped with a circular level for rough leveling, and a coincidence level reading to within 1 second of arc (.0015 in. at 25 ft.). The vertical line of sight may be displaced approximately 1 $\frac{1}{4}$ in. laterally in any direction. In order to maintain extremely accurate vertical sights, it is recommended that the plumb aligner bracket and the alignment telescope be purchased as a unit. Weight 40 lbs. approx.

71 5170 Alignment Telescope Bracket – The bracket supports and provides a means for adjusting the position of alignment telescopes and alignment collimators. It can be attached to any standard cup mount, such as the Adjustable Cup Mount 71 5140. The yoke is easily repositioned on the bracket so that setups may be made with the bracket secured in a vertical, inclined, or upside-down position. With the addition of the Extension Arm 71 5175, the alignment bracket can be used with the alignment telescope and attached Optical Square 71 2410 or 71 2412. Weight 11 lbs. approx.

71 5175 Extension Arm – The arm extends the yoke of the Alignment Telescope Bracket 71 5170 so that it will support an alignment telescope in combination with the optical square. Weight 3 lbs. approx.

***71 5180 Bracket for Alignment Telescope and Optical Square** – This bracket supports an optical square combined with an alignment telescope, or an alignment telescope equipped with a sphere. The bracket consists of a steel plate with a cup assembly for supporting the square or sphere. An adjustable V-block assembly supports the telescope barrel, allowing a line of sight to be easily adjusted in the azimuth and elevation planes. The cup assembly is adjustable along the line of sight by means of a fine motion screw. This permits a downward sight through the optical square and results in precise positioning over any station. Weight 20 lbs. approx.



*To order only.

Bracket and Support Equipment



71 5182 V-Block, Cone-Type—This is an adjustable cone-type V-block with the cones offset from the mounting assembly. When used in combination with another cone assembly, the optical axis of an alignment telescope or collimator can be adjusted horizontally or vertically. Weight 6 lbs. approx.

71 5191 T-Slotted Base Plate—Plate has two parallel T-slots and a 3½" x 8 threaded section for attaching plate to the head assembly of an instrument stand or tripod. When used with two V-blocks (71 5192) it becomes baseline bracket that permits adjusting the optical axis of an alignment telescope horizontally or vertically. Size, 9 x 8 x 1¼". Weight 7 lbs. approx.

71 5192 V-Block Cone Assembly—This is an adjustable cone-type V-block assembly. When used in combination with another cone assembly, the optical axis of an alignment telescope or collimator can be adjusted horizontally or vertically. T-slotted bolts fit K&E T-slotted base plates 71 5191 and 71 5201. Weight 7 lbs. approx.

71 5201 T-Slotted Base Plate—This 10 in. long base has two parallel T-slots. The plate is provided with three counter-bored holes for mounting on Test Stand 71 7010. It can also be used as an instrument bracket, independently of 71 7010. Cone Assembly 71 5192 may be used on this plate. Weight 9 lbs. approx.

71 5204 Same as 71 5201 — 14 in. long.

71 5203 Same as 71 5201 — 18 in. long.

Illumination Units



71 5511 Auto-Collimation Illumination Unit — The Auto-Collimation Unit consists of a transformer, cord, switch, and light plug assembly. It is designed for 110 volts AC, 50-60 cycles, and may be used with all auto-collimation illumination attachments.

71 5520 Lamp Housing — The lamp housing provides illumination for the reticle pattern of an alignment collimator or any transparent target positioned in a spherical adapter such as 71 5100 or 71 5103. The lamp is rated at 15 watts and requires 110 volts AC. Cannot be used with 71 4030.

*** 71 5535** — Holder for 71 5520 lamp housing.

*To order only.

Targets and Mirrors

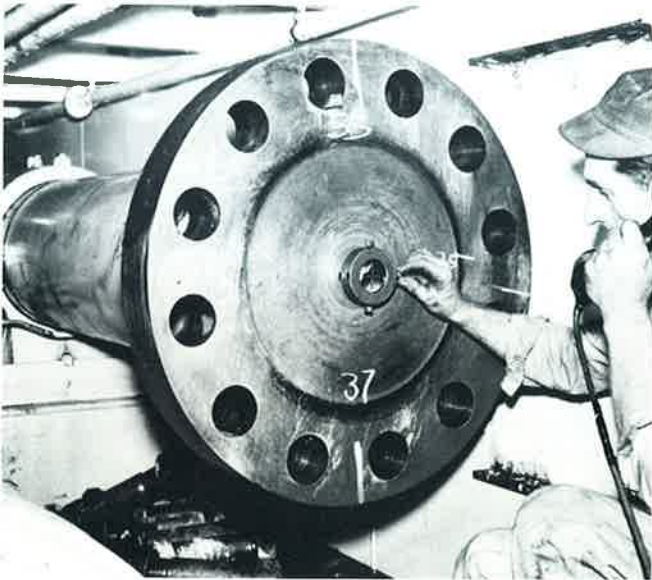
71 6110 Glass Alignment Target — This paired-line glass target is mounted in a hardened and ground stabilized steel ring 2.2498 in. (+0, -.0005) diam. \times 1/2 in. thick. It is centered within .0005 in. with respect to the outside diameter of the ring. It will fit into any of the standard spherical adapters, such as 71 5100 and 71 5103, conforming to A.I.A. specifications. Fixing holes: 2" center-to-center, 30 (.1285) DR.

71 6120 Glass Alignment Target — Same as 71 6110 but unmounted and 1/4 in. thick. The paired-line pattern is centered within .0005 in. with respect to the outside diameter. The target will fit into any standard spherical adapter, such as 71 5100 and 71 5103, conforming to A.I.A. specifications. Fixing holes: 2.250 center-to-center, .063 R.

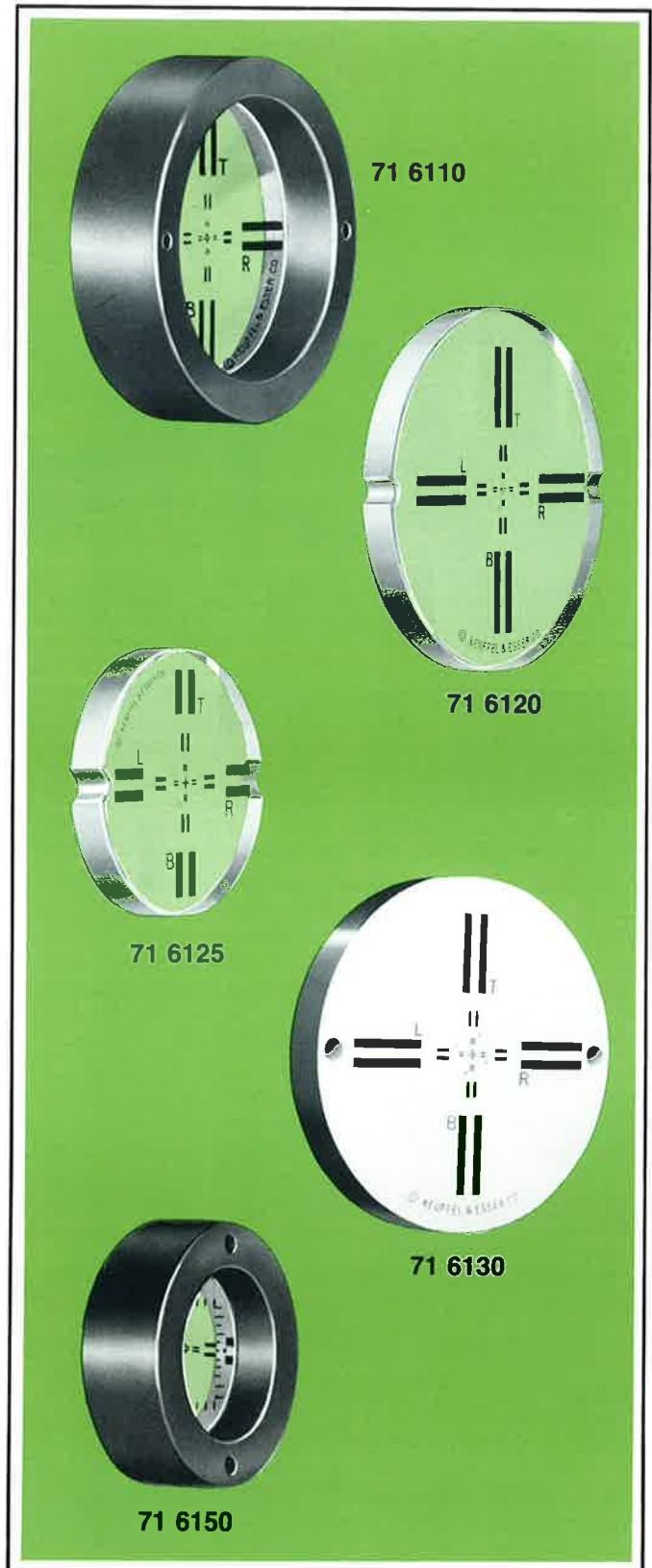
71 6125 Glass Alignment Target — This unmounted paired-line glass target is 1.4990 in. (-0, +.005) diam. \times 1/4 in. thick. Its paired-line pattern is centered within .0005 in. with respect to the outside diameter. Fixing holes: 1.500 center-to-center, .063 R.

71 6130 Aluminum Alignment Target (Disc-Type) — This target has a paired-line target pattern like 71 6110 but is printed on a 2.2498 in. (+0, -.001) diam. disc of aluminum, 3/8 in. thick. Fixing holes: 2" center-to-center, 30 (.1285) DR.

71 6150 Glass Displacement Target — This paired-line glass target, with horizontal and vertical displacement scales, is mounted in a hardened and ground stabilized steel ring 1.4990 in. (-0, +.0005) diam. \times 3/8 in. thick. It is centered within .0005 in. with respect to the outside diameter of the ring. The displacement scales are graduated up to .300 in. each side of zero, the large divisions reading .050 in., the smaller, .010 in. Fixing holes: 1.250" center-to-center, 30 (.1285) DR.



K&E alignment telescopes and targets have long been used for aligning propeller shafts and gear housings in shipyards. Shown is a shaft's centerline of rotation being located by sighting an alignment telescope on a mirror target. Because of distance involved, directions must be phoned.



Targets and Mirrors



71 6160 Plastic Alignment Target — This 2.2498 in. (+0, - .002) diam. x .375 in. thick target consists of a bull's-eye-type target pattern impressed on a milk white translucent plastic disc. The target pattern consists of a center dot .010 in. diam., an inside circle .100 in. diam., and an outside circle .200 in. diam. Fixing holes: 1.875" center-to-center, .1875 diameter holes.

71 6163 Plastic Alignment Target (Not Shown) — Consists of a bull's-eye-type target pattern on a milk white translucent plastic disc. Target diameter is 1.4990 in. (+0, - .002) x .375 in. thick. Target pattern consists of a center dot .010 in. diameter, inside circle .100 in. diameter and outside circle .200 in. diameter. Target is similar to 71 6160 Plastic Alignment Target but without holes.

71 6165 Adhesive Alignment Target This target has a standard paired-line alignment target pattern, 1½ in. square, with additional bull's-eye pattern. The target can be cemented to any flat or curved surface for alignment reference, for example: walls, machine beds, missile casings, fixtures, etc. The target has an anodized aluminum foil face. It meets abrasion, temperature, weather, and salt spray requirements of MIL specifications. It employs an adhesive back with peel-off release liner which peels off clean and fast with no distortion of target face.

71 6168 Multiple Bi-Filar See-Thru Target (Not Shown) — An open alignment target used where a target is required at several positions along a line of sight. The open target design makes it possible to sight directly through it without distortion. Centering the alignment cross of a telescope is easy with the new open cross pattern. The pattern consists of four quadrants, each of them having four sets of paired lines with spacing 0.10", 0.20", 0.40" and 0.80". The target is mounted in a hardened and ground stabilized steel ring 2.2498-2.2493 in. (+0, -0.0005) diameter x ½ in. thick.

71 6170 Open Alignment Target — This target is used when a target is required at several positions along a line of sight. Because it is an open target, it is possible to sight directly through it without distortion. Its nylon monofilament crosslines are mounted in a hardened and ground stabilized steel ring 2.2498 in. (+0, - .0005) diam. x ½ in. thick. They are centered within .001 in. with respect to the outside diameter of the ring. The target will fit into any standard spherical adapter conforming to A.I.A. specifications, such as 71 5100 and 71 5103. Fixing holes: 2" center-to-center, 30 (.1285) DIAM.

71 6175 V-Pattern Open Alignment Target — This target is similar to the Open Alignment Target 71 6170 except that it has a double V-pattern of nylon monofilament. Fixing holes same as 71 6170.

71 6202 Magnet Back Mirror — A magnet back mirror is used to check the perpendicularity of any flat surface to a line of sight by means of auto-reflection or auto-collimation. The mirror has a circular front surface 2½ in. diam. Its reflecting surface is flat to within ¼ wave length of light over any area not greater than 50 mm diameter. A single magnet is cemented to the back of the mirror. Its contact surface is ground parallel to the mirror surface within 3 seconds of arc.

71 6204 Magnet Back Mirror — Used for the same purpose as 71 6202, the mirror provides a much larger field of view and allows auto-reflection and auto-collimation to be established more quickly at greater distance. It is a circular front surface mirror, 4 in. diam. Its reflection surface is flat to within ¼ wave length of light over any area not greater than 50 mm diameter. Three magnetic feet are cemented to the back of the mirror. Their contact surfaces are ground parallel to the mirror surface to within 3 seconds of arc.

71 6240 Adjustable Spindle Mirror Target – This instrument establishes the axis of rotation of machine tool spindles, pumps, compressors, motors, radar tracking devices, marine propeller shafts, and many other rotating machine elements. By establishing the axis of rotation, the alignment of one rotating element to another can be made to a high degree of precision. The instrument consists of an optically flat front surface mirror target supported in an adjustable mount capable of shifting or tilting the mirror for adjustment. The instrument can be mounted either by means of its three rear surface magnets or by means of its removable arbor.

Overall dimensions are 4 $\frac{7}{8}$ in. diam. x 3 $\frac{3}{4}$ in. deep (without arbor). The device has a fine motion target shifting range of $\frac{3}{16}$ in. and the mirror tilting range is 1 $\frac{1}{2}$ °. Arbor is $\frac{1}{2}$ in. in diameter and 2 in. long. The lines are opaque matte finish and disperse the light. They appear black when illuminated with collimated light perpendicular to the surface, and white when illuminated from the side. Weight 2 $\frac{1}{2}$ lbs. approx.

* **71 6245 Adjustable Cube Mirror Target** – This instrument is similar to the Adjustable Spindle Mirror Target 71 6240. The unit consists of a glass cube with mirror targets on five sides. The cube is mounted on an adjustable steel plate and can be shifted and tilted. The adjustable cube mirror

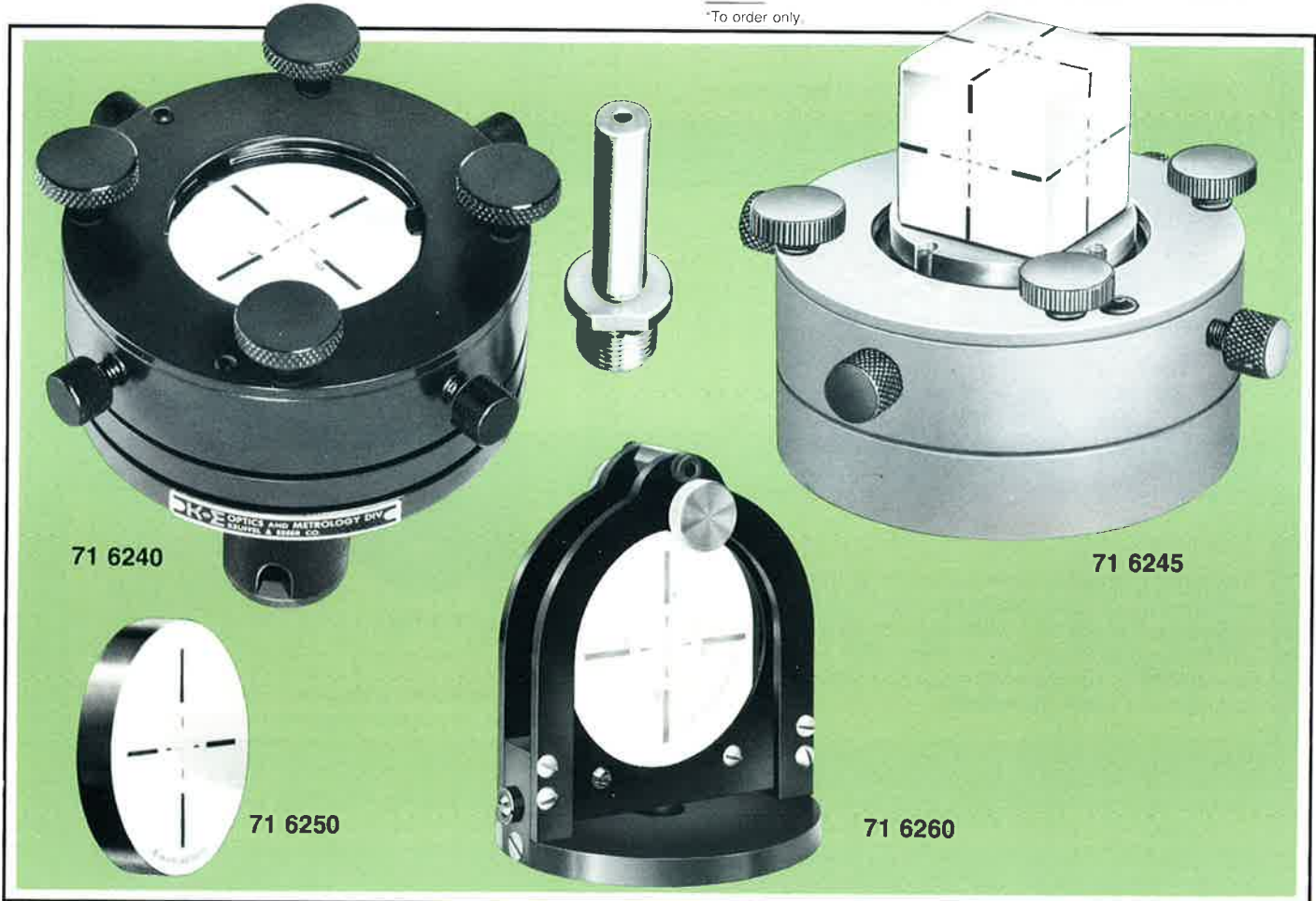
target can be mounted either by means of its three rear surface magnets or by means of its removable arbor. Its overall dimensions are 4 $\frac{7}{8}$ in. diam. x 3 $\frac{3}{4}$ in. deep (without arbor). Fine motion target shifting range is $\frac{3}{16}$ in. and the mirror tilting range is 1 $\frac{1}{2}$ °. The arbor is $\frac{1}{2}$ in. in diameter and 2 in. long. The cube is 1 $\frac{3}{8}$ in. and all face-to-face angles are 90° within 3 seconds of arc. Weight 3 $\frac{3}{4}$ lbs. approx.

71 6250 Mirror Target – This 2 $\frac{1}{4}$ in. diam. glass mirror target is used to check the perpendicularity of a part by auto-reflection or auto-collimation and also to position the part on the line of sight. The target is unmounted and can be fitted directly into the part to be positioned, or into any standard sphere such as 71 5100 or 71 5103.

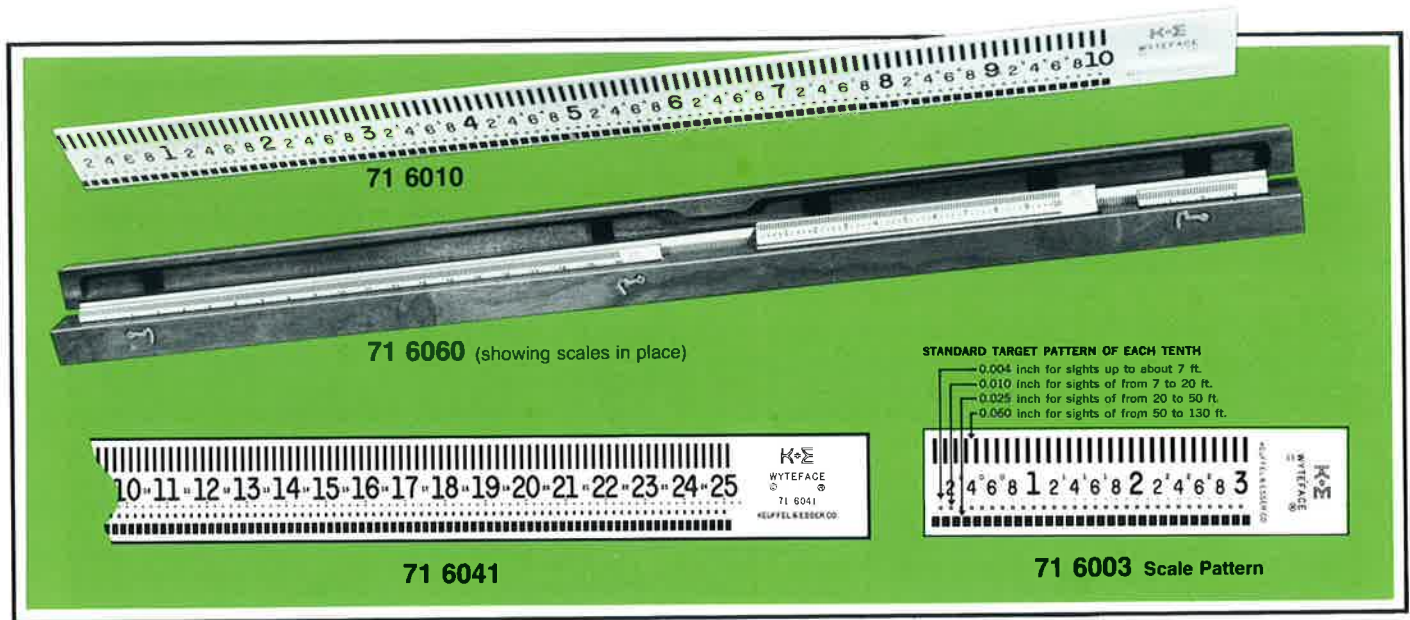
The target has a front surface mirror flat to within $\frac{1}{4}$ wave length of light. It is $\frac{1}{4}$ in. thick, 2.2498 in. (+0, -0.0005) diam.

* **71 6260 Spindle Tilt Mirror Target** – A plano-parallel double faced 100% reflective mirror, paired-line target, 2 $\frac{1}{4}$ in. diam. Adjustable, mounted in a metal frame attached to a circular 3 in. diam. base. The base can readily be attached to the end of a roller journal. Its use greatly facilitates alignment of multiple rollers in paper and coating machines and rolling mills. In use only one jig transit or alignment telescope is employed. Weight 1 lb. approx.

*To order only.



Alignment Scales



WYTEFACE® Optical Alignment Scales – These scales are made of hardened tool steel with a white matte surface. The paired-line graduations are black to provide maximum contrast.

On the English graduated scales the center of the space between each pair of lines represents .100 in. and is accurately located to within $\pm .001$ in. (at 68°F) from the zero end of the scale. Four pairs of lines, each with a different separation, are provided at each .100 in. for different lengths of sights, as follows:

SEPARATION IN INCHES	SIGHT DISTANCES IN FEET
0.004	Up to 7
0.010	7 to 20
0.025	20 to 50
0.060	50 to 130

The 3, 10, and 20 in. scales are graduated throughout their length. The 40 in. scale has the first 19½ in. blank and the last 20½ in. graduated. Graduations are numbered at each inch and subnumbered at each .200 inch. Inch numbers are repeated between every subnumber for easier reading.

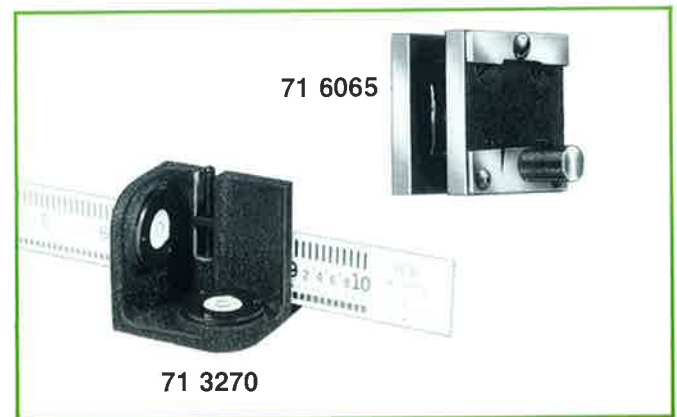
On the Metric graduated scale the center of the space between each pair of lines represents 2.0mm and is accurately located to within ± 0.02 mm (at 68°F) from the zero end of the scale. Four pairs of lines, each with a different separation, are provided at each centimeter for different lengths of sights, as follows:

SEPARATION IN MILLIMETERS	SIGHT DISTANCES IN FEET
0.1mm	Up to 7
0.2mm	7 to 20
0.6mm	20 to 50
1.2mm	50 to 130

Graduations are numbered at each centimeter and subnumbered at each half centimeter.

PRODUCT NUMBER	GRADUATED LENGTH	OVERALL LENGTH	WIDTH
71 6003	3 in.	4 in.	1 in.
71 6010	10 in.	11¼ in.	1 in.
71 6020	20 in.	21½ in.	1 in.
71 6040	40 in.	41½ in.	1½ in.
Ⓜ 71 6041	25 cm	28,5 cm	2.5 cm

71 6060 Empty Mahogany Box– Holds a set of 4 scales, 71 6003 to 71 6040.



71 6065 Scale Holding Magnet – The magnet holds 3, 10, 20 in. and 25 cm optical alignment scales at right angles to the finished surface of any magnetic metal. Overall size 2 in. x 2 in. x 1 in.

71 3270 Scale Level – This level sets optical alignment scales vertically or horizontally. It can be attached to any steel scale, up to ⅛ in. in thickness, and between 1 in. and 1½ in. in width. Both of the vials have a sensitivity of 15 minutes of arc per 2 mm movement.

Ⓜ Metric.

* **71 6050 WYTEFACE Alignment Bar Scale for Alignment Telescope with Optical Square** – The Alignment Bar Scale is made of tool steel with a white surface. The paired-line graduations are black to provide maximum contrast. The center of the space between each pair of lines represents .050 in. Each graduation is accurately located to within .001 in. (68°F) from the zero end of the scale. Graduated length 10 in., overall length 11¼ in. Two sets of numbers are provided so that the scale face reads from either side of the alignment bar. The scale has two dowel pins, spaced 10 in. apart; the zero graduation of the scale pattern is centered to the first pin.

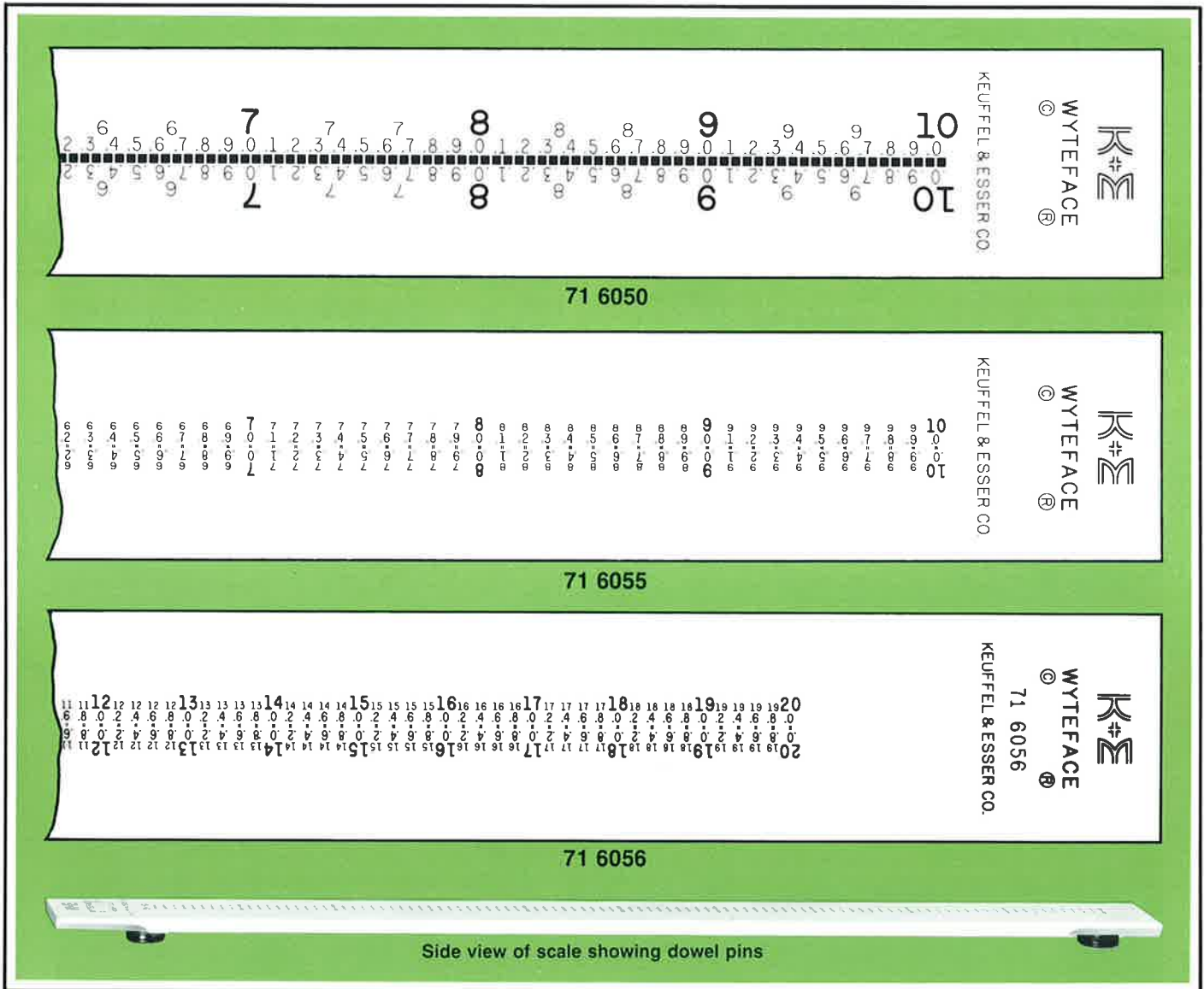
* **71 6055 WYTEFACE Alignment Bar Scale for Jig Transit** – Same as 71 6050 but center of the space between each pair of lines represents .100 in. Graduated length 10 in., overall length 11¼ in.

Ⓜ * **71 6056 WYTEFACE Metric Alignment Bar Scale for Jig Transit** – Made of tool steel with a white surface. The paired-line graduations are black to provide maximum contrast. The center of the space between each pair of lines represents 2.0mm. Each graduation is accurately located to within ±0.02mm (at 68°F) from the zero end of the scale. Graduated length 20cm; overall length 28cm. Two sets of numbers are provided so that the scale face reads from either side of the alignment bar. The scale has two dowel pins, spaced 20cm apart; the zero graduation of the scale pattern is centered to the first pin.

This scale is used with K&E Alignment Bar System, which can be provided with a Metric Index Bar, Catalog Nos. 71 5623 and 71 5624.

*To order only

Ⓜ Metric



Alignment Bar Systems

Linear distance measurements to accuracies of .001 in. are a common problem, not only in the field of aircraft and missile alignment, but also in the manufacture and inspection of machine tools, atomic reactors, and other precision assemblies. The methods of making such measurements have involved to an increasingly greater extent the use of the "Alignment Bar." K&E Alignment Bar Systems provide industry with a simple, versatile, economical means of achieving the desired degree of precision in measuring linear distances ranging from a fraction of an inch to one hundred feet and more. K&E offers both horizontal and vertical alignment bar systems.

Horizontal Alignment Bar System

The horizontal alignment bar system basically consists of:

1. Track supporting a jig-bored index bar having precision drilled bushings spaced every 10 in. or 20 cm.
2. Carriage carrying an optical instrument, such as the jig transit or alignment telescope with optical square. This carriage traverses the instrument along the track.

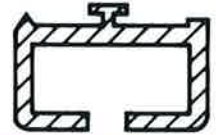
Instrument may be positioned over linear stations by sighting onto a K&E precision scale (71 6050, 71 6055 or 71 6056); see page 35, which is indexed to the drilled bushings of the index bar.

Plane of sight containing this station is then established perpendicular to an optical base or reference line which is separated from, but parallel to, the alignment bar itself. This perpendicularity is established by collimation or auto-collimation to the base line telescope.

Box Track, a one-piece aluminum alloy extrusion consisting of an integral support beam and track. It can be mounted directly on fixed support posts or on adjustable mobile support stands. The K&E box track is supplied with a 6-volt

electrical wiring system complete with a 6-volt transformer and Hubbell twist lock outlet every 5 ft.

PRODUCT NUMBER	LENGTH
** *71 5610	10 ft.
** *71 5611	15 ft.
** *71 5612	20 ft.
** *71 5613	30 ft.



* **71 5620 Index Bar** – This is a 1¼ in. x ½ in. rectangular jig-bored steel bar 10 ft. long. Jig-bored holes with 7/16 in. diam. drilled bushings are located precisely at 10 in. intervals. The index bar is fastened to the top of the T-shaped center of the track with provisions for expansion and contraction. The end design is such that successive sections can easily be joined together.

Other materials to match coefficients of expansion of parts being measured can be supplied on special order.

* **71 5621 Index Bar** – Same as 71 5620 but 5 ft. long.

Ⓜ * **71 5623 Metric Index Bar** – Same as 71 5620 but bar is 3 meters long. Jig-bored holes with 7/16 in. diam. drilled bushings are located precisely at 20cm intervals.

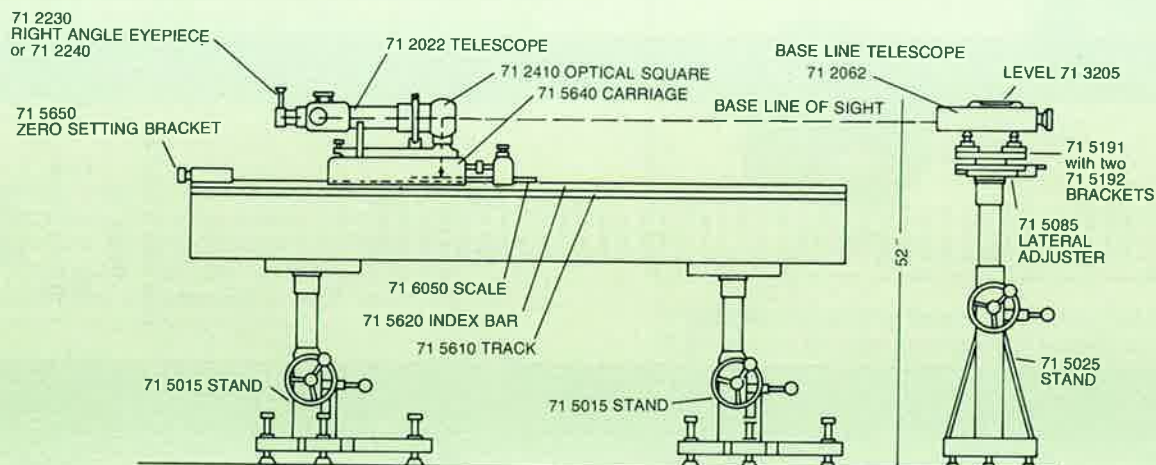
Ⓜ * **71 5624 Metric Index Bar** – Same as 71 5623 but 1.5 meters long.

* **71 5650 Index Bar Zero Setting Bracket** – The bracket is used to initially align the index bar with a fixed reference point or zero station of the working piece, if required. The bracket consists of a base casting with a "Push-Pull" type adjusting screw arrangement and an L-shaped lever arm. The bracket is clamped to the track on one end of the metrological bar and the L-shaped lever arm to the end of the index bar.

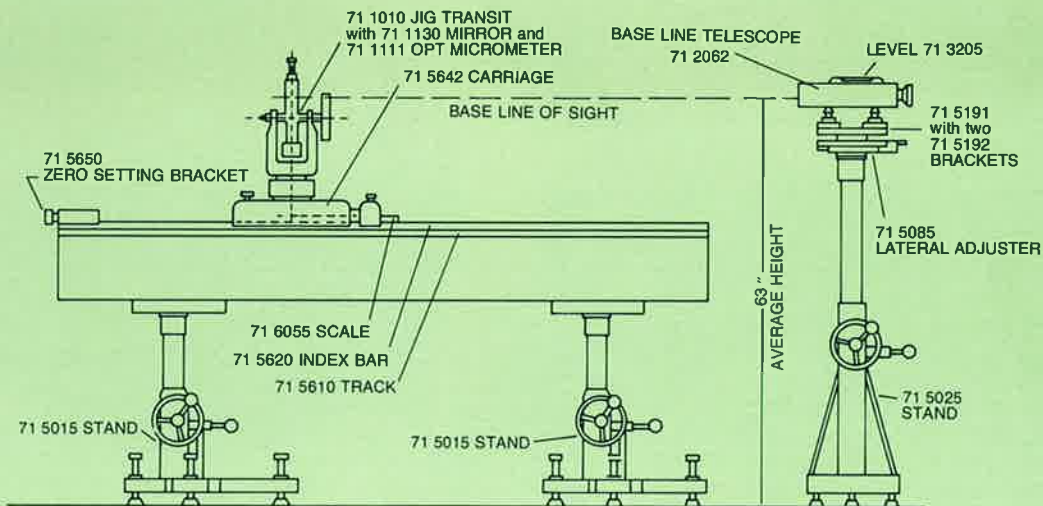
*To order only Ⓜ Metric

** Indicate if needed in metric.

Horizontal Alignment Bar System using Alignment Telescope with Optical Square



Horizontal Alignment Bar System using Jig Transit



* **71 5655 Spacing Gauge** – The gauge is used to join successive index bar sections. It is a rectangular steel bar provided with two dowel pins very precisely spaced 10 in. apart, which insures the proper spacing between the two holes on either side of the joint.

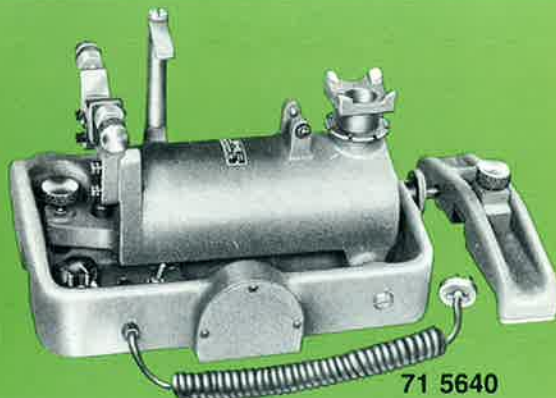
* **71 5640 Carriage for Alignment Telescope with Optical Square** – The carriage consists of a base casting with an instrument tilting plate which straddles the alignment bar scale. The tilting plate pivots the instrument about the intersection of the line of sight and the top surface of the scale. The carriage rides on two V-type rollers and a plain roller.

The V-type rollers are guided by the V-rail on one side and the plain roller rides on the raised flat rail on the other side of the track. A clamp bracket is provided to lock the unit quickly to the T-shaped center of the track. By means of a fine motion lead screw the carriage can be precisely adjusted and located over the desired station. The range of the fine adjustment is approximately $\frac{3}{4}$ in.

A 6-volt electrical system is built into the carriage to provide illumination for the alignment bar scale. A rheostat is used to give proper illumination for projection and auto-collimation. This is especially useful when the K&E combination projection, auto-collimation eye piece is attached to the telescope supported by the carriage.

* **71 5642 Carriage for Jig Transit** – Same as 71 5640 but with fittings to hold the Jig Transit 71 1010.

*To order only



71 5640



71 5642

Alignment Bar Systems

Vertical Alignment Bar System

The K&E vertical alignment bar makes it possible to measure vertical linear distances to a degree of precision not previously obtainable. The unique features of the K&E vertical metrological bar are:

The vertical station position is read optically on the alignment bar scale from the instrument itself. No mechanical linkage between instrument, carriage and scale reading system is required.

The PARAGON[®] Tilting Level 71 3010, a highly accurate tilting level specifically designed for use on the vertical alignment bar, is used to establish horizontal planes.

The 71 1111 or 71 1113 Optical Micrometer attached to the instrument provides means for making precise readings. When the tilting plate in the micrometer is tilted by turning a graduated drum, the line of sight is moved parallel to itself. With the 71 1111 the amount of displacement can be read directly to .001 in., and estimated to .0001 in.

The design features built into the K&E vertical alignment bar carriage assure fast and easy station settings. No time is lost in moving the carriage over the proper station point while at the same time trying to maintain the instrument in

a horizontal plane. The K&E system incorporates two distinct operations, neither of which influences the other.

The carriage is counterbalanced with a weight suspended from two steel cables. The base casting rides on two V-type rollers and a plain roller on a standard metrological bar track. It is held to the track by spring loaded braces to assure firm contact with the V-type rails.

The tilting bracket which straddles the alignment bar scale is pivoted about an axis that intersects the top surface of the alignment bar scale. A glass index scale mounted on top of the base bracket is permanently lined up with this pivot axis. Therefore, when the sight level is aimed at the glass index scale, the line of sight intersects the tilting bracket pivot axis. This means that the subsequent leveling accomplished by tilting the bracket about the pivot axis does not disturb the scale setting.

A clamp bracket is provided to lock the carriage quickly to the T-shaped center rail of the track. By means of a fine motion lead screw, the carriage can be precisely located over the desired station point.

A 6-volt electrical system is built into the carriage to provide illumination for the tooling bar scale. A rheostat gives proper illumination for projecting and auto-collimating when the K&E combination auto-collimator projection eyepiece is attached to the telescope.

The K&E vertical alignment bar is furnished complete with:

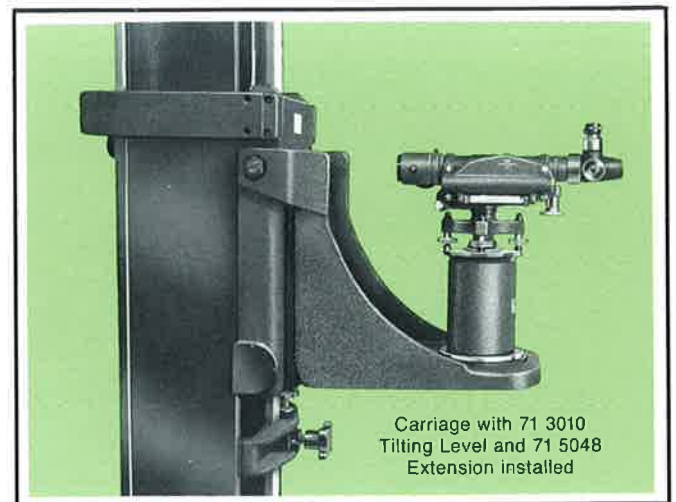
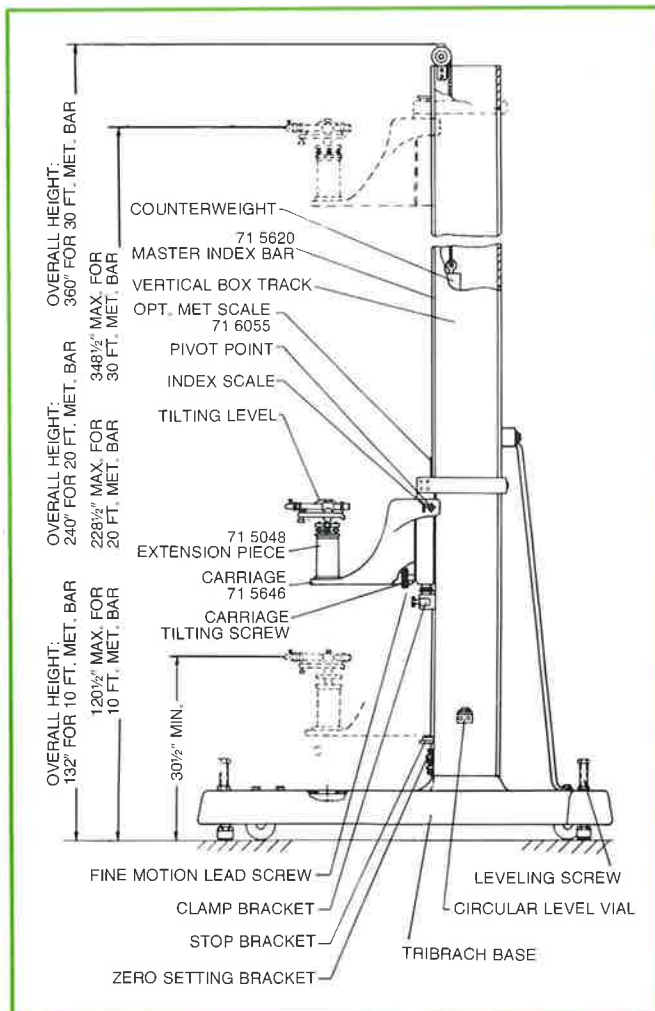
1. **Tribrach base** with retractable casters and leveling screw
2. **Vertical box track** with circular level vial
3. **Counterbalanced carriage**
4. **71 5620 Master index bar**; see page 36
5. **71 5650 Zero setting bracket**; see page 36
6. **71 6055 WYTEFACE[®] alignment bar scale**; see page 35
7. **71 5048 Extension Piece**, used with tilting level only; see page 27

The vertical alignment bar is also equipped with a 6-volt electrical wiring system complete with a 6-volt transformer, 12 feet of cord and Hubbell twist lock outlets on the box track.

* 71 5670 Vertical Alignment Bar System – Complete system, 10 ft.

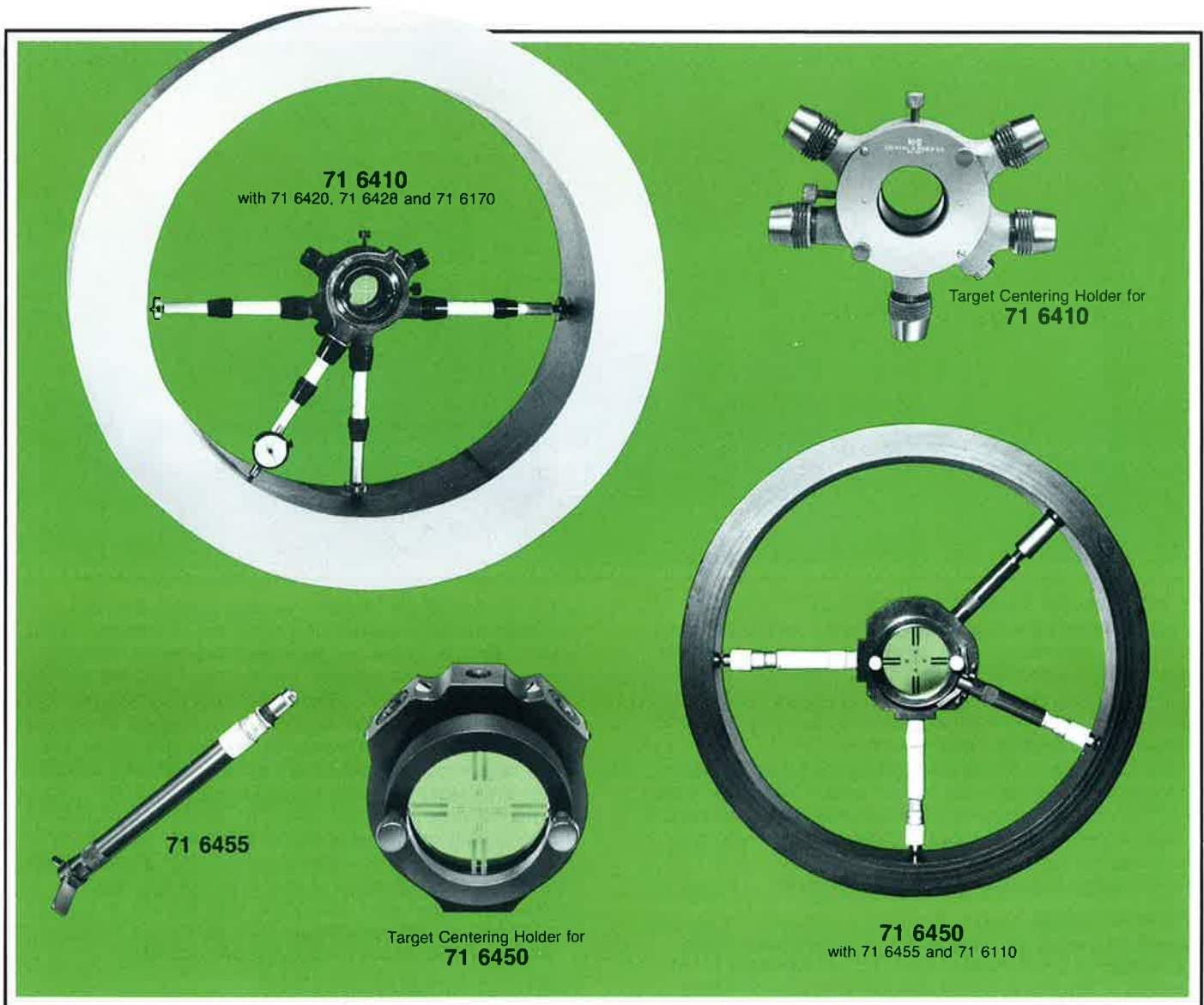
* 71 5677 Vertical Alignment Bar System – Complete system, 20 ft.

* 71 5679 Vertical Alignment Bar System – Complete system, 30 ft.



*To order only.

Target Holding and Centering Equipment



71 6410 Adjustable Target Holder for Large Bores – This device holds a target, such as 71 6110, 71 6170 or 71 6175 in any bore from 18 in. to 68½ in. in diameter. The target holder is supported by three telescoping legs. Three sets of legs are supplied for use in bores of diameters from 16 in. to 23½ in., 23½ in. to 38½ in., and 38½ in. to 68½ in., respectively. The legs can be clamped at any position within their range. To center the target in the bore, an Indicator Holder 71 6420 with Dial Indicator 71 6428 must be attached to the target holder. Weight 10 lbs. approx.

ACCESSORIES for Adjustable Target Holder for Large Bores 71 6410

71 6415 Legs – For use in bores of diameters from 65 in. to 121 in. Set of three.

71 6420 Indicator Holder – For use with 71 6410.

71 6425 Extension Rod – For 71 6420, for use on bores of diameters from 67 in. to 121 in.

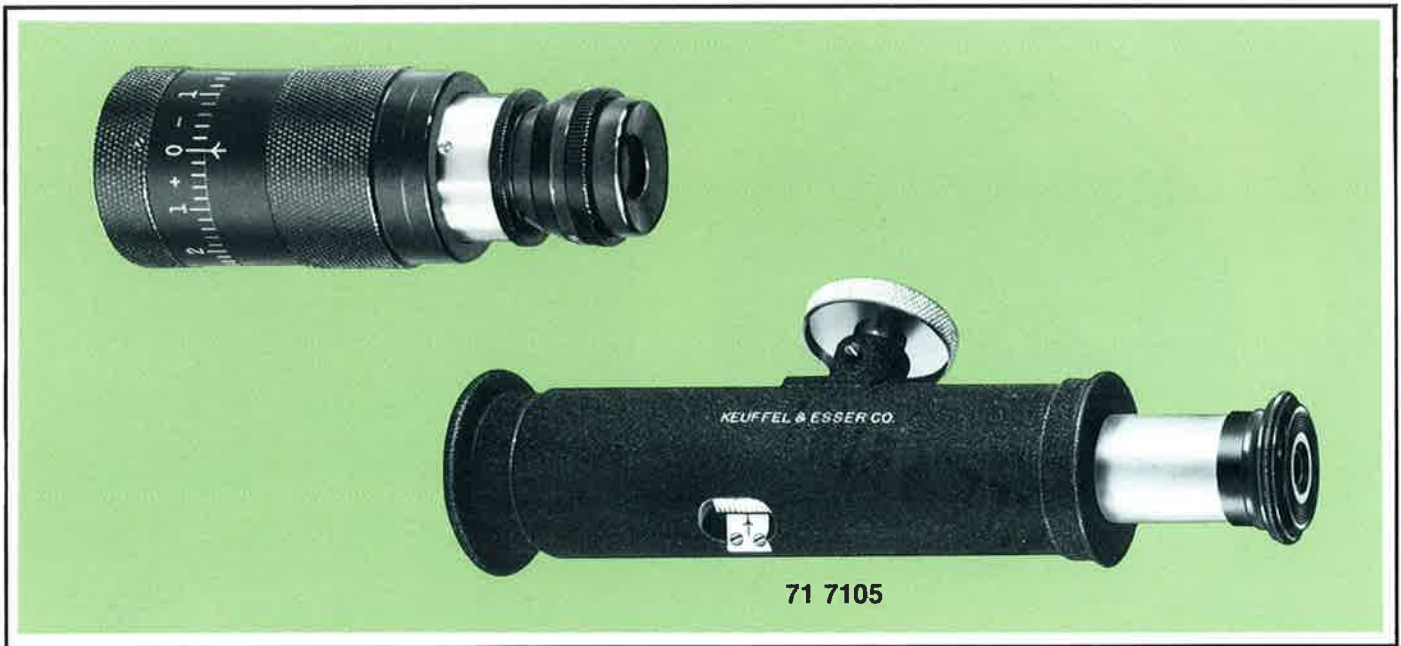
71 6428 Dial Indicator – For use with 71 6420, reading to .001 in., graduated 0-100, range .250 in.

71 6450 Adjustable Target Holder for Small Bores—This device holds a target in any bore from 5½ in. diam. to 21½ in. diam. The target holder is supported by two micrometer stick legs and one spring loaded plunger leg. The kit comes complete with a set of legs and extensions to fit all diameters between 5½ in. and 21½ in.

71 6455 Target Centering Device for Adjustable Target Holder for Small Bores 71 6450 – This device is a micrometer stick with vernier micrometer reading to .001 in. and a V-type adapter on one end, and is used to center the target mounted on the Target Holder 71 6450. Consists of three sets of three each extensions necessary to fit bores from 5 in. to 21½ in. diam. Weight 4 lbs. approx.

*To order only.

Testing Instruments



71 7101 Diopter Tester—Primarily used to check the range and make the “zero” setting of focusing eyepieces for optical instruments such as the binocular, rangefinder microscope, theodolite, spectrometer, telescope, etc. Used for measuring power of lens (within range), measuring field curvature of lens, determining range of focusing eyepiece, measuring astigmatism of a telescope.

The K&E Diopter Tester has a range of 9 diopters (from plus 4 to minus 5). Its scale is calibrated in major numbered divisions of whole diopters, with the smallest divisions equal to 0.2 diopters. Estimates to 0.1 diopter are easily and accurately made.

Alignment Bar System quoted upon request.

SPECIFICATIONS

Diameter: 1 $\frac{3}{8}$ in. **Length (closed):** 3 $\frac{1}{16}$ in. **Length under working conditions:** 3 $\frac{1}{2}$ in. **Field of view:** 12° 40'. **Aperture:** 13 mm. **Diameter of Exit Pupil:** 4 $\frac{1}{4}$ mm. **Magnification:** 3x. **Minimum Focus:** 8 in. **Range:** 9 diopters, from plus 4 to minus 5. **Graduations:** Smallest division 0.2 diopters, with whole diopters numbered. **Zero Setting:** At infinity (for perfectly collimated light). **Weight:** 1 $\frac{1}{2}$ lbs. approx.

*** 71 7105 Exit Pupil Tester**—An instrument used to evaluate the performance of a telescope. It provides direct measurements of the exit pupil diameter of the telescope and of the distance between the exit pupil and the eye lens (the “eye relief”). It also facilitates direct measurement of the clear aperture of the objective lens. Division of the diameter of the clear aperture by the diameter of the exit pupil (also known as the “eye-ring” or “Ramsden circle”) gives the magnifying power of the telescope.

The instrument is a ten-power microscope which may be focused on a reticle calibrated in millimeters. This reticle in turn may be racked towards or away from the eye-lens of the telescope; at position of best focus (of the objective aperture) the eye relief distance is read directly off a scale on the side of the instrument.

Alignment Bar System quoted upon request.

SPECIFICATIONS

Length (closed): 5 in. **Diameter:** 1.5 in. **Reticle calibration:** 8 mm, in 0.1 mm steps. **Rack calibrations:** 50 mm, in 1 mm steps. **Microscope power:** 10x. **Weight:** 1 $\frac{1}{2}$ lbs. approx.

*To order only.



How K&E can help you . . .

K&E can help you choose the most efficient optical system for your operation. This catalog lists the full line of K&E optical tooling and industrial alignment equipment. It is the most complete line available, backed by over 100 years of leadership in the development of optical instruments.

Experienced K&E Field Representatives—with the assistance of our optical engineers, physicists and design specialists—are always available for consultation and service. If you have dimensional-control problems—in tooling, assembly, inspection or other areas—we invite you to call on us, through your nearest K&E Dealer or Branch.

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Conversion Tables

Seconds of arc in terms of thousandths of an inch							
	10 ft.	20 ft.	30 ft.	40 ft.	50 ft.	100 ft.	
1 sec.	.0006	.0012	.0017	.0023	.0029	.0058	
2 sec.	.0012	.0023	.0035	.0047	.0058	.0116	
3 sec.	.0017	.0035	.0052	.0070	.0087	.0175	
4 sec.	.0023	.0047	.0070	.0093	.0116	.0233	
5 sec.	.0029	.0058	.0087	.0116	.0145	.0291	
10 sec.	.0058	.0116	.0175	.0233	.0291	.0582	
15 sec.	.0087	.0175	.0262	.0349	.0436	.0873	
20 sec.	.0116	.0233	.0349	.0465	.0582	.1164	
25 sec.	.0145	.0291	.0436	.0582	.0727	.1454	
30 sec.	.0175	.0349	.0524	.0698	.0873	.1745	
60 sec.	.0349	.0698	.1047	.1396	.1745	.3491	

Angles to linear measurement				Linear measurement to angles			
angle	per inch	per 10 inches	per foot	linear	per inch	per 10 inches	per foot
1 sec.	.000005	.000048	.000058	.000001"	0.206 sec.	0.021 sec.	0.017 sec.
5 sec.	.000024	.000242	.000291	.000025"	5.157 sec.	0.516 sec.	0.430 sec.
10 sec.	.000048	.000485	.000582	.00005"	10.3 sec.	1.03 sec.	0.86 sec.
20 sec.	.000097	.000970	.001164	.0001"	20.6 sec.	2.06 sec.	1.72 sec.
30 sec.	.000145	.001454	.001745	.001"	3 min. 26.3 sec.	20.6 sec.	17.2 sec.
1 min.	.000291	.002909	.003491	.005"	17 min. 11.3 sec.	1 min. 43.1 sec.	1 min. 25.9 sec.

Decimal equivalents metric conversion								
fraction	decimal	mm	fraction	decimal	mm	fraction	decimal	mm
$\frac{1}{16}$	.015625	.3969	$\frac{3}{8}$	.375	9.525	$\frac{11}{16}$	.671875	17.0656
$\frac{1}{32}$	.03125	.7938	$\frac{7}{16}$	.4375	11.125	$\frac{13}{16}$	.8078125	20.6375
$\frac{3}{16}$	.1875	4.7625	$\frac{1}{2}$	.5	12.7	$\frac{3}{4}$	.75	19.05
$\frac{1}{8}$	.125	3.175	$\frac{9}{16}$	.5625	14.2875	$\frac{7}{8}$	.875	22.225
$\frac{5}{16}$	.3125	7.9375	$\frac{5}{8}$	.625	15.875	1	1.0	25.4
$\frac{3}{8}$	.375	9.525	$\frac{11}{16}$	.671875	17.0656			
$\frac{1}{4}$	.25	6.35	$\frac{13}{16}$	.8078125	20.6375			
$\frac{9}{16}$.5625	14.2875	$\frac{3}{4}$.75	19.05			
$\frac{1}{2}$.5	12.7	$\frac{7}{8}$.875	22.225			
$\frac{5}{8}$.625	15.875						
$\frac{3}{4}$.75	19.05						
$\frac{7}{8}$.875	22.225						
1	1.0	25.4						



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