WILD
HEERBRUGG

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WILD T1

Micrometer Theodolite with Automatic Vertical Index

Instructions for Use

Attention!

Automatic Vertical Index: The T1 must be levelled up in order to see the vertical circle correctly in the reading microscope.

"Getting Along With Instruments"

A survey instrument will work efficiently only if it is carefully looked after and maintained, and if the survey methods and techniques conform to its basic properties and design. An Instruction for Use is supplied with each Wild instrument, giving explicit information regarding its care and correct use. The Instruction is of no value at all if it is kept in a drawer and never studied.

Storage. If possible, the instrument should be stored in a dry, dust-proof room, which does not have a big temperature range. In a humid climate it must be removed from its tightly closed container and the air must be allowed to circulate freely around the instrument. This is the best method for preventing mildew or fungus growth. The longer an instrument is not in use the more liable it becomes to such a growth. To counter this, the instrument should be stored in an opened state (i.e. not in its container) in a heated airing cupboard. The airing cupboard should have an electric bulb or a heating element and the shelves should be either slatted or ventilated with air-holes. In any case, care must be taken to ensure a steady flow of air.

In extremely cold areas, an instrument should not be taken into a heated room during non-working periods but must be exposed, in a sheltered position, to the outside temperature. In this way the steaming-up of its optics and the formation of water condensation in the instrument's interior is avoided, thus allowing survey work to be restarted without additional delays.

Checking. At the start of a field season an instrument should be examined according to the Instructions for Use and, in certain cases, it will have to be adjusted. This procedure is also recommended at the end of the field season, during long intervals of non-use or after long journeys, so that the loss of valuable working time in the field, due to defective instruments, may be avoided.

Transport. For a long journey, by rail or road, the instrument should be packed in a foam-padded plastic transport case (optional accessory), which should be kept upright during the trip. When being transported by pack horse care must be taken to ensure that it is carried upright in its container, preferably hanging down the side of the horse. When being carried over water, in small boats, it is advisable to secure the container (with the instrument inside it) firmly to the boat, as an unsecured instrument is almost certain to be lost if the boat capsizes. At all other times, the best way to transport the instrument in a vehicle is to carry it on one's lap or, at least, to wrap it up well in blankets and to stand it in such a way that it cannot suffer any hard knocks or shocks.

Unpacking. A golden rule when unpacking an instrument is to notice carefully – **and to remember** – how it is fastened in the container, so that re-packing after use may be made correctly and easily. Theodolites and Tacheometers must be gripped by the "Right" standard (i.e. the one without the vertical circle) or with the handle. With heavy instruments the left hand must grip beneath the tribrach in order to help support the weight. Only the T3 theodolite is taken out with a hand on each of the two standards.

Setting Up. The instrument is then put on top of the tripod, which has already been set up, and is screwed to it, with one hand being used to grip the instrument. The instrument must **never** be left on the tripod without being screwed to it. If the instrument has a detachable tribrach make sure this is locked in position, i.e. the arrow on the knob must be pointing down. Levels are always handled by the tribrach and pressure must **never** be exerted on the tubular level.

For full use of its accuracy the instrument must have temperature equilibrium. If there is a large temperature difference between the instrument (store or vehicle) and the outside air, the instrument must be given time to attain the outside temperature. As a rough guide, the time needed in minutes corresponds to the temperature difference in °C. E.g. if an instrument is taken from a store at +20 °C and set up outside at –10 °C, 30 minutes should be allowed.

Packing Up. Before packing up, all clamps and sliding bolts of the container's base plate must be loosened, thus preparing it for receiving the instrument. The instrument is gripped with one hand and the tripod fixing screw loosened. The instrument is lifted from the tripod, put on the container's base plate and fastened to it. The instrument must **never** be left unscrewed on the tripod. After the instrument has been clamped to the base plate all instrument clamps must be tightened, without undue force, the hood put on and the locking hooks fastened carefully.
In any case, the Instructions for Use must **always** be studied.

If these hints, the Instructions for Use and plain common sense are followed, the instrument should give good service and have a long life.

Contents

1. Equipment

	Stock No.	kg	lb
1.1 **Standard Equipment**			
1 Wild T1 Micrometer Theodolite, 400ᵍ, erect image,	360 325	5.8	12.8
in metal container		2.8	6.2
or			
1 Wild T1 Micrometer Theodolite, 360°, erect image	360 324	5.8	12.8
in metal container		2.8	6.2
Accessories in metal container:			
1 Screwdriver with 2 blades and 2 adjusting pins			
1 Tripod GST20, with telescopic legs	296 632	6.5	14.3
or			
1 Tripod GST10L, metal, with telescopic legs	332 315	6.3	13.9
or			
1 Centring Tripod GST70, with telescopic legs	373 725	8.0	17.6
Tripod accessories:			
1 protective cover for tripod head			
1 pouch with plumb bob and hexagonal key			

1.2 **Optional Accessories**

1.2.1 **Miscellaneous**

	Stock No.	kg	lb
Shoulder Carrying Strap for tripods GST20 and GST70	315 010		
Centring Rod, with circular bubble			
cm graduation	373 726	0.7	1.5
0.05 ft graduation	373 727	0.7	1.5
Tripod GST20-2, extra-long 2.5 m, telescopic legs	316 170	8.8	19.4
Centring Rod, extra-long 2.5 m, cm graduation	373 731	1.0	2.2
Telescope Level, split bubble	353 599		
Telescope Eyepiece, for 18× magnification	336 573		
Autocollimation Eyepiece, with plug in lamp and cable (battery box if required)	175 190		
Diagonal Autocollimation Eyepiece, with lamp and cable (battery box if required)	246 368	0.2	0.4
Eyepiece Lamp, for using the telescope as a collimator (battery box if required)	246 279	0.1	0.2
Parallel Plate Micrometer GPM5, with counterweight, in case			
Measuring range 10 mm	373 705		
Measuring range 0.5 in	373 706		
Measuring range 0.02 ft	373 707		
Auxiliary Lens, for short range focussing, in case			
Lens GVO7	363 871		
Lens GVO8	363 872		
Lens GVO9	363 873		
Sunshade, for telescope objective	358 255		
Rain and Dust Cover, plastic	212 285		
Rucksack	166 688	2.6	5.7
Plastic Transport Case, foam-padded	370 480	4.5	9.9
Pillar Plate, with centring pin	202 489	3.5	7.7
Tripod Base GST4 (brochure G1 423e)	332 200	0.9	2.0
Wild GAK1 Gyro Attachment (brochure G1 413e)			
Wild DI3 Distomat (see brochure G1 311e)			
Wild GLO1 Laser Eyepiece (brochure G1 403e)			

1.2.2 **Electric Illumination**

	Stock No.	kg	lb
Illumination Torch, fits on standard with 2 dry cell batteries (354 914)	373 710	0.2	0.4
or			
Battery Box Illumination Set, comprising	373 711		
1 Plug-in lamp, with cable and plug	366 580	0.1	0.2
1 Battery box, hangs on tripod leg	199 896	1.2	2.6
6 Dry cell batteries	166 877	0.6	1.3
1 Handlamp, with cable and plug	268 034	0.1	0.2
or			
Illumination Set, flame-proof, without handlamp	373 712	1.9	4.2

1.2.3 **Forced-Centring Equipment**
(For traversing two target sets are recommended)

Targets

	Stock No.	kg	lb
1 Target Set, comprising:	373 713		
1 Target Plate GZT1	367 555	0.1	0.2
1 Carrier GZR1, for target and Distomat reflector, with optical plummet	360 530	0.7	1.5
1 Tribrach GDF10	305 065	0.8	1.8
1 Container GVp 389	368 896	2.0	4.4
or			
1 Target Set, with electric illumination, comprising:	373 714		
1 Target Plate GZT1	367 555	0.1	0.2

	Stock No.	kg	lb
1 Carrier GZR1, for target and Distomat reflector, with optical plummet	360 530	0.7	1.5
1 Reflector	368 435		
1 Screw-in lamp and cable	199 895		
1 Battery box, hangs on tripod leg	199 896	1.2	2.6
6 Dry cell batteries	166 877	0.6	1.3
1 Tribrach GDF10	305 065	0.8	1.8
1 Container GVp 390	365 355	2.5	5.5
or			
with flame proof battery box (199 897)			
For extra-long sights:			
1 Large Target Plate GZT2, fits on target GZT1	367 557	0.2	0.4

Tripods

	Stock No.	kg	lb
1 Tripod GST20, with telescopic legs	296 632	6.5	14.3
or			
1 Centring Tripod GST70, with telescopic legs	373 725	7.9	17.4
For the GST70, target sets should be ordered without the tribrach GDF10 (305 065)			

1.2.4 **Subtense Bar Equipment**

	Stock No.	kg	lb
1 Subtense Bar GBL, 2 m, invar	196 728	4.4	9.7
1 Tribrach GDF10	305 065	0.8	1.8
1 Canvas Carrying Bag, for GBL and GDF10	199 925	1.8	4.0
1 Distance Table, 360°/metres	199 917		
360°/feet	199 918		
400ᵍ/metres	199 919		
1 Tripod GST20, with telescopic legs	296 632	6.5	14.3
or			
1 Centring Tripod GST70, with telescopic legs	373 725	7.9	17.4
For the GST70, the subtense bar should be ordered without tribrach GDF10 (305 065)			

	Stock No.	kg	lb
Electric Illumination if required:			
1 Battery box, with 6 dry cells, 1 connection cable and 1 handlamp	200 720	1.9	4.2
or			
1 Battery box flame-proof, with 6 dry cells and 1 connection cable	374 904		

1.2.5 **Compasses**

	Stock No.	kg	lb
Circular Compass, 360°, in case	363 893	0.4	0.9
Circular Compass, 400ᵍ, in case	363 894	0.4	0.9
Tubular Compass	366 508	0.1	0.2

1.2.6 **Plumbing Accessories**

	Stock No.	kg	lb
Zenith and Nadir Plummet ZNL	284 831	1.9	4.2
(without tribrach) in wooden box		2.2	4.8
Roof and Ground Plummet ZBL	284 830	0.8	1.8
(without tribrach) in wooden box		0.5	1.1
Objective Pentaprism, with counterweight, in case	373 704	0.3	0.7
Telescope Roof Plummet	351 093	0.1	0.2
Diagonal Eyepieces, for telescope and reading microscope, in case	373 708	0.2	0.4

1.2.7 **For Astronomy**

	Stock No.	kg	lb
Eyepiece Prism Unit, for telescope and reading microscope, with colour filters, for sights up to +65°, in case	373 709		
Diagonal Eyepieces, for telescope and reading microscope, in case	373 708	0.2	0.4
Eyepiece Filter, for telescope and diagonal eyepiece — black	370 472		
green	370 473		
Wild – Roelofs Solar Prism, in container	370 489	0.7	1.5
Electric Illumination, see 1.2.2			

1.2.8 **Vertical Staffs**

	Stock No.	kg	lb
Levelling Staffs, folding, erect numbering, with circular level			
GNLE3, 3 m long, cm chessboard graduation	196 702	4.3	9.5
GLNE4, 4 m long, cm chessboardgraduation	196 704	5.4	11.9
GNLE12, 12 ft long, 0.01 ft line graduation and 0.1 ft pattern	196 708	5.0	11.0
Topographic Staffs, folding, erect numbering, with circular level			
GTLE3, 3 m long, cm graduation	196 712	4.3	9.5
GTLE4, 4 m long, cm graduation	196 714	5.4	11.9

For information on other Wild staffs see brochure G1 905 e

2. Technical Data

Telescope		erect image
Magnification		30×
Clear objective aperture	1.65 in	42 mm
Field of view at 1000 ft/m	27 ft	27 m
Shortest focussing distance	5.6 ft	1.7 m
Multiplication factor		100
Additive constant		0
Bubble sensitivity per 2 mm run		
Circular level		8′
Plate level		30″
Automatic vertical index		
Setting accuracy		±1″
Working range		±2′
Glass circles	360° or	400ᵍ
Graduation diameter Hz and V circles	3.11 in	79 mm
Graduation interval of Hz and V circles	1° or	1ᵍ
Direct reading on micrometer	0.1′ (6″) or	0.2ᶜ
Estimation to	0.05′ (3″) or	0.1ᶜ

3. Description

The terms Face Left and Face Right are used throughout this booklet. Face Left position is when the vertical circle is Left of the telescope eyepiece. Face Right is when the vertical circle is Right of the eyepiece.

3.1 **Instrument** (see fig. 1 at the end of this booklet).

3.1.1 **Tribrach GDF10**

The tribrach (26) is the base of the instrument. It has 3 footscrews (2) for setting the standing axis vertical. The base plate (1) has a central thread common to all Wild tripods making it possible to set up the T1 on any Wild tripod. A spring plate presses the footscrews into the base plate. The circular level (24) allows approximate levelling. The centring flange of the T1 (and other interchangeable equipment) fits exactly into the tribrach dish, i.e. forced-centring. The three studs on the base of the instrument pass through holes in the tribrach. When the arrow of the swivel locking knob (41, fig. 16) points downwards, the studs are engaged and the instrument is locked in the tribrach. On leaving the factory this knob is secured in the "arrow down" (locked) position by a recessed screw. This screw must be screwed in before the interchangeable forced-centring system can be used. When the knob is turned so that the arrow points upwards the instrument can be lifted out of or placed in the tribrach (arrow down = locked; arrow up = unlocked).
The tribrach is not needed if the T1 is set up on the GST70 Centring Tripod.

3.1.2 **Lower Part**

This comprises the centring flange, the standing axis system, the horizontal circle, and associated parts. The axis sleeve is screwed fast to the centring flange, which fits into the tribrach. The axis stem, which is screwed fast to the alidade, turns inside the sleeve. The horizontal circle carrier is mounted around the axis sleeve.
The T1 has a lower plate clamp (25), a lower plate drive (3), an upper plate clamp (7) and an upper plate drive (23). The upper plate clamp (7) locks the alidade to the horizontal circle carrier. The lower plate clamp (25) locks the circle carrier to the axis sleeve and, therefore, the tribrach.
The horizontal circle turns with the alidade:

1. When lower plate clamp is slackened, upper plate clamp is tightened, and alidade is turned by hand.
2. When both upper and lower clamps are tightened and the lower plate drive (3) is turned.

If both upper and lower plate clamps are slackened, the circle can be turned by means of the milled ring (5). To facilitate setting the circle, this ring is marked 0°, 90°, 180°, 270° (0^g, 100^g, 200^g, 300^g) and there is a white index line (6) on the alidade.
The lower plate clamp and drive are used only for setting the circle (section 4.5.2), repetition (section 4.5.4) and carrying bearings (section 4.5.5). During normal angle measurement the lower plate clamp and drive are not touched, which is why the knobs have a distinctive shape.

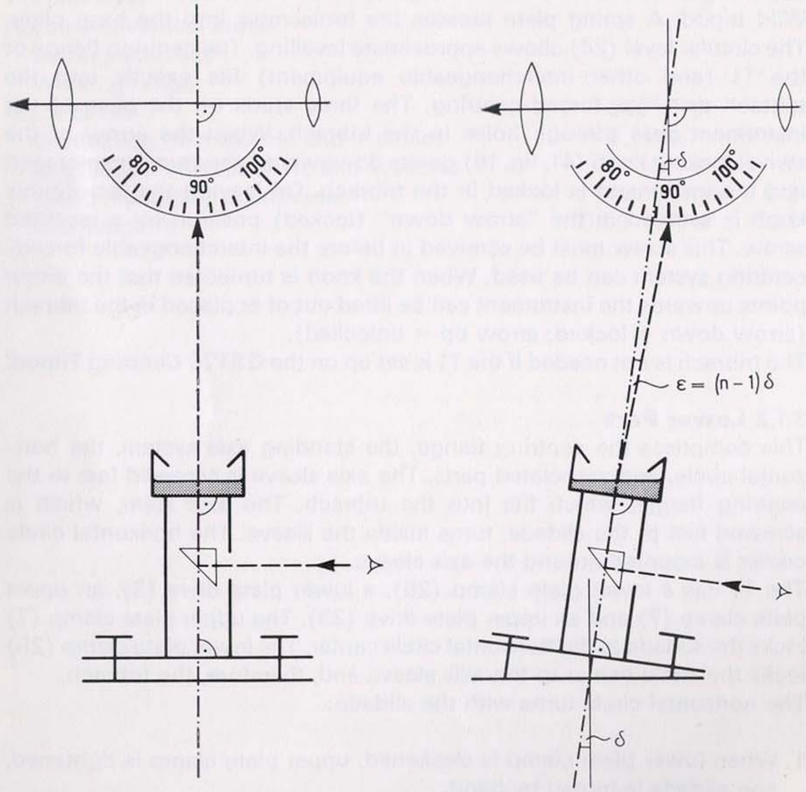


Fig. 2 Functioning of the automatic index: left – the standing axis is vertical; right – the standing axis is out of plumb by the small angle δ: both illustrations are for a horizontal sight.

3.1.3 **Alidade**

The alidade is the upper part of the instrument which rotates about the standing axis. The telescope and reading microscope are mounted on the tilting axis between the two standards. A white dot on the vertical circle housing marks the tilting axis. The left standard with circle illumination mirror (11) houses the vertical circle and automatic index. The plate level (8) is for levelling up, i. e. setting the standing axis vertical. The optical plummet (22) is for centring over a ground point. The upper plate clamp and drive (7, 23) and vertical clamp and drive (20, 21) are used for setting the telescope to a target. The horizontal circle appears yellow, the vertical white. The circles are read with the aid of the micrometer (19). The vertical circle rotates with the telescope about the tilting axis. The circle is numbered from 0° to 360° (400^g). Vertical circle readings in Face Left are zenith angles. The effect on the vertical circle reading of any residual error in levelling up is eliminated by the automatic index.
A carrying handle (16) is attached to the standards. It has to be removed if certain accessories are used, for example the circular compass or DI3 Distomat, or if one measures in both faces with objective accessories fitted. To remove the handle: loosen the locking screw (15), push the safety catch (17) upwards and slide off the handle. To replace: slide the handle onto its guides and tighten the locking screw (15).

3.1.4 **Automatic Vertical Index** (fig. 2)

On the way to the reading microscope, the image of the vertical circle passes through a transparent container filled with silicon oil, which is as clear as glass. If the standing axis of the theodolite is exactly vertical (fig. 2, left), the bottom of the container and the surface of the oil are parallel and the rays will pass through without deviation. However if the standing axis is inclined to the vertical by a small angle δ (fig. 2, right), the oil forms a wedge of angle δ. If the refractive index of the oil is n, the deviation of the rays is (n - 1) δ. This deviation compensates for the influence, on the vertical circle reading, of any residual non-verticality of the standing axis. The refractive index is influenced by temperature, however with the oil used the factor (n - 1) changes by only 0.1% for a 1° change in temperature. Assuming a relatively large non-verticality of the standing axis of 60″ (corresponding to a variation in the position of the plate level of 4 intervals when turning the alidade through 180°) the error introduced by a difference in temperature of 50 °C from the standard temperature of +20 °C is only $0.05 \times 60'' = 3''$. As such large differences in both temperature and levelling up will hardly ever occur, any error in the automatic index will always be within the measuring accuracy of the T1.

3.1.5 **Telescope**

The telescope transits at both ends. The image is erect. The eyepiece (10) is rotated for focussing the reticle. It has a dioptric scale to allow immediate setting for an observers eye. After a left turn of the bayonet ring (12) the eyepiece can be removed for exchange with another eyepiece. One half of the vertical hair of the reticle (fig. 3) is a single hair for splitting a target, the other half is a double hair for straddling a target. The stadia hairs with 100× multiplication factor are for optical distance measurement. The telescope is focussed with the sleeve (13) which has coarse/fine motion. Arrows on the sleeve indicate the direction to infinity. The optical sight (14) is used for the initial pointing to a target.
When using electrical illumination (section 5.2, figs. 13 and 15) for night or underground work, the lever under the optical sight must be pushed towards the objective until it reaches its stop. The light from the electric lamp is then reflected off a mirror inside the telescope towards the reticle. A sunshade (optional accessory) may be fitted over the objective.

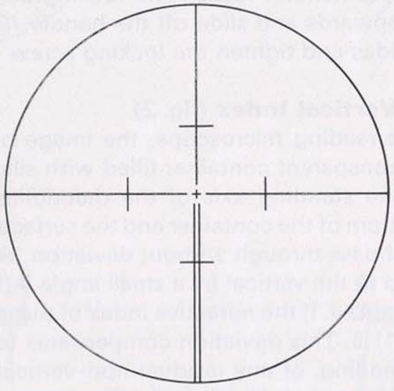


Fig. 3 Telescope reticle with 1:100 stadia hairs

3.1.6 **Container** (fig 4)

The container comprises metal base plate and hood. The T1 rests in the base plate supported by the upper plate drive (23) and the support point (4). The instrument fits correctly in the container when the red mark on the alidade is over the red dot on the lower plate drive. Two clamps with rubber buffers hold the theodolite in the base plate. See Unpacking (section 4.2) and Packing Up (section 4.7).

Fig. 4 The Wild T1 and its container. The red mark on the alidade must be over the red dot on the lower plate drive.

3.2 **Tripod**

In general the GST20 Tripod is recommended for the T1. The GST70 Centring Tripod and GST10L Metal Tripod are also suitable (section 1.1). These tripods have telescopic legs. Note that, as the fixing screw on all Wild tripods has the same thread, the T1 will fit on any Wild tripod if necessary.
There is a plastic cover for the tripod head. When the theodolite is attached this cover should be hooked into the slot at the top of one of the tripod legs. The tripod pouch holds a plumb bob and hexagonal key. This key is for tightening the tripod screws (section 6.1). A shoulder strap is available as an accessory (section 1.2.1).

4. Instructions for Use

4.1 **Setting Up the Tripod**
First, check that all the tripod screws are tight. Tighten loose screws with the hexagonal key (section 6.1).

4.1.1 **With Standard Type Tripod e.g. GST20**
Extend tripod legs so that instrument will be at comfortable height. Take plumb bob from tripod pouch. Push bayonet plug of plumb bob into fixing screw and secure by turning to right. Set up tripod so that tripod plate is approximately horizontal, and so that plumb bob is within 2 cm (1 inch) of ground point, with central fixing screw in the centre of its range of movement. Tread tripod shoes firmly into ground. If shoes do not penetrate to an equal depth re-establish horizontality of tripod plate by extending or retracting the legs. Before attaching the instrument check that the clamps of the telescopic legs are tight.

4.1.2 **With GST70 Centring Tripod** (fig. 5)
With the GST70 the instrument is used **without** tribrach (fig. 5).
Extend tripod legs so that instrument will be at a comfortable height. Set

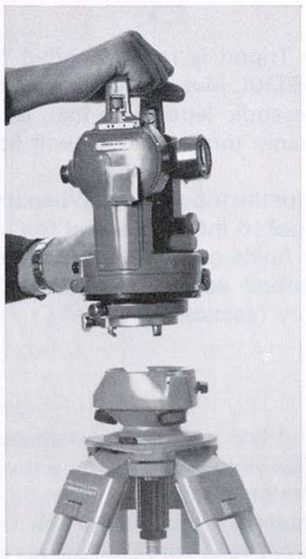


Fig. 5 Placing the T1 in the GST70 Centring Tripod

tripod by eye over ground point. Tread tripod shoes firmly into ground. Slacken central screw of tripod. Place point of centring rod on ground mark. Extend or retract tripod legs until circular bubble of rod is approximately within its setting circle. Press down the black catch on base of tripod head and shift tripod head carefully over tripod plate until circular bubble of rod is exactly within its setting circle. Rotate lower part of rod through 180°. If the bubble is no longer central follow procedure described in section 4.3.2. Tighten central screw and check that clamps of telescopic legs are tight. Place instrument in tripod head and lock in position by turning swivel locking knob (41, fig. 16) to ARROW DOWN. Level up with three footscrews of tripod head according to 4.3.3. The circular level on the head is used for levelling those accessories which do not have their own bubble, e.g. subtense bar. For set ups where the centring rod is too long or too short, unscrew the rod and use either the plumb bob or optical plummet for centring. The height of the instrument's tilting axis is read off the rod. See also sections 4.3.2 and 6.8.
Note. When folding up the centring tripod, the head must be within the grooved ring on the tripod plate, otherwise the rod may get bent and damaged.

4.1.3 **General Hints**
The instrument can be carried on the tripod to a nearby station. Before moving check that the central fixing screw of the tripod is tight and that the swivel locking knob (41, fig. 16) is in ARROW DOWN locked position. At the new station, when treading the tripod shoes into the ground, hold the theodolite to prevent jars or shocks.
On smooth hard surfaces, e.g. on concrete or indoors, where the points of the tripod shoes will not hold, the GST4 Tripod Base should be used. See section 1.2.1.

4.2 **Unpacking the Instrument** (fig. 4)
Place container on level surface. Pull out ends of carrying strap to release locking hooks. Lift off hood. Lift up the two levers on the base plate columns to release the clamps. Lift out instrument, place on tripod and, with one hand still holding the instrument, attach by means of tripod fixing screw. The fixing screw should not be overtightened. Close the container.
If the T1 is to be used to the limit of its precision the following are advisable:
1. In hot sunny weather shade instrument and tripod with an umbrella.
2. If there is a large temperature difference between the instrument and the surrounding air, allow the instrument to reach air temperature before starting to observe. As a rough guide, the time needed in minutes corresponds to the temperature difference in °C. E.g. if instrument is

taken from store at +20 °C and set up outside at –10 °C, 30 minutes should be allowed.

3. Rotate alidade and telescope several times to ensure an even distribution of lubricant through the bearings.

4.3 **Centring and Levelling Up**

4.3.1 **Centring with the Plumb Bob**

In calm conditions the plumb bob can be used for centring to about ±2 mm. Slacken central fixing screw and move instrument over tripod plate until plumb bob is exactly over ground mark. Retighten fixing screw. Level up as in section 4.3.3.

4.3.2 **Centring with the Centring Rod**

The centring rod consists of two sections. It is telescopic. A circular level is attached to the lower section and the whole is suspended from a bayonet plug which connects with the tripod fixing screw. For centring, place point of rod on ground mark. Extend or retract tripod legs until circular bubble of rod is approximately within its setting circle. Clamp tripod legs. Now slacken tripod fixing screw and move instrument over tripod plate until bubble of rod is centred. Turn lower half of rod through 180° and if bubble is no longer in centre of setting circle move instrument over the tripod plate so as to take up **half** of the displacement of the bubble. The instrument is now centred. (Note that it is preferable to keep the bubble in adjustment so that it remains in the central position. See section 6.8). Tighten fixing screw and level up as described in 4.3.3. With the centring rod it is possible to centre to about ±1 mm.

The height of the theodolite's tilting axis can be read (to 0.05 ft or 1 cm) on the upper part of the rod, with the upper lip of the lower part serving as the reading index. This height is valid with the footscrews in the centre of their run and provided that the point of the rod is engraved T1/T16 (centring rods for other instruments will not give the correct height).

4.3.3 **Levelling Up**

As a memory aid in levelling up, note that the **level** bubble follows the direction of the **left** thumb when turning the footscrews. The plate level should be protected from direct sun rays as these many cause the bubble to run off. An approximate levelling is made by using the footscrews to centre the circular bubble. Then proceed as follows:

1. Upper plate clamp (7) open and optical plummet (22) over a footscrew A. Footscrews B and C are turned by equal and opposite rotations until the plate level bubble (8) is centred.
2. Turn the alidade through 90° in a clockwise direction and centre the bubble with footscrew A.

3. Turn the alidade clockwise through 90°. Note the position of the bubble. Bring the bubble to a point halfway between this position and the central position by turning B and C by equal and opposite rotations.
4. Turn the alidade in the same direction through 90°. By turning A, set the bubble to the mean (halfway) position obtained in step 3.
5. The bubble should now remain in this position for all directions of the alidade. If it does not, repeat the procedure, but this time use the mean position obtained in step 3 as if it were the central position for the bubble.

The instrument is levelled up when the bubble remains in the same, though not necessarily central position, for all directions of the alidade. It is convenient to keep the plate level in adjustment so that the bubble remains in the central position. See section 6.2 for adjustment.

4.3.4 **Centring with the Optical Plummet**

The optical plummet is used to centre the T1 over a ground mark within the range 0.5 m (1.6 ft) to infinity. When the instrument is the usual 1 to 2 m (3 to 6½ ft) above the ground the centring accuracy is about ±0.5 mm.

Method 1:

As described in 4.1.1, set tripod over ground mark and centre roughly by eye, by dropping a pebble or by using plumb bob. Attach instrument. Centre circular bubble (24). Turn eyepiece of optical plummet (22) until cross hairs are in focus. Pull out eyepiece of plummet until ground point is in focus. Slacken tripod fixing screw and move instrument over tripod plate until cross hairs coincide with ground mark. When doing this do not rotate tribrach in relation to tripod head or circular bubble will be disturbed. Finally retighten fixing screw. Level up as described in 4.3.3. Look through plummet and check centring. Re-centre and re-level if necessary. Now turn alidade through 180°, any deviation of the reticle from the ground mark is corrected by moving the instrument to take up **half** of this deviation. The instrument must be re-levelled if necessary.

The centring is correct when, for a full rotation of a levelled up alidade, the reticle stays on the mark or describes a small circle around it. (See adjustments section 6.6.)

Method 2:

Set tripod over ground mark by eye and tread tripod shoes into ground. Attach instrument. Look through optical plummet and bring cross hairs onto ground mark by turning the footscrews. Now centre circular bubble by extending or retracting tripod legs. The cross hairs will still be on the ground mark. Level up as described in 4.3.3 and, if necessary, adjust the centring by moving the instrument over the tripod head as described in method 1.

4.3.5 **Centring under Roof Points**

The instrument can be centred under a plumb bob suspended from a roof or ceiling point, by lining up the plumb bob with the small pin at the centre of the optical sight (14). The carrying handle must be removed (section 3.1.3), the instrument levelled-up as in 4.3.3, and the telescope set horizontal (i.e. vertical circle to 90° 00′ or 100.00ᵍ, see section 4.5.1). The instrument is now moved over the tripod plate (do not turn tribrach) until the small pin is exactly under the tip of the plumb bob. Another method is to use the telescope roof plummet or the plumbing equipment mentioned in section 5.6.

4.4 **Focussing and Sighting**

4.4.1 **Reticle Cross Hairs**

Point telescope to sky or a uniformly light surface, e.g. a wall or piece of paper. Turn eyepiece (10) until cross hairs are sharp and black. The dioptric scale now indicates the correct setting for the observer's eye. Note reading for future settings.

4.4.2 **Target Image Focussing**

Point telescope to target by means of optical sight (14). Tighten clamps. Look through telescope eyepiece and turn focussing sleeve (13) until target is seen. Set cross hairs close to target by turning drive screws. Complete focussing by turning sleeve until target image is sharp and free from parallax, i.e. there should be no apparent movement between cross hairs and target as observer moves his eye slightly. If there is parallax remove by adjusting the focussing slightly. Note that the focussing sleeve has coarse and fine motion. Arrows on the sleeve indicate the direction to infinity.
Focussing does not affect the sharpness of the cross hairs (section 4.4.1).

4.4.3 **Sighting**

For horizontal angles: Turn upper plate drive (23) until single vertical hair splits or double hair straddles the target.
For vertical angles: Turn upper plate drive (23) to set vertical hair a little to the left or right of the target. Then, turn vertical drive (21) to set horizontal hair precisely on target.
Note: The last turn of a drive screw should be clockwise, i.e. against the spring.

4.5 **Circle Reading and Angle Measurement**

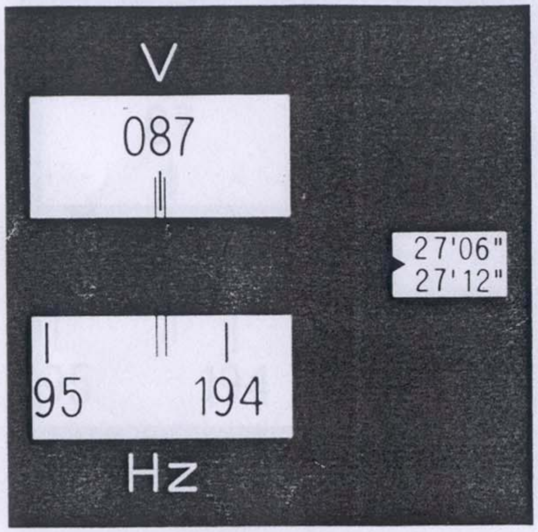
4.5.1 **Circle Reading** (figs. 6 and 7)

Open and turn mirror (11) until illumination of circles, as seen in reading microscope (9), is uniformly bright. For electric illumination see section 5.2.
Turn eyepiece (9) of reading microscope until circle graduation lines and double index lines are in sharp focus. In the upper window V is the vertical circle. In the lower window Hz is the horizontal circle. Each window has a double line index. The horizontal circle appears yellow. The circle graduation interval is 1° or 1ᵍ. In the right-hand window is the micrometer. It is digital with numbers every 0.1′ (=6″) or 0.002ᵍ (=0.2ᶜ).
To read horizontal circle, lower window Hz:
Turn micrometer knob (19) until a circle graduation line is exactly in the middle of the double line index. Read the degrees or grades from this graduation line. The centre of the micrometer window is indicated by a black pointer. Read the minutes and decimals of a minute – or decimals of a grade – against this pointer. If the pointer is between two numbers it is possible to estimate half a micrometer interval, i.e. 0.05′ (=3″) or 0.001ᵍ (=0.1ᶜ).
Vertical circle readings are taken in exactly the same way. After rotating the alidade, it may be necessary to wait for a second to allow the vertical circle image to steady. Note that the T1 must be levelled up in order to see the vertical circle in the upper window V.
See examples figs. 6 and 7.

4.5.2 **Setting the Horizontal Circle to Zero or Required Value**

It is usual to set the horizontal circle reading to the R.O. (reference object) to zero or other required value, e.g. known bearing.

1. Slacken upper plate clamp (7) and lower plate clamp (25). Turn milled ring (5) until required degree (grade) line is seen in Hz window of reading microscope. To facilitate this the milled ring is marked 0°, 90°, 180°, 270° (0ᵍ, 100ᵍ, 200ᵍ, 300ᵍ) and there is a white index line (6) on the alidade. Tighten upper plate clamp (7).
2. Turn micrometer knob (19) to set required minutes and decimals of a minute (decimals of a grade) against pointer of micrometer window.
3. Turn upper plate drive (23) to set required degree (grade) graduation line in middle of double line index. The required reading is now set in the instrument.
4. Turn alidade by hand and sight R.O. with optical sight (14). Tighten lower plate clamp (25). Turn lower plate drive (3) to bring vertical hair onto R.O. target.



Vertical circle 87°27'09"

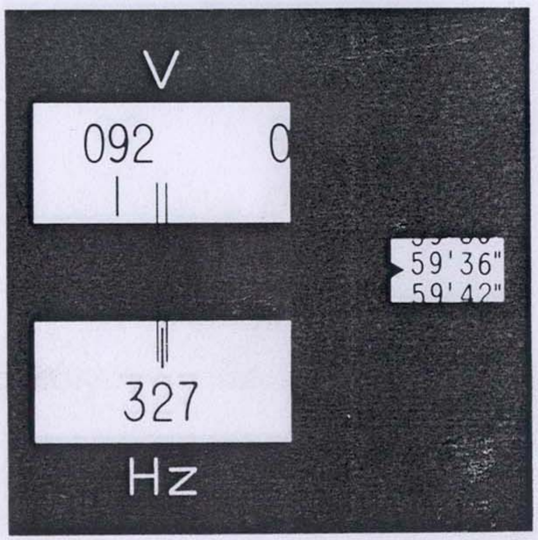
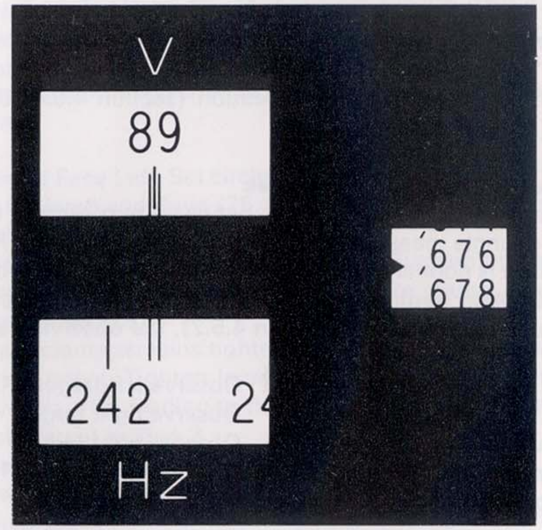


Fig. 6 Circle reading 360° Horizontal circle 327°59'36"



Vertical circle 89.677^{g}

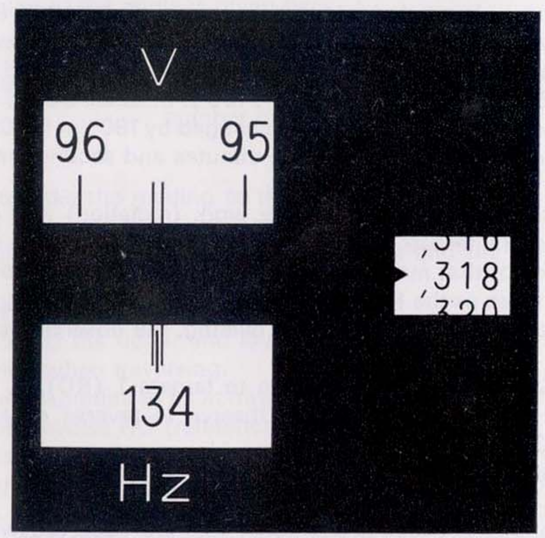


Fig. 7 Circle reading 400^{g} Horizontal circle 134.318^{g}

5. The required reading is now set to the R.O. Subsequent angle measurement is carried out with upper plate clamp and upper plate drive only. The lower plate clamp and lower plate drive must not be touched. They are used only for setting zero, repetition (section 4.5.4) and carrying bearings (section 4.5.5).

4.5.3 **Measuring Horizontal Angles**

The measurement of a single angle between two targets is the most simple form of angle measurement and is used in traversing. For accurate measurements it is normal to observe in both Face Left and Face Right and take the mean. After setting the reading to the R.O. (reference object) to zero, or to the known bearing (section 4.5.2), the observing sequence is:

1. Face Left. Swing clockwise. Observe left target (R.O.)
2. Face Left. Swing clockwise. Observe right target
3. Face Right. Swing anticlockwise. Observe right target
4. Face Right. Swing anticlockwise. Observe left target (R.O.)
   This comprises one set.

Step 1 may be carried out as described in 4.5.2 for setting the required reading to the R.O. The lower plate clamp and drive (25, 3) are not touched again and steps 2, 3 and 4 are carried out with the upper plate clamp and drive (7, 23) only.
If more accuracy is needed additional sets are observed. If two sets are observed the setting to the R.O. for the second set is changed by 90° (100^g). If four sets are observed the settings to the R.O. should be approximately 0°, 45°, 90°, 135° (0^g, 50^g, 100^g, 150^g). In other words, if n sets are observed, the settings to the R.O. are changed by $180° \div n$ ($200^g \div n$). When changing the setting to the R.O. the minutes and seconds must also be altered.
In triangulation and polar coordinate work (radiation) it is common to observe to several targets from one station. The routine is the same as just described except that more targets are observed. A distinct distant target should be chosen as the R.O. (reference object). After setting the reading to the R.O. to zero, or to the known bearing, the observing sequence is:

Face Left. Swing clockwise. Observe to targets 1 (RO), 2, 3 4, 5...n.
Face Right. Swing anticlockwise. Observe in reverse order to targets n...5, 4, 3, 2, 1 (R.O.).
This comprises one set.

If more accuracy is needed, additional sets are observed with different circle settings as described above.

4.5.4 **Repetition Method for Measuring Single Angles**

By manipulating the upper and lower plate clamps and drives, single angles can be measured by repetition. This method is used mainly for measuring parallactic angles, such as for subtense bar or subtense base measurements.

1. Instrument in Face Left. Set circle to zero and fine point left target using lower plate clamp and drive (25, 3) as described in section 4.5.2. Read horizontal circle.
2. Lower plate clamp (25) remains tightened. Slacken upper plate clamp (7). Turn to right target. Tighten upper plate clamp. Fine point with upper plate drive (23).
3. Upper plate clamp remains tightened. Slacken lower plate clamp. Turn back to left target. Tighten lower plate clamp. Fine point with lower plate drive (3). The reading to the left target is now the same as it was to the right target in step 2.
4. Repeat step 2.
5. Repeat step 3.
6. Repeat step 2.
   And so on.

Finally, read the horizontal circle for the last pointing to the right target. The procedure can be repeated any number of times but the number of repetitions must be counted.
The final value of the angle is given by:

$$\frac{\text{final reading to right target} - \text{initial reading to left target}}{\text{number of repetitions}}$$

It is useful to take the reading to the right target at step 2. This gives a measure of the angle and guards against miscounting.
The procedure may be repeated in Face Right and the results meaned.

4.5.5 **Carrying Bearing when Traversing**

By manipulating the upper and lower plate clamps and drives, bearings can be carried when traversing.
Consider the theodolite to be at traverse station 1 and measuring the angle between the traverse RO (reference object) and station 2. The observing procedure is modified so that the last pointing is on Face Right to station 2. After taking the FR reading to station 2, keep the upper plate clamp (7) locked and slacken the lower plate clamp (25), thus locking the circle to the alidade. At station 2, with the instrument now in Face Left, fine point to station 1 using the lower plate clamp and lower plate drive (25, 3).

The FL reading station 2 to station 1 will thus be the same as the FR reading station 1 to station 2, i. e. the correct reading has been set. By this procedure bearings can be carried through the traverse, plus or minus a small amount which must be allowed for when taking the means of FL and FR.

4.5.6 **Measuring Vertical Angles**

The T1 has an automatic index. The instrument must be levelled up (section 4.3.3) in order to see the vertical circle in the upper window V.
With instrument in Face Left, bring horizontal hair onto target by turning vertical drive (21). Read vertical circle. If the observer knows the instrument is properly adjusted for vertical index error and if an accuracy of 1′ or 2ᶜ is acceptable, it is sufficient to measure in Face Left only. For an accurate measurement, transit to Face Right and repeat the observation. The reading A_L in Face Left is the zenith angle ζ. The reading A_R in Face Right is $(360°-\zeta°)$ or $(400^g-\zeta^g)$. The vertical angle β (elevation + or depression –) can be derived from the vertical circle readings as follows:

$$\beta_L = 90° - A_L° \text{ or } 100^g - A_L^g$$
$$\beta_R = A_R° - 270° \text{ or } A_R^g - 300^g$$
$$\beta = \tfrac{1}{2}(\beta_L + \beta_R)$$
$$\zeta = \tfrac{1}{2}(A_L - A_R) \quad (360° \text{ or } 400^g \text{ has to be added to } A_L)$$

Example

360°	A_L	= 83°23.2′	β_L	= +6°36.8′
	A_R	= 276°36.4′	β_R	= +6°36.4′
	$A_L + A_R$	= 359°59.6′	β	= +6°36.6′
	$A_L - A_R$	= 166°46.8′	ζ	= 83°23.4′
400ᵍ	A_L	= 107.864ᵍ	β_L	= –7.864ᵍ
	A_R	= 292.154ᵍ	β_R	= –7.846ᵍ
	$A_L + A_R$	= 400.018ᵍ	β	= –7.855ᵍ
	$A_L - A_R$	= 215.710ᵍ	ζ	= 107.855ᵍ

Reduction by this method is self-checking. The sum A_L+A_R should always be constant within ±0.2′ or ±0.3ᶜ. The difference of A_L+A_R from 360° or 400ᵍ is twice the vertical index error which can be adjusted as described in section 6.5.

4.5.7 **Measuring Vertical Angles with the 3 Wire Method**

If the vertical angle has to be measured several times in order to increase the accuracy and to expose gross reading errors, the two horizontal stadia hairs as well as the horizontal cross hair are used on both FL and FR. Let U_L (face left) and U_R (face right) be the vertical circle readings

with the upper stadia hair, A_L and A_R with the centre hair as before, and L_L and L_R with the lower hair. In the example the numbers in brackets indicate the sequence of observing. The vertical angle β is calculated from:

$$\beta° = \tfrac{1}{2}(FR-FL-180°)$$
$$\beta^g = \tfrac{1}{2}(FR-FL-200^g)$$

Example

U_L	83°40.4′ (1)	A_L	83°23.2′ (2)	L_L	83°06.0′ (3)
L_R	276°53.5′ (6)	A_R	276°36.4′ (5)	U_R	276°19.3′ (4)
	193°13.1′		193°13.2′		193°13.3′

Mean	193°13.2′
	–180°00.0′
2β = +	13°13.2′
β = +	**6°36.6′**

i. e. at Face Left and at Face Right one starts to observe always with the upper hair in the field of view.

4.6 **Tacheometric Observations**

For tacheometric work it is sufficient to observe in Face Left only. The telescope has stadia lines (factor 100×) for measuring the distance to a vertical staff. The staff is read where it is cut by the lower stadia and the upper stadia. The difference between these readings is the intercept I. For a horizontal sight, 100 times the intercept is the horizontal distance from instrument to staff. If the line of sight is inclined the vertical angle β must be measured and the horizontal distance D calculated from:

$$D = 100 \cdot I \cos^2\beta \qquad (\beta = \text{vertical angle})$$
$$= 100 \cdot I \cdot \sin^2\zeta \qquad (\zeta = \text{zenith angle})$$

If the difference in height is needed, the reading z where the staff is cut by the centre hair is taken. The height i of the theodolite's tilting axis above the ground is also measured. The difference in height $\triangle H$ between the ground at the instrument and the foot of the staff is:

$$\triangle H = 100 \cdot I \cdot \sin\beta \cos\beta + (i-z)$$
$$= 100 \cdot I \cdot \sin\zeta \cos\zeta + (i-z)$$

The sign of the first term $(100 \cdot I \cdot \sin\beta \cos\beta)$ is + for an elevation, – for a depression.

To simplify the calculation it is useful to sight the staff so that z=i. A tacheometric slide rule, a pocket calculator or tacheometric tables (e.g. F.A. Redmond's Tacheometric Tables) will be useful for reductions.

4.7 **Packing Up** (fig. 4)
Open container. Open out the clamps on base plate columns. On instrument, close illumination mirror (11), set telescope vertical and tighten vertical clamp (20) lightly. Turn alidade until red mark on alidade is over red dot on lower plate drive. Tighten upper and lower plate clamps (7, 25) lightly. Hold instrument with one hand and unscrew tripod fixing screw with other hand. Lift instrument off tripod and place in base plate. The upper plate drive (23) and the support point (4) rest in the base plate columns. Fold the two clamps with rubber buffers over the alidade and then press down their locking levers simultaneously until they snap shut (fig. 4). Put the hood on and fasten it, making sure the hooks are under the base plate rim. Fold up the tripod.
If the instrument has become wet it should be wiped carefully and the container must be opened as soon as possible to allow the instrument to dry out completely. Never leave a damp instrument in a closed container.

5. Optional Accessories

5.1 **Miscellaneous**

5.1.1 **Telescope Level** (fig. 8)
The telescope level allows the theodolite to be used for spirit levelling. The sensitivity of the level is 60″ per 2 mm. The setting accuracy of the split bubble is ±2″, corresponding to ±1 mm in 100 m (±0.003 ft in 300 ft).
To mount the level: Put telescope in Face Right. Remove the four screws from the flat area on top of telescope. Fix level in position with the screws provided.
To adjust telescope level: Set up a vertical staff about 50 m (yds) from the theodolite. Put telescope in Face Left. Set micrometer to read zero then, with vertical drive, set vertical circle reading to 90°00.0′ or 100.000ᵍ. Then read staff where it is cut with horizontal cross hair. Transit to Face Right. Set vertical circle to 270°00.0′ or 300.000ᵍ. Read staff again. Now, by using vertical drive, set horizontal hair to the mean of the two staff readings (i.e. to the horizontal line of sight) and then turn the adjusting screw of the telescope level until the ends of the split bubble are in coincidence.

5.1.2 **Autocollimation Eyepiece GOA** (fig. 9)
The autocollimation eyepiece converts the theodolite into an autocollimation instrument. Autocollimation is used mainly in optical tooling,

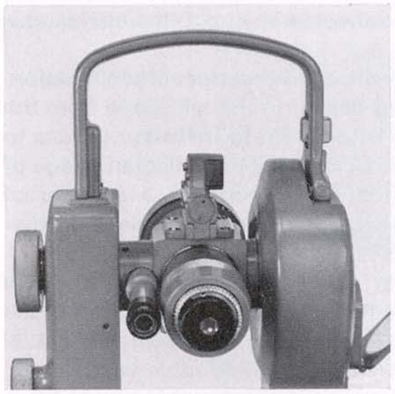


Fig. 8 Telescope Level (instrument in Face Right, i.e. vertical circle right of the line of sight)

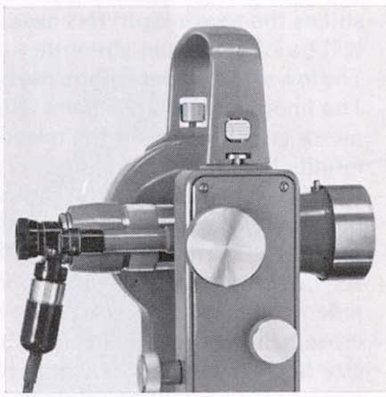


Fig. 9 Autocollimation Eyepiece GOA

industry and laboratories, for aligning machine parts and measuring deviations.

To fit the autocollimation eyepiece: Turn bayonet ring (12) anticlockwise and remove standard eyepiece (10). Fit autocollimation eyepiece taking care that the pin engages the notch in the eyepiece mount. Turn bayonet ring clockwise. Illumination is provided by the plug-in lamp of the autocollimation eyepiece. Connect cable to a battery box (section 5.2.2) or to a 4 V transformer.

Principle of autocollimation: The telescope focussed to infinity is pointed to a plane mirror. If the mirror is almost at right angles to the line of sight, the parallel light rays from the infinity-focussed telescope are reflected back to form a mirror image of the cross hairs in the plane of the reticle. Thus both the reticle and its reflected image are seen in the telescope field of view. When the reticle and its reflected image are exactly in coincidence – this is termed autocollimation – the mirror is exactly at right angles to the line of sight. If they are not in coincidence the angular deviation of the mirror can be measured. To do this, take the horizontal and vertical circle readings for the line of sight, then turn the upper plate and vertical drives (23, 21) until the reticle and its reflected image are in exact coincidence (autocollimation), and finally read the circles again. The difference between the circle readings gives the angular deviations of the mirror, in Hz and V, from the plane perpendicular to the line of sight.

The following should be noted when working with autocollimation:

- Autocollimation can only begin when the mirror is nearly at right angles to the line of sight and when at least a part of the mirror protrudes into the cylinder of rays. It is preferable that the whole cylinder of rays strikes the mirror as, in this case, the reflected image of the reticle cross will be of maximum strength.
- The lower the ambient light, the better the conditions for autocollimation.
- The image of the cross hairs reflected back into the telescope from the mirror is only visible if the telescope is focussed to **infinity.** (Focus to infinity by turning the focussing sleeve (13) until the reflected image of the cross hairs is sharp.) Infinity focussing produces a cylinder of parallel light rays, therefore autocollimation is not dependent on distance. The mirror may even be directly in front of the objective.
- As the distance between theodolite and mirror increases the green reflected image of the objective becomes smaller and the portion of the cross hair image which can be seen is cut down. However, the actual size of the image, as indicated by the width of the double vertical hair, remains the same. The effective maximum range is anything up to 50 m (yds) depending on the ambient light.

There are two ways of achieving autocollimation. Depending on the

application, either the telescope is set perpendicular to the mirror or the mirror is set at right angles to the line of sight of the telescope.

If the mirror is to remain fixed and the line of sight is to be set perpendicular to the mirror, the telescope, focussed to infinity, is first pointed at the mirror. If the autocollimation image, i.e. the reflected image of the cross hairs, cannot be located by turning the telescope, the theodolite set-up must be adjusted. The observer must stand behind the theodolite and move his head until he sees the green, circular image of the objective in the mirror. The required telescope position lies halfway between the observers eye and the initial telescope position. The theodolite set-up is now adjusted until the telescope is in the required position. The telescope is again pointed at the mirror and, by turning the vertical and upper plate drives, the reflected image of the cross hairs is located and brought into exact coincidence with the reticle itself.

The other case is if the mirror, or piece of machinery fitted with the mirror, is to be aligned at right angles to the pre-set line of sight. In this case, the item fitted with the mirror is turned and tilted until the reticle coincides with its reflected image.

For steep and vertical sights a Diagonal Autocollimation Eyepiece is available.

5.1.3 **Eyepiece Lamp** (fig. 10)

The eyepiece lamp illuminates the reticle from behind and converts the telescope into a collimator. Focus the telescope to **infinity** by sighting a distant target. Turn bayonet ring (12) anticlockwise and remove standard eyepiece. Fit eyepiece lamp taking care that pin on lamp engages notch on eyepiece mount. Turn bayonet ring clockwise. Connect cable of lamp to battery box (section 5.2.2) or to a 4 V transformer.

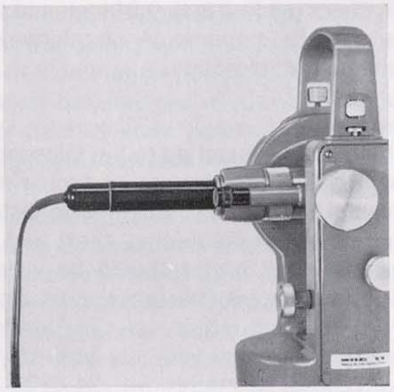


Fig. 10 Eyepiece Lamp

Fig. 11 Parallel Plate Micrometer GPM5. The counterweight balances the telescope

5.1.4 **Parallel Plate Micrometer GPM5** (fig. 11)
The parallel plate micrometer, which can be fitted to the telescope objective, is used to measure small displacements from the line of sight by shifting the line of sight parallel to itself. It consists of a mounting with a parallel glass plate which can be tilted by turning the graduated drum. The mounting has two notches, at 90° to each other, by means of which the micrometer is positioned to measure displacements in either the horizontal or the vertical plane. In addition, the micrometer can be turned around the objective so that, if required, displacements in any other direction can be measured. The metric version has a range of 10 mm (5 mm on either side of the telescope's line of sight), direct reading is to 0.2 mm and estimation is to 0.05 mm. The non-metric versions have ranges of 0.5 inch and 0.02 ft, direct reading is to 0.01 inch and 0.001 ft and estimation is to fractions of these amounts. A counterweight is fitted to the eyepiece end to balance the telescope.

5.1.5 **Auxiliary Lenses**
Auxiliary lenses, which can be attached to the telescope objective, enable observations at less than the normal minimum focussing range. During the observations the position of the lens must not be disturbed. To eliminate the possibility of errors when combining short and long range observations, it essential that each target should be viewed immediately in both faces. The focussing range for the lenses now available is as follows:

Lens	Focussing range	Focussing range
GVO7	0.88–1.72 metres	34.6–67.7 inches
GVO8	0.63–0.92 metres	24.8–36.2 inches
GVO9	0.50–0.65 metres	19.7–25.6 inches

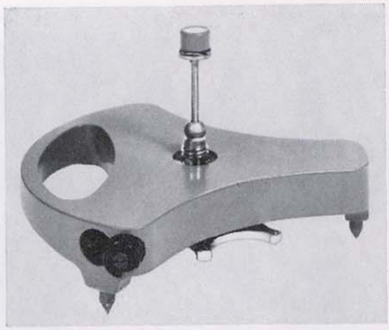


Fig. 12 Pillar Plate. Note the centring pin

5.1.6 **Pillar Plate** (fig. 12)
When observing at concrete pillars or similar points, the heavy pillar plate with its three pointed studs ensures a stable set up. For centring the pillar plate, remove the centring pin with circular level from its housing, press the pin down into the plate's fixing screw, and put the point of the pin on the station mark. Then move the plate until the bubble is centred. As a check on the pin's circular level, turn the pin through 180° and if the bubble is displaced take up half of the displacement by moving the pillar plate slightly. Then screw the theodolite onto the plate.

5.1.7 **Centring Rod** See sections 4.3.2 and 6.8

5.2 **Electric Illumination**
If the light from the mirror is insufficient for circle readings, either the illumination torch or the battery box illumination set must be used. Open and fold down illumination mirror (11). Push illumination torch or plug-in lamp of battery box into the window. Both circles and the reticle are illuminated. For field of view illumination (reticle), move the lever under the optical sight (14) towards the objective until it reaches its stop.

5.2.1 **Illumination Torch** (fig. 13)
This is normally used for measurements of short duration, e.g. inside buildings or in twilight conditions. Turn knob clockwise to switch ON and regulate brightness. Turn knob fully anticlockwise to switch OFF. To open the torch, unscrew the milled rim around the cover glass. The bulb is 2.5 V / 0.1 A. There is a spare bulb inside the torch. The two 1.5 V batteries are of a type found everywhere. When ON the batteries last about 4 hours.

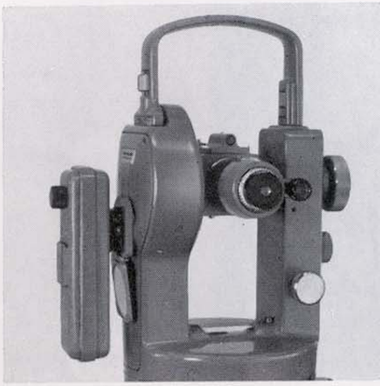


Fig. 13 T1 with Illumination Torch

Fig. 14 For packing, the illumination torch slides onto one of the clamps of the container base plate.

To store the illumination torch:
One of the clamps of the container base plate has two grooves. Slide the illumination torch into these grooves (fig. 14). Close the clamps and the container.

5.2.2 **Battery Box Illumination Set** (fig. 15)
This is recommended when electric illumination is needed continuously, e.g. at night or underground. It consists essentially of battery box and plug-in lamp. The battery box, which hooks on the tripod, holds six dry cells (standard 1.5 V torch batteries). The inner three are connected in series with the switch and plug sockets. The outer three cells are spares. In the box are stored the plug-in lamp, four reserve 4 V / 1.4 W bulbs and a handlamp. The switch is also a rheostat for varying the illumination. To switch ON and regulate brightness turn the knob clockwise. To switch OFF turn anticlockwise until the black line on the knob corresponds to the black line on the box. The two battery sockets, on the side opposite the handle, are exposed by sliding the metal button. The outer socket is connected to the switch/rheostat. The plug-in lamp for instrument illumination should be connected to this socket. The other socket is connected directly to the batteries and is used for the handlamp, eyepiece lamp, autocollimation eyepiece, targets, etc. If the milled rim of the plug-in lamp is unscrewed the lamp can be opened and the bulb removed.
A flame-proof battery box is available. It has only one socket, for the plug in lamp. The box can be locked with a key which is usually not taken into the mine.

Fig. 15 T1 with Battery Box Illumination Set

5.3 **Forced Centring and Target Set** (fig. 16)
When observing over short distances, e.g. in traversing or triangulation with short sides, it is advisable to work with forced centring to eliminate centring errors. Tripods with tribrachs attached remain over the station points until observations are completed. Theodolites, targets, Distomat reflectors etc. are interchanged as required in the tribrachs. The system permits fast work as a tripod plus tribrach is set up only once at each point. It is usual to have at least two extra tripods and two target sets. A target set comprises tribrach (26), carrier GZR1 (40) and target plate GZT1 (33) (section 1.2.3). The carrier fits in the tribrach and is locked in place by turning swivel locking knob (41) to arrow DOWN (section 3.1.1). On pressing its release button (38) the target plate GZT1 is fitted on the carrier. The horizontal marks (34) of the target plate are the same height above the tribrach dish as the T1 tilting axis. When using the DI3 Distomat, the single-prism reflector GDR31 (42) is fitted on the carrier. The horizontal target mark of the reflector is also the same height as the T1 axis. The carrier has a tubular level (32) (sensitivity 60" per 2 mm) and optical plummet (31). For levelling and centring see section 4.3. For centring under a plumb bob there is a white dot (35) on top of the target

plate. To illuminate the target plate GZT1, at night or underground, a reflector (36) with screw-in lamp can be attached. The cable (37) connects to a battery box (section 5.2.2). See also section 6.7.
For daylight sights over 1 km the Large Target Plate GZT2 (DIN A4 size) can be fitted over the target plate. The Large Target Plate allows sights to 8 km (5 miles) in good visibility.

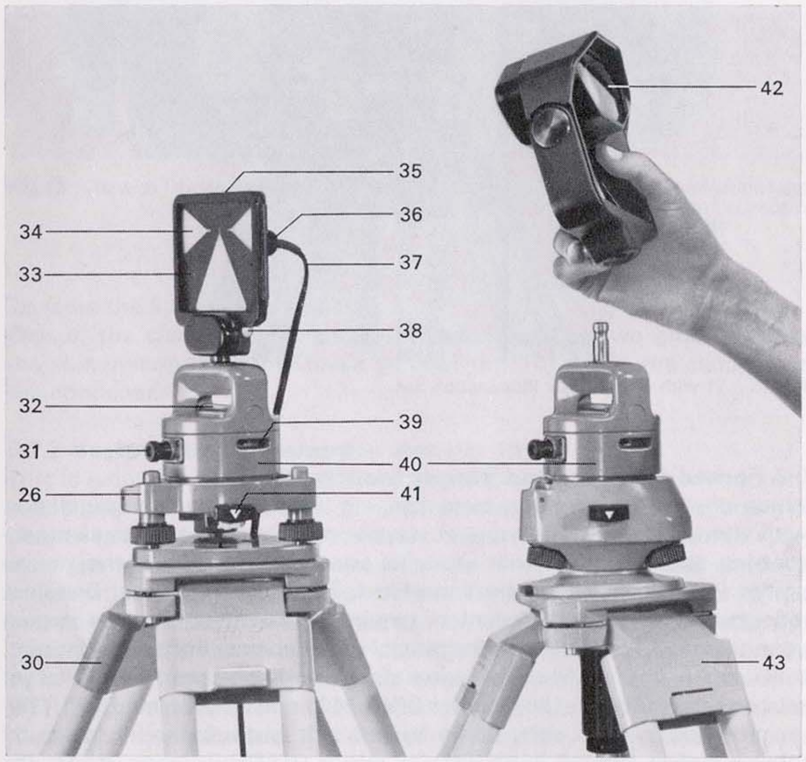


Fig. 16 Forced-Centring. Target Set and Distomat Reflector

26 Tribrach GDF10
30 Tripod GST20
31 Optical plummet
32 Tubular level
33 Target plate GZT1
34 Horizontal mark for vertical angles
35 White dot marking vertical axis. For centring under a roof point
36 Reflector with screw-in lamp
37 Cable
38 Release button
39 Adjusting screw for 32
40 Carrier GZR1
41 Swivel locking knob, with recessed screw. Arrow DOWN=locked UP = unlocked
42 Single-prism reflector GDR31, for DI3 Distomat
43 Centring tripod GST70

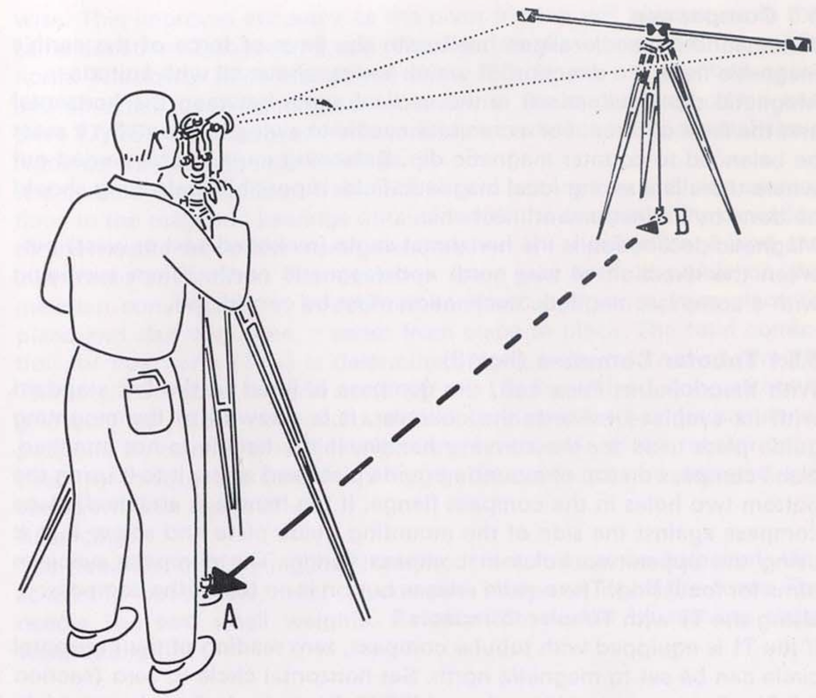


Fig. 17 Measuring distances with the Subtense Bar GBL

5.4 **2-m Subtense Bar GBL** (fig. 17)

The subtense bar is for horizontal distance measurement. With theodolite over point A and subtense bar over B, it is necessary to measure only the parallactic angle between the bar's two targets and then look up the horizontal distance AB in the table supplied. For night or underground work a battery box is required. There is a lamp behind each target. Subtense bar and theodolite are interchangeable in the tribrach, i.e. forced centring. If the parallactic angle is measured four times with the T1 (the repetition method section 4.5.4 may be used) the following standard deviation (m_D) for a distance (D) should be obtained. See brochure G1 412 e.

D =	20	40	60	80 metre (1 m = 3.28 ft, 1 cm = 0.033 ft)
m_D =	±0.2	±1	±2	±4 cm

5.5 **Compasses**

The magnetic needle aligns itself with the lines of force of the earth's magnetic field, the direction of which varies, above all with latitude.
Magnetic dip (inclination) is the vertical angle between the horizontal and the lines of force. For a compass needle to swing horizontally, it must be balanced to counter magnetic dip. Balancing must not be carried out where there is a strong local magnetic field. If possible, balancing should be done by an instrument mechanic.
Magnetic declination is the horizontal angle (reckoned east or west) between the direction of true north and magnetic north. When surveying with a compass, magnetic declination must be considered.

5.5.1 **Tubular Compass** (fig. 18)

With theodolite in Face Left, the compass is fitted to the left standard with its eyepiece towards the observer. It is screwed to the mounting guide plate used for the carrying handle. If the handle is not attached, place compass on top of mounting guide plate and screw it to it using the bottom two holes in the compass flange. If the handle is attached, place compass against the side of the mounting guide plate and screw it to it using the upper two holes in compass flange. The compass eyepiece turns for focussing. The needle release button is on top of the compass.
Using the T1 with Tubular Compass:
If the T1 is equipped with tubular compass, zero reading of the horizontal circle can be set to magnetic north. Set horizontal circle to zero (section 4.5.2). Keep upper plate clamp (7) tightened, slacken lower plate clamp (25), press down compass needle release button and turn alidade by hand until the two upturned ends of the compass needle are almost in coincidence. Now tighten lower plate clamp (25) and bring ends of compass needle into exact coincidence by turning lower plate drive (3). Always bring the needle ends into coincidence from the same direction which is achieved by always making the last half turn of the drive clockwise. This improves accuracy as the pivot friction will always act in the same direction. Zero reading and telescope are now oriented to magnetic north. The lower plate clamp and drive (25, 3) are not touched again and all subsequent sightings are made with the upper plate clamp and drive (7, 23). If this procedure is carried out subsequent horizontal circle readings will be magnetic bearings.

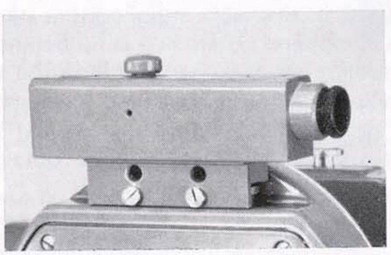


Fig. 18 Tubular compass

It is common to deduce true azimuth or grid bearings by applying corrections to the magnetic bearings obtained with the compass. The deviation of the needle from true north depends on the declination δ and the instrument constant $\varkappa$. The deviation from grid north depends on the meridian convergence γ, in addition to δ and $\varkappa$. δ varies from place to place and also with time. γ varies from place to place. The total correction for true north ($\delta+\varkappa$) is determined along a line of known azimuth. The total correction for grid north ($\delta+\gamma+\varkappa$) is determined along a known grid bearing. These corrections should be determined as frequently as possible. By turning the adjusting screw on the side of the tubular compass, the instrument constant $\varkappa$ for the compass can be adjusted and varied within a range of $\pm 3°$.
Balancing:
The needle should swing horizontally. If not it must be balanced. Unscrew the four screws under the compass body and lift off the cover. The needle has two small weights. Balance the needle by moving these weights slightly.

5.5.2 **Circular Compass** (fig. 19)

Fitting the Circular Compass:
In contrast to the tubular compass, the circular compass is placed on the theodolite only when required. It is attached in place of and in the same manner as the carrying handle. Its focussable eyepiece faces the observer with the theodolite in face left. The circle is divided into 1° (1^g) intervals. Readings are estimated to 0.1° (0.1^g). The magnet is fixed to the underside of the circle. To lower the circle onto the pivot and take compass readings, turn the spring-loaded knob (45). When the knob is released, the circle is automatically lifted and clamped so that the pivot will not be damaged during transport.
Balancing:
Level up theodolite and attach circular compass. Remove three screws (49), slacken clamp (46), and pull off upper housing (48). Turn knob (45) to lower circle onto pivot. The gap between the swinging circle and its supporting plate should be everywhere the same. If the gap is not constant the compass circle is inclined and must be balanced. Release knob (45) to lift circle off pivot. Carefully slacken screws of adjusting weights and slide weights along their grooves until circle is in ba-

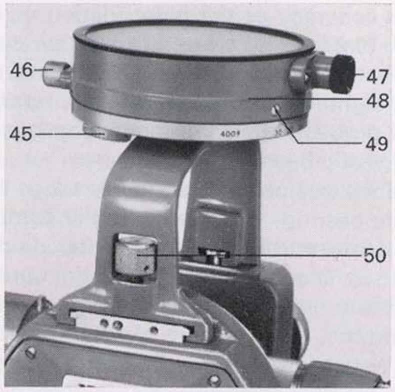


Fig. 19 Circular compass

45 Knob, spring-loaded, for lowering compass circle onto pivot
46 Clamp
47 Eyepiece
48 Upper housing
49 Screws for 48
50 Locking screw for compass bridge

lance, i. e. gap between swinging circle and its supporting plate is everywhere the same.
Using the T1 with Circular Compass:
It is common to deduce true azimuth or grid bearings from the magnetic bearings obtained with the compass. Thus the comments in section 5.5.1 apply equally well to the circular compass. With the telescope aligned on a known magnetic bearing, slacken clamp (46), turn housing (48) until reading is correct, then retighten clamp. Subsequent readings of the compass will be magnetic bearings. Alternatively, the compass can be set to give readings related to true north, grid north, or any other reference direction including south. The compass can be read for all pointings or it can be used merely to orientate the alidade as with the tubular compass. In order that the friction of the pivot always acts in the same direction, the last half turn of the drive screw (upper or lower plate drive) should always be clockwise. The metal ring around the base of the compass carries a short scale. This ring can be moved independently of both the compass base and upper housing provided that the three screws underneath the compass are slackened. By turning the ring, the zero of the scale is set to the index line under the eyepiece and the screws are tightened again. By means of this scale, the compass can always be set correctly is relation to the telescope. If the declination changes, or if it is required to set the compass according to some other reference direction, the compass can be turned against this scale.

5.6 **Plumbing Equipment**
For optical plumbing the following can be used with the T1:

Zenith and Nadir Plummet ZNL
Roof and Ground Plummet ZBL
Telescope Roof Plummet (fig. 20)
Objective Pentaprism (fig. 21)
Diagonal Eyepieces (fig. 23)

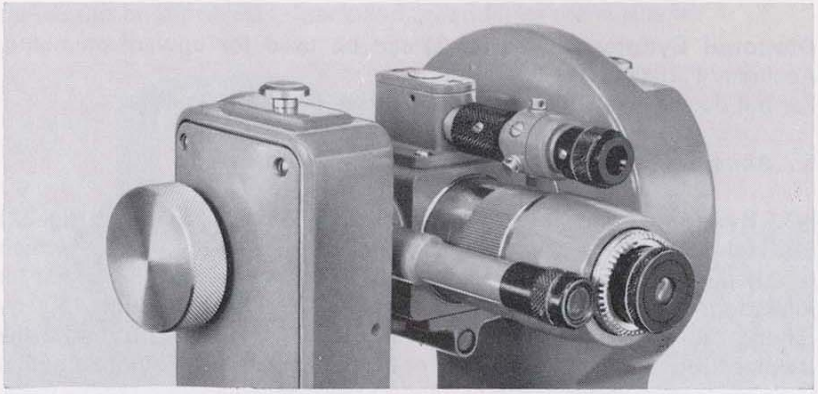


Fig. 20 Telescope Roof Plummet

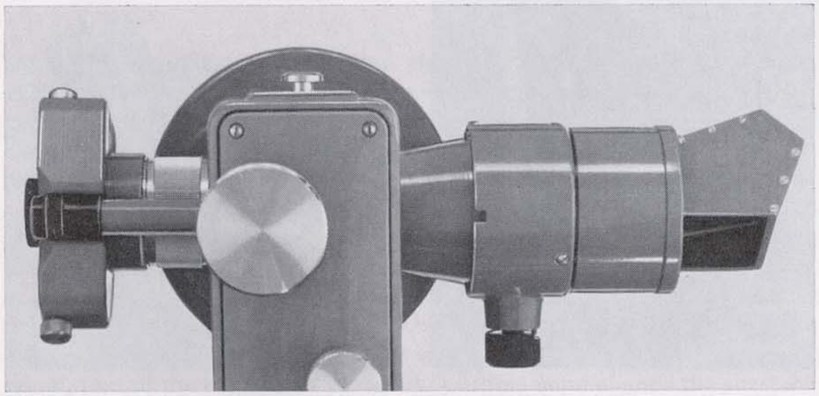


Fig. 21 Objective Pentaprism with counterweight

The **ZNL and ZBL** are independent instruments having the same centring flange as the theodolite for forced-centring interchange in the tribrach. They are for upward and downward plumbing. ZNL plumbing accuracy 1:30000. ZBL 1:10000.

The **Telescope Roof Plummet** is attached to the telescope in the Face Right position in the same way as the telescope level. It is for centring below roof points. Accuracy 1:5000 (fig. 20).

The **Objective Pentaprism** is for upward and downward plumbing. Accuracy 1:70000 (fig. 21).

Diagonal Eyepieces (see 5.7.2) can be used for upward plumbing. Accuracy 1:70000 (fig. 23).
For full details on plumbing equipment see brochure G1 417 e.

5.7 Accessories for Astronomical Observations

5.7.1 Eyepiece Prisms for sighting up to 65° vertical angle (fig. 22)

Both telescope and reading eyepiece prisms are in a one-piece unit which simply pushes onto the eyepieces. Both eyepieces can still be turned for focussing. After changing face the prisms are rotated through 180° by turning the large milled rings. Rotating the prisms does not affect the eyepiece settings. A yellow, green or black filter can be positioned before the telescope eyepiece prism by turning the small milled rim. These filters are for sighting the sun and bright objects.

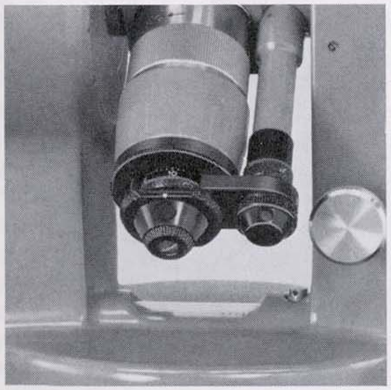


Fig. 22 Eyepiece Prisms for sighting up to +65°

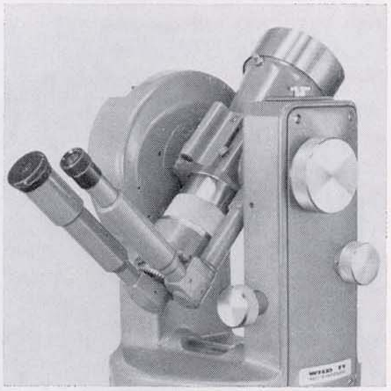


Fig. 23 Diagonal Eyepieces, for sighting up to the zenith

5.7.2 Diagonal Eyepieces for sighting up to the zenith (fig. 23)

Turn bayonet ring (12) anticlockwise and remove standard eyepiece (10). Fit telescope diagonal eyepiece taking care that pin engages notch in eyepiece mount. Turn bayonet ring clockwise. Unscrew reading microscope eyepiece (9). Slip reading diagonal eyepiece onto tube and clamp with its small lever. On changing face the diagonal eyepieces are turned through 180°. They are for astronomy, plumbing and observing in confined spaces.

5.7.3 Eyepiece Filters (fig. 24)

These slip over the telescope eyepiece or diagonal eyepiece for observing the sun or bright objects. Black and green filters are available.

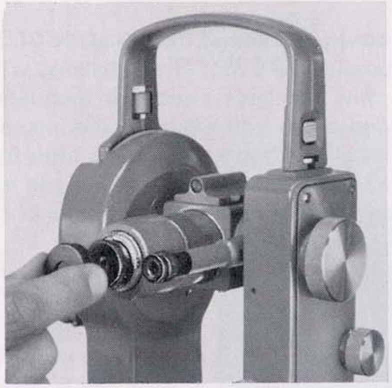


Fig. 24 Eyepiece Filter for telescope eyepiece or diagonal eyepiece

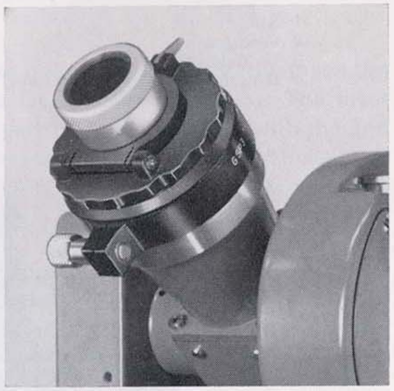


Fig. 25 Wild T1 with Wild-Roelofs Solar Prism. Note the prong-shaped vane

5.7.4 Wild-Roelofs Solar Prism (figs. 25, 26 and 27)

This fits over the objective and permits direct observations to the sun's centre. Sun observations are therefore easier and more accurate. Four overlapping images of the sun are produced, leaving in the middle a small diamond shape which corresponds to the centre of the sun and is intersected by the cross hairs. In hazy conditions the images are slightly blurred, however this does not affect pointing accuracy. Built-in filters protect the observer's eye. The normal eyepiece filter (section 5.7.3) is not needed. In hazy weather the inner filter can be screwed off (milled ring).
Above the prism is a folding vane, which throws a shadow facilitating orientation of the telescope. When upright this vane clamps the rotatable mount after the prism has been turned to align the cross-hairs and images

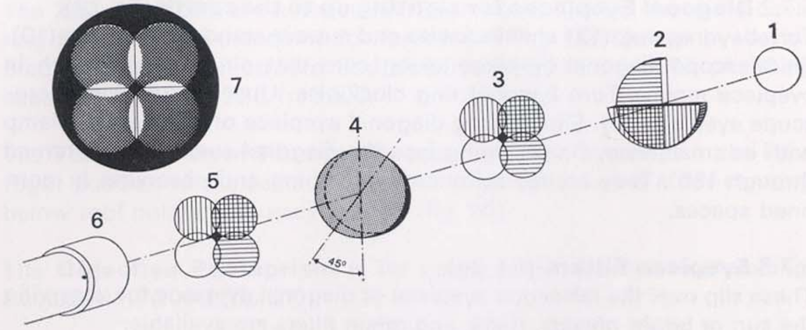


Fig. 26 Wild-Roelofs Solar Prism, formation of the sun's images

1 Sun
2 Wedges
3 1st deflection
4 Double wedge (also sun filter)
5 2nd deflection
6 Objective (Theodolite)
7 Field of View

Fig. 27 Solar Prism folded down

of the sun. When observing on both faces the telescope must be transitted via the eyepiece end and the solar prism must not be touched. The prism folds down for pointing to the terrestrial target.

5.8 **Wild GAK1 Gyro Attachment**

Above or below ground, the Wild GAK1 Gyro Attachment gives True North to within ±20" in only 20 minutes of working time and with only 1 or 2 minutes of simple calculations. The gyro can be used for independent azimuth determinations, azimuth checks in traverses and for the transfer of bearings to underground workings. A special bridge has to be mounted permanently on the standards of the theodolite but this does not prevent the T1 from being used for normal work after the removal of the gyro (see brochure G1 413 e).

5.9 **Wild DI3 Distomat, reducing infra-red tacheometer**

With a range of about 400 m to one prism and an accuracy of ±5 mm, the Wild DI3 Distomat is especially suitable for township work, traversing, cadastral surveys, engineering jobs, tacheometry etc. The DI3 fits on the T1 theodolite. Angles can be measured in both faces. Distance measurement is fully automatic and lasts only 10 seconds. After tapping in the vertical angle read from the T1 both the horizontal distance and difference in height are displayed – an important advantage especially when setting out. Maximum range is about 900 m with 9 prisms. (see brochure G1 311 e.)

5.10 **Wild GLO1 Laser Eyepiece**

To convert the T1 into a laser theodolite it is only necessary to replace the standard telescope eyepiece with the GLO1 Laser Eyepiece. The laser beam, projected out of the telescope itself, coincides exactly with the line of sight and focusses with the telescope to give a sharp point of laser light at any position. The T1/GLO1 combination is ideal for precise positioning and alignment (see brochure G1 403 e).

5.11 **Plastic Transport Case, foam-padded** (fig. 28)

The T1 in its container fits into this padded case and is well protected. This light 4.5 kg (9.9 lb) case is ideal for freighting and transporting the instrument. It is so convenient that it can be used everyday when travelling in a vehicle.

Fig. 28 Plastic Transport Case, foam-padded

6. Testing and Adjusting

The screwdriver handle contains two blades and two adjusting pins.

6.1 **Tripod** (fig. 29)
There should be no play between the various components of the tripod. The hexagonal key kept in the tripod pouch is used to tighten up the tripod leg screws (51). The hinges between the tripod head and the legs can also be adjusted (52). They should be sufficiently stiff so that when the tripod is lifted by its head the legs just remain spread-out. It may happen in very dry climates, that the clamps of telescopic tripods do not grip properly. In this case, a thin wedge can be used as a temporary remedy, but a better solution is to wrap the tripod in wet rags, thus allowing the wood to swell.

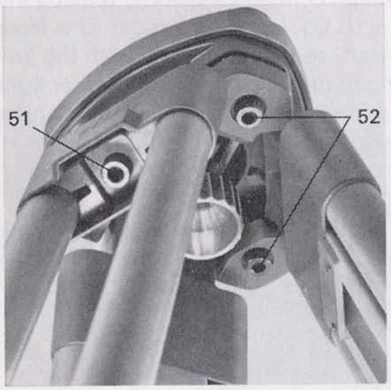


Fig. 29 Tripod head

51 Tripod leg screw
52 Tripod hinge screw

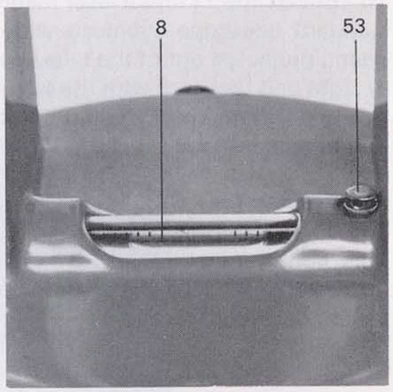


Fig. 30 Adjusting the plate level

8 Plate level
53 Adjustment screw

6.2 **Plate Level** (fig. 30)
Level up as described in section 4.3.3. If the bubble will not remain centred within one division for all positions of the alidade, adjust as follows:

1. Upper plate clamp (7) open and optical plummet (22) over a footscrew A. Footscrews B and C are turned by equal and opposite rotations until the plate level bubble (8) is centred.
2. Turn the alidade through 90° in a clockwise direction and centre the bubble with footscrew A.
3. Turn the alidade clockwise through 180°. Note the position of the bubble. Bring the bubble to a point **halfway** between this position and the central position by turning footscrew A. Now, with an adjusting pin, carefully turn the adjustment screw (53) until the bubble is centred.
4. Repeat until bubble remains centred within one division for all positions of the alidade.

6.3 **Circular Bubble of Tribrach** (**Centring Tripod Head**) fig. 31
Level up with plate level as described in section 4.3.3. The circular bubble should now be in the centre of its setting circle. If not it must be adjusted, i.e. brought to the centre.
There are two small adjustment screws in the side of the level holder. Use the small blade of the screwdriver. As a screw is tightened the bubble runs towards it. As a screw is slackened the bubble runs away from it. Turn one of the screws until the bubble is on the line joining the other screw and the centre of the setting circle. Now turn the other screw to bring the bubble to the centre of the circle. Repeat if necessary. The screws must not be turned more than is necessary for the adjustment.

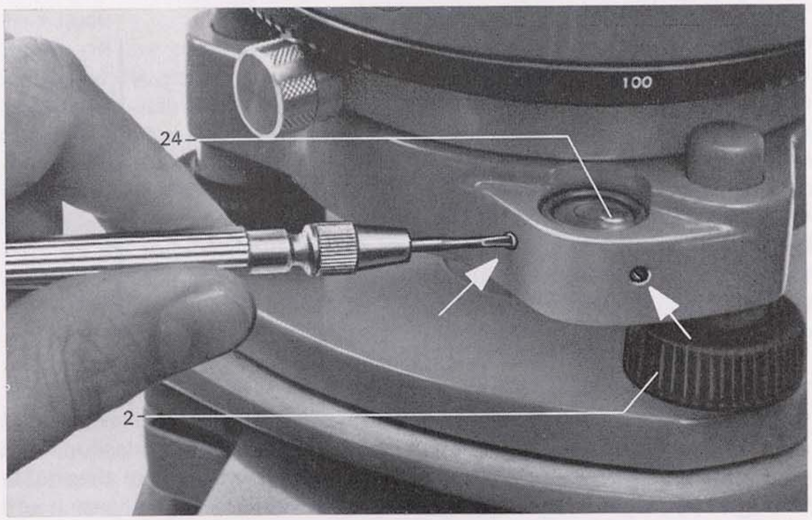


Fig. 31 Adjusting the circular bubble of the tribrach (centring tripod)

2 Footscrew
24 Circular bubble
Arrow: Adjustment screws (Use the small blade of the screwdriver)

6.4 **Horizontal Collimation Error** (figs. 32 and 33)

Ideally the line of sight should be perpendicular to the tilting axis. Any deviation from the right angle is known as the horizontal collimation error c. At the factory, the instrument is adjusted so that horizontal collimation error is as small as possible, however it cannot be reduced to zero. A small horizontal collimation error has no significant effect on angles measured in one face with the T1. In any case, the influence of horizontal collimation error is eliminated completely by observing in both faces and taking the mean. Therefore, to try to adjust horizontal collimation error to zero is not recommended for two reasons: First, it is neither possible nor necessary. Second, if the adjustment screws are not set correctly (too tight or too loose) the theodolite will not keep the adjustment.
The adjustment for horizontal collimation error is delicate and should be carried out only when absolutely necessary.

To determine the horizontal collimation error c:
On a flat stretch of ground set up theodolite at A. Set a target at B so that AB is about 60 m (200 ft) and so that target is at about same height as theodolite. Mark a point C so that BAC is a straight line and AC is approximately equal to AB. Set a levelling staff or scale at C so that staff is horizontal, at about same height as theodolite and perpendicular to line CAB.

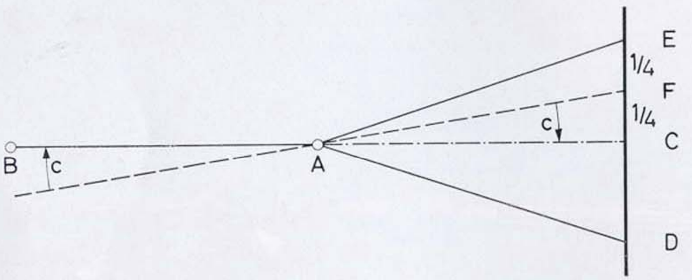


Fig. 32 Adjusting horizontal collimation error

With theodolite in the Face Left position, sight B with vertical hair and then, keeping upper and lower plate clamps locked, transit telescope and read staff where it is cut by the vertical hair e.g. at D. Turn theodolite through 180°, sight B again (theodolite is now in Face Right), transit and read staff e.g. at E. The angle DAE is four times the collimation error c. If, for example, DE is 3.6 cm (0.12 ft) and AC is 60 m (200 ft) the collimation error is about 30″ or 1ᶜ and for angle measurements this is quite acceptable.

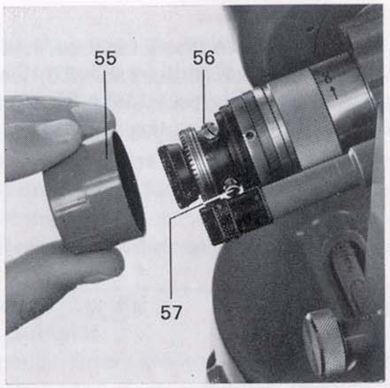


Fig. 33 Adjusting horizontal collimation error

55 Cover
56 Left adjustment screw
57 Right adjustment screw

To adjust:
Screw off the cover (55). There are four screws by the eyepiece. The adjustment is carried out by means of the two horizontal capstan-headed adjustment screws. The vertical hair is still on point E. By turning the capstan-headed adjustment screws with an adjusting pin the vertical hair must be brought to point F on the staff. F is known because EF=¼ED. If the vertical hair is to the left of point F unscrew the adjustment screw (56) on the left side by a small amount and immediately screw in the right one (57) by the same amount (if the hair is to the right of F the reverse will apply). Turn the screws in this way, by small and equal amounts, until the vertical hair is on point F. Excessive tightening of the screws must be avoided. Finally repeat the test to see if the collimation error is now within acceptable limits, if not repeat the adjustment. Screw on the cover (55). This adjustment is delicate and should be carried out only when absolutely necessary.

6.5 **Index Error** (**Vertical Collimation Error**) (fig. 34)

The vertical circle should read 90°00.0′ or 100.000ᵍ in Face Left when the line of sight is horizontal. If it does not, the deviation is known as the index or vertical collimation error i. By measuring vertical angles in both faces and taking the mean the effect of this error is eliminated. Index error is not eliminated if vertical angles are measured in only one face.

To determine the index error:
Level up theodolite. With theodolite in Face Left bring horizontal hair onto a well defined target, which should be at least 100 m (yds) away, and take FL reading. Repeat in Face Right and take FR reading. The difference of FL + FR from 360° or 400ᵍ is twice the index error i.

Example:		Vertical Circle Reading	i = index error	Correct value
360°	FL	86°14.5′	+1.1′	86°15.6′
	FR	273°43.3′	+1.1′	273°44.4′
	FL+FR	359°57.8′	+2.2′	360°00.0′
	2i	−2.2′		
400ᵍ	FL	105.822ᵍ	−0.016ᵍ	105.806ᵍ
	FR	294.210ᵍ	−0.016ᵍ	294.194ᵍ
	FL+FR	400.032ᵍ	−0.032ᵍ	400.000ᵍ
	2i	+ 0.032ᵍ		

If i is more than 0.5′ or 0.01ᵍ (i.e. if FL + FR differs by more than 1′ or 0.02ᵍ from 360° or 400ᵍ) it is advisable to adjust as follows:

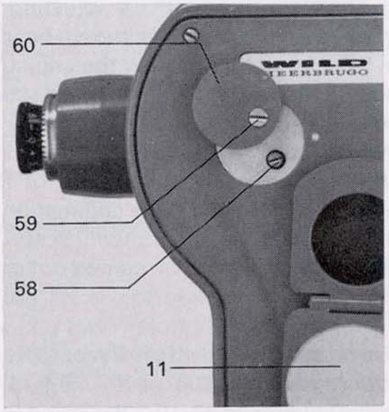


Fig. 34 Adjusting the index error

11 Illumination mirror
58 Adjustment screw
59 Screw for 60
60 Cover

To adjust:
Fit large blade into screwdriver. Slacken screw (59) and open cover (60). The adjustment screw (58) for the vertical index is now seen. The theodolite is still in Face Right with the horizontal hair exactly on the target. Turn the micrometer knob (19) and set the correct value – 44.4′ (0.194ᵍ) in example – against the pointer of the micrometer window. Then turn the adjustment screw (58) until the required graduation line – 273° (294ᵍ) in example – is exactly in the middle of the double line index of the V window. Close cover (60). Repeat observations and if necessaryj the adustment.

6.6 **Optical Plummet** (fig. 35)
To test the optical plummet:
Stick a piece of paper on floor. Mark a fine point on paper – POINT 1. Set up T1 on tripod over paper. Turn eyepiece (63) of optical plummet to focus cross hairs. Pull out optical plummet (63) to bring POINT 1 on paper into focus. By turning the footscrews set cross hairs of plummet exactly onto POINT 1. (Move the eye slightly to check that there is no parallax between cross hairs and POINT 1. If there is parallax adjust focussing.) Now turn alidade through 180°. Carefully, mark position of cross hairs on paper – POINT 2. If POINTS 1 and 2 coincide the plummet is in adjustment. If not it must be adjusted.

To adjust:
Mark POINT 3 halfway between POINTS 1 and 2. By turning the footscrews set cross hairs on POINT 3. Now slacken the four screws (61) in the

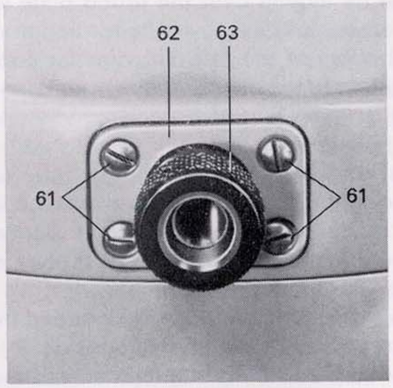


Fig. 35 Adjusting the optical plummet

61 Screws fastening plummet to alidade
62 Plate
63 Eyepiece of optical plummet

plate (62) around the optical plummet until the plummet and plate can just be moved. Move plummet and plate carefully until the cross hairs are exactly on POINT 1. Tighten the four screws again. Repeat the test and if necessary repeat the adjustment.

Note:
In the procedure described the plate level has no influence and must be ignored.
Rather than marking points on paper it may be preferable to use millimetre paper and "read off coordinates".

6.7 **Carrier GZR1, for Target or Reflector** (fig. 16)
Checking and adjusting the tubular level (32, fig. 16) is as described in section 6.2. The adjustment screw (39, fig. 16) is in the recess in the side of the carrier.
Checking and adjusting the optical plummet (31, fig. 16) is as described in section 6.6.

6.8 **Centring Rod** (of centring tripod or centring rod accessory, see sections 4.1.2 and 4.3.2).
If the bubble of the centring rod is out of adjustment centring errors can reach an appreciable amount. The bubble must be checked from time to time. Set T1 over a suitable mark, such as a pipe of small diameter. Place point of rod in pipe. Move instrument over tripod plate until bubble of circular level on centring rod is centred. Now tighten central fixing screw. Turn lower part of the centring rod through 180°. If the bubble is no longer central, the T1 must be moved over the tripod plate to take up half the displacement. The other half is removed by turning the adjustment screws under the circular bubble of the rod. The circular bubble of the centring rod is in correct adjustment when the bubble remains central throughout a 360° rotation of the lower part of the rod.

6.9 **Circular Level of Staff**
On the newer Wild staffs the circular level has no adjustment screws, the adjustment is made in the factory and is permanent. The level is fitted in a groove on the back of the staff. The groove is parallel to the axis of the staff and also protects the level.
To check the bubble, the staff should be suspended from a roof overhang or the branch of a tree with a plumb bob alongside. By moving the base of the staff, the whole staff can be brought parallel to the suspended plumb bob. In this position the circular bubble on the staff should be central.

7. Care and Maintenance

The Wild T1 is a precision instrument of high measuring accuracy. It must be handled carefully and kept clean. Dirt and dust should be removed only with a clean soft cloth or with a soft brush. (If a cloth is used it should be a many-times-washed soft cotton.) The lenses should be treated with particular care. It is permissible to breathe on the lenses before wiping them, but liquids such as oil, benzine and water etc. should never be used for cleaning purposes. Lenses should never be rubbed with a finger.

If an instrument has become wet it should be wiped carefully and the container must be opened as soon as possible to allow the instrument to dry out completely. Never leave a damp instrument in a closed container.

Each instrument is provided with a small bag of silica gel when leaving the factory. These highly absorbent grains of amorphous crystals are blue when dry and pink when saturated. If they do become pink, care must be taken to ensure that the instrument is not stored in the container, which, by this time, is far too damp. The crystals themselves can be re-stored by pouring them from the bag into a pan and heating them to just above the boiling point of water (this can be tested by drops of water). If they are overheated the crystals may burst. Once the grains have turned blue again they are allowed to cool and put back into the bag. Always keep the silica gel bag in a closed container. If left in the open the silica gel absorbs moisture from the air.

Each instrument is treated to inhibit the development of fungus growth, but, under very moist climatic conditions, the instrument should be remov-ed from its container and stored on a well ventilated shelf, in a constant air draught and preferably with some form of heating (such as an electric bulb). Ideally, for such climatic conditions, a slatted shelf in an airing cupboard should be used.

1 Base plate of tribrach
2 Footscrew
3 Lower plate drive
4 Support point, rests in container base plate
5 Milled ring, numbered, for setting circle
6 Index line for setting circle with milled ring
7 Upper plate clamp
8 Plate level
9 Eyepiece of reading microscope
10 Telescope eyepiece with dioptric scale
11 Illumination mirror
12 Bayonet ring, locks eyepiece in position
13 Focussing sleeve with coarse/fine motion
14 Optical sight, with pin for centring under roof points and lever for reticle illumination
15 Locking screw for carrying handle
16 Carrying handle
17 Safety catch for carrying handle
18 Telescope objective
19 Micrometer knob
20 Vertical clamp
21 Vertical drive screw
22 Optical plummet
23 Upper plate drive
24 Circular bubble
25 Lower plate clamp
26 Tribrach GDF 10

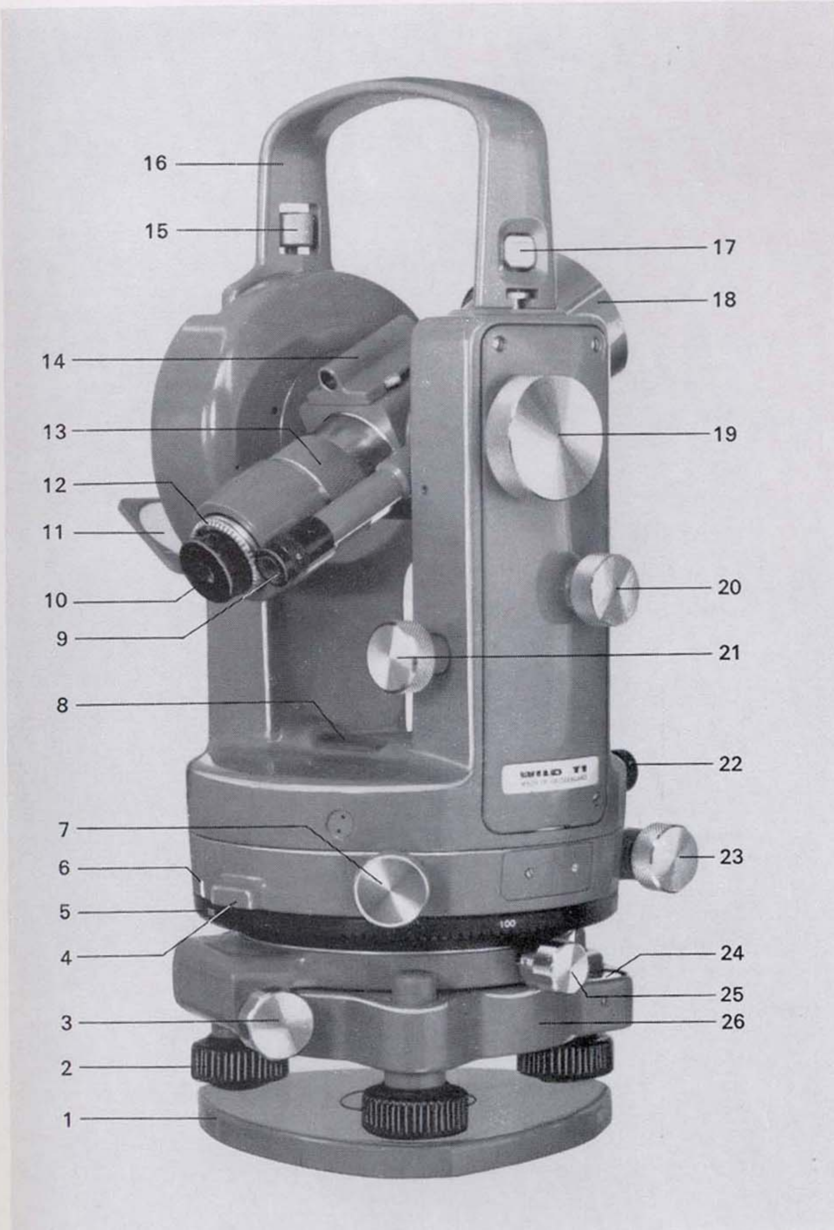


Fig. 1 Wild T1 Micrometer Theodolite