WATTS AUTOSET LEVEL

The Watts Autoset Level provides a level line of sight without the need for careful levelling because it has in the telescope an optical stabiliser which automatically compensates for small tilts. There is no accurate spirit level; only a circular bubble to be brought within its circle.

The instrument is supplied in a wooden or metal case in which it is supported with the telescope in a vertical position.

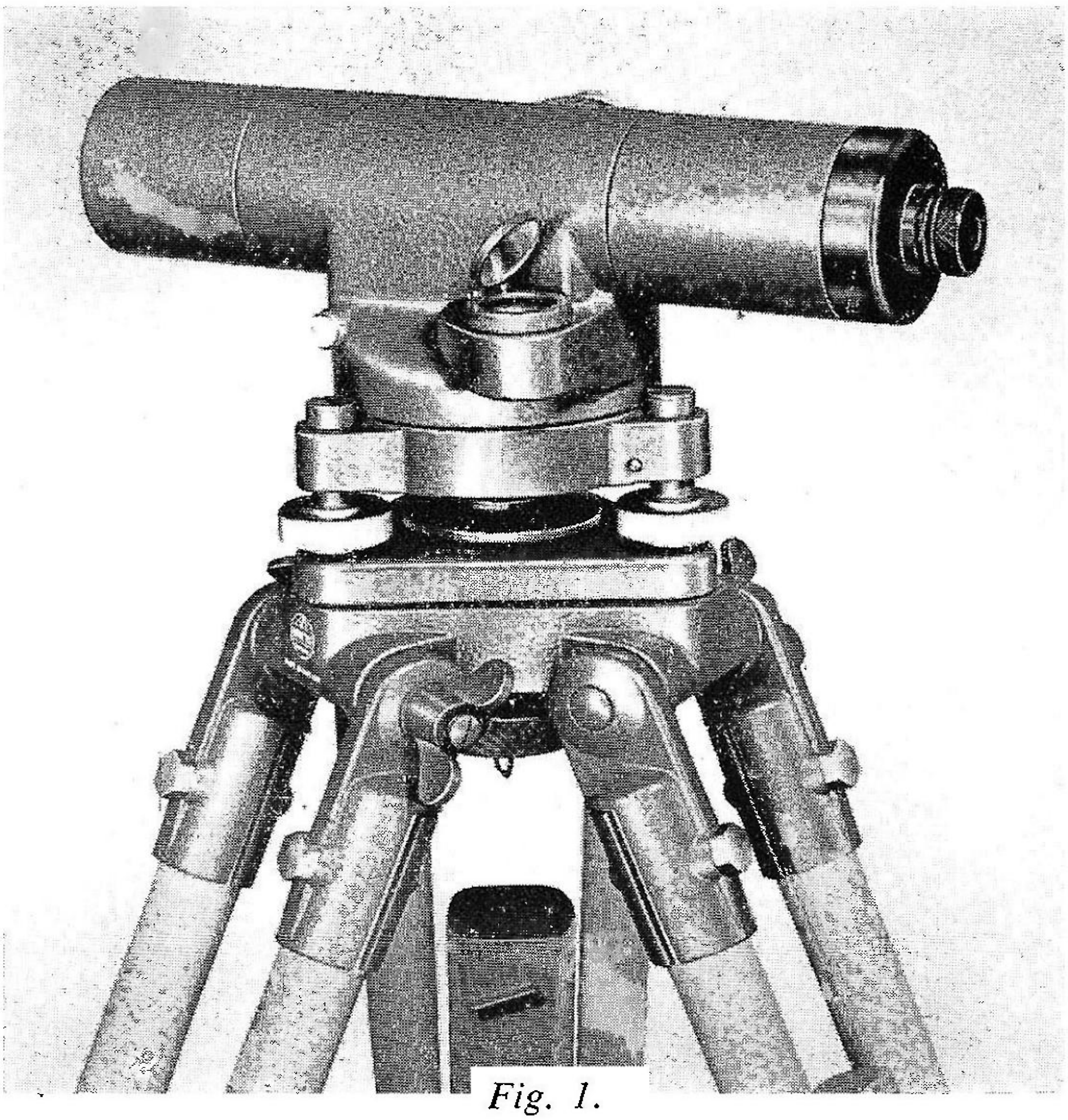

Fig. 1.

INSTRUCTIONS FOR USE

Setting-up Procedure

The instrument is attached to the tripod by a $\frac{5}{8}$ in. dia. threaded bolt and it may be centred over a ground mark where accurate horizontal circle readings are required. For this purpose a plumbob may be attached to the bolt. The circular bubble is brought into the centre of the ring by manipulating the footscrews which have been made with a very fast pitch in order to level quickly, there being no need for great precision.

The stabiliser will operate within a tilting range of $\pm$20 minutes of arc and normally there is no need to level any better than to 10 minutes (about 1 mm. movement of the bubble). For the most precise work it is desirable to centre the circular bubble a little more carefully. There is no need to reverse the instrument to check the bubble excepting when its adjustment is suspected.

The telescope is focused by the large knob on the right hand side, the direction of focusing being indicated by the arrows on its rim. First, however, focus the eyepiece on the reticle by unscrewing to its fullest extent and then turning in slowly until the lines appear sharp. Do this with the telescope well out of focus then point the telescope to the staff, for which purpose there are pointer sights on the ray shade. The azimuth clamp is operated by turning forwards the lever which is concentric with the tangent screw.

Adjust the telescope focusing knob until the staff graduations are sharp and there is no parallax movement when the eye is raised and lowered slightly. Tap the tripod leg or the instrument to disturb the pendulum to prove that the stabiliser is swinging.

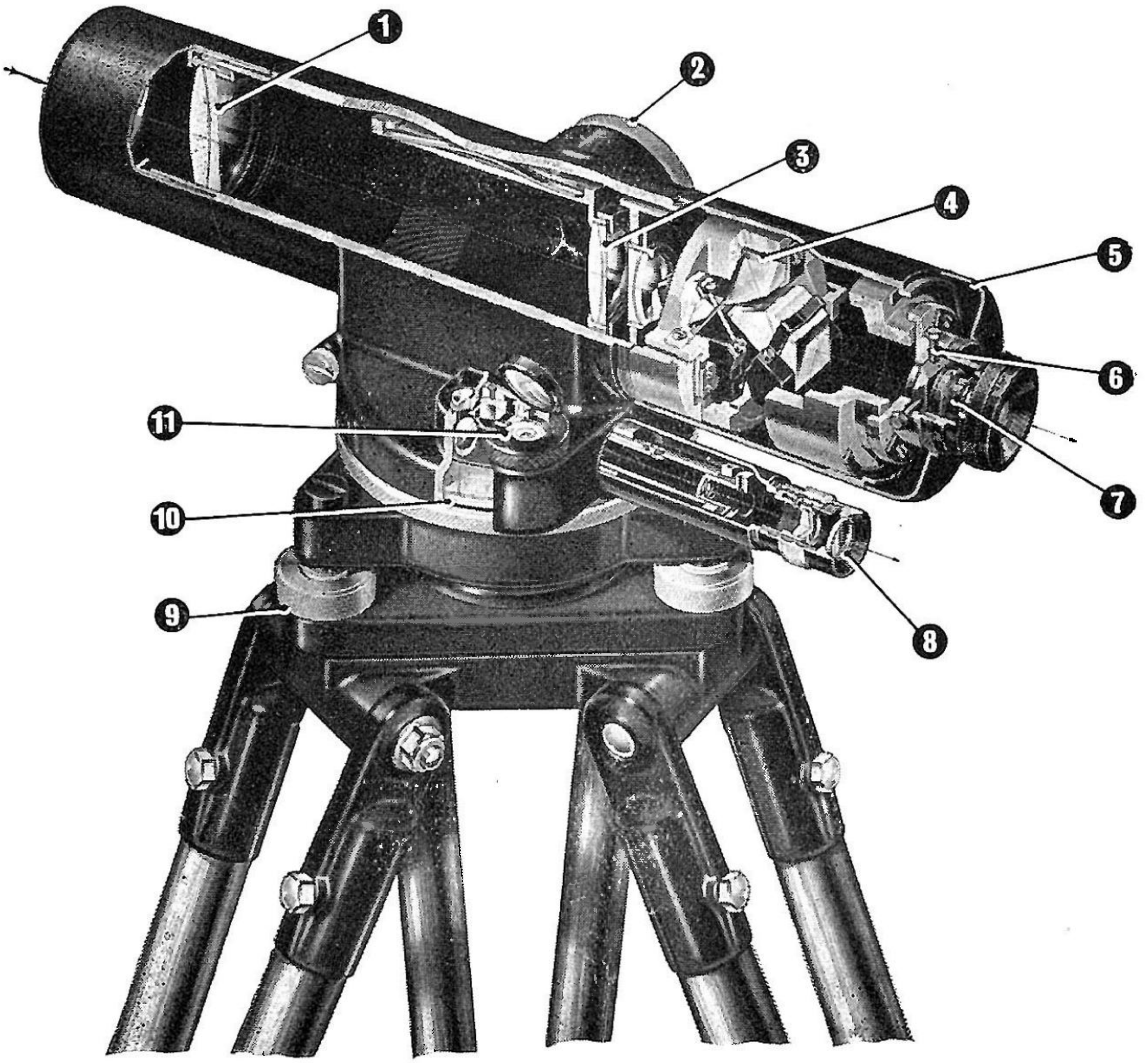

Fig. 2.

KEY

1. *Objective lens*
2. *Focusing knob*
3. *Focusing lens*
4. *Stabiliser*
5. *Cover for reticle adjustment*
6. *Adjusting screws for reticle*
7. *Reticle*
8. *Eyepiece of circle reading microscope*
9. *Levelling screw*
10. *Horizontal circle*
11. *Circular bubble*

Azimuth Circle

The instrument can be supplied with an azimuth circle which is observed through a microscope eye-piece to the side of the telescope.

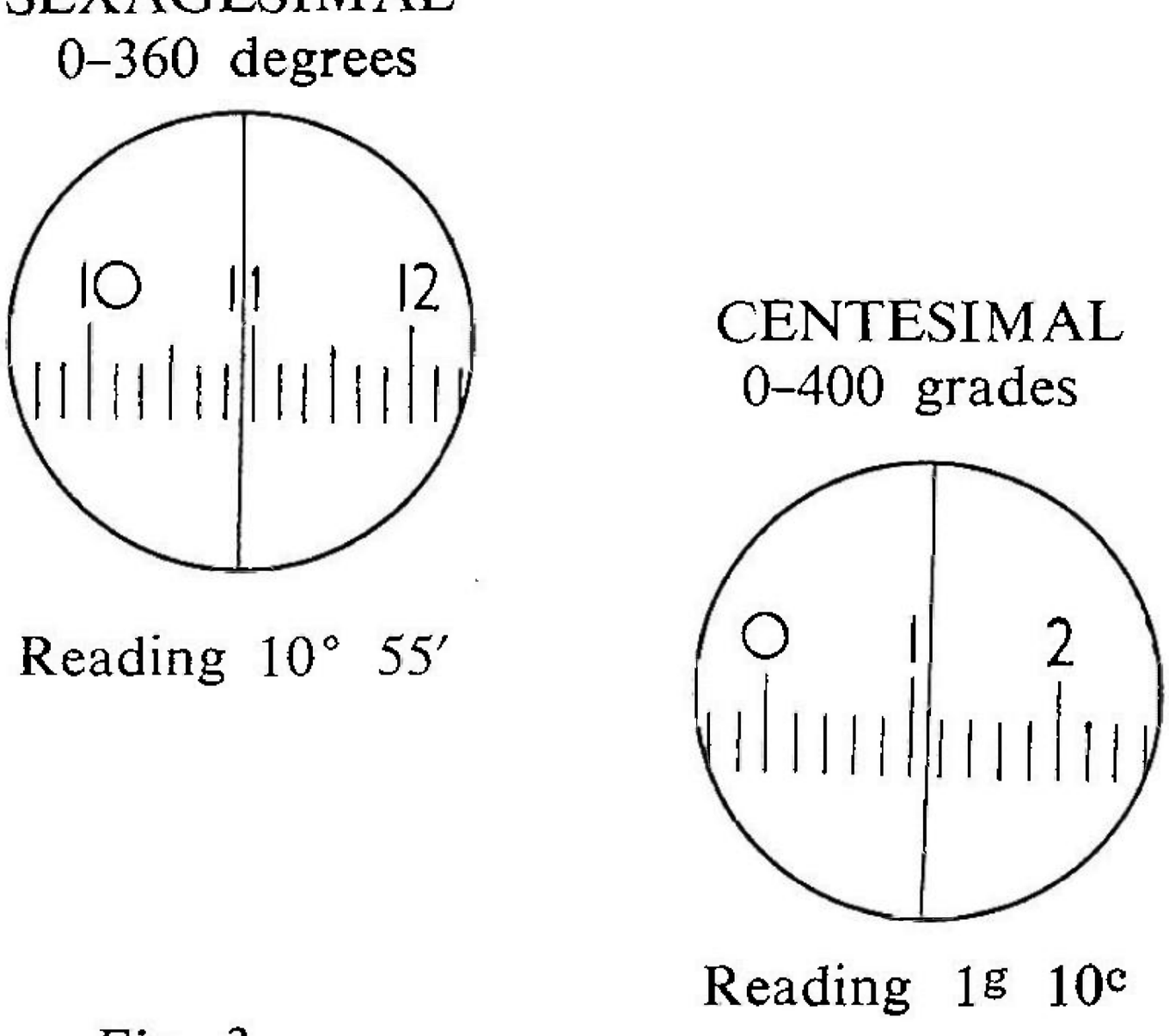

Fig. 3

The circle is illuminated by light falling upon the ground glass window close to the circular bubble. The eyepiece is focused by turning the knurled sleeve. The circle is graduated in degrees (or grades) and sub-divided to 10 minutes (or 20 grades) and is read against a single index line so that estimation can be made to $\frac{1}{10}$ division. The circle can be zeroed by revolving the knurled ring around the tribach.

Optical Micrometer

When the instrument is used for precise levelling, staves graduated on Invar are usually used and it is advantageous to use an optical micrometer to measure fractions of a division instead of estimating. The

optical micrometer is attached to the object end after removing the ray shade. It has a range of 0·02 ft. (or 5 mm.) and is subdivided to 0·001 feet (or 0·5 mm.).

General Use of Instrument

Although the instrument has a relatively delicate pendulum mechanism it is designed to have great robustness and it does not require to be handled with exceptional care. Like all precise instruments, however, rough handling should be avoided. When used under windy conditions it will be found advantageous to space widely the feet of the tripod taking as a guide that the distance between feet should be about the length of leg. In soft ground the feet should be very well trodden in. No particular precautions need be taken when working in sunny conditions, as unlike a spirit level, the optical stabiliser is not sensitive to small changes in temperature.

The stabiliser is designed to compensate throughout the temperature range $-40°$C. to $+50°$C., but when working in extreme temperatures it is advisable to check the level of the line of sight by the usual two-peg test. (See page 7).

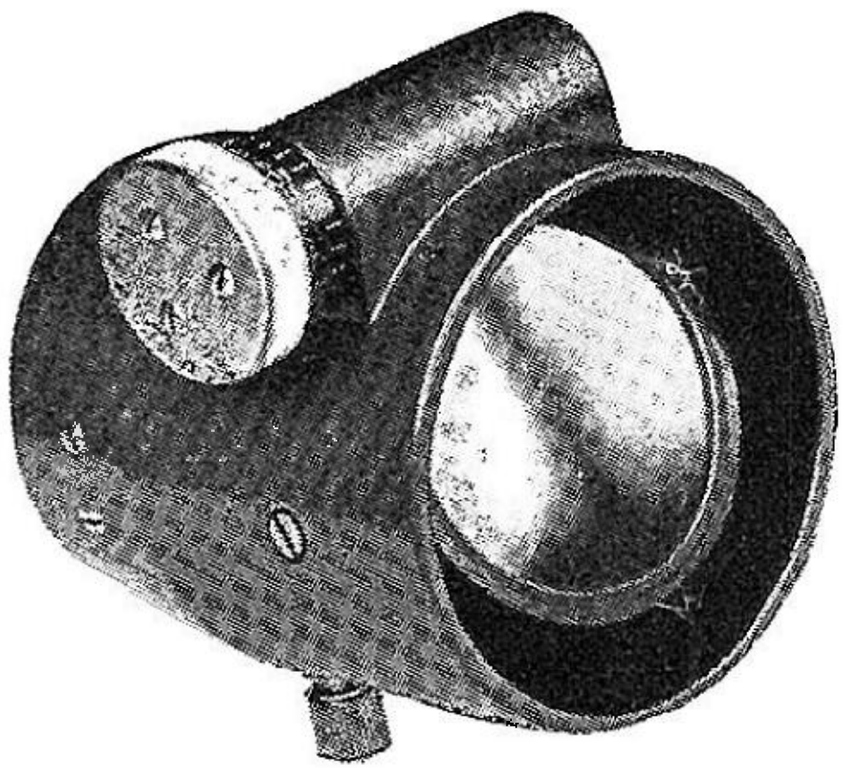

Fig. 4 Optical Micrometer.

FIELD ADJUSTMENTS

Circular Bubble

The circular bubble should be adjusted so that when brought to the centre, the instrument may be rotated without its position varying. In order to check and adjust it so that this is so, first bring it to the centre by using the levelling screws and then turn the instrument 180 degrees. If it is no longer central, correct *half* the error by the levelling screws and the other half by the bubble-adjusting screws which are disclosed by removing the mirror mount. This can be unscrewed after undoing the cheese-headed stop screw adjacent to the mirror hinge. The four adjusting screws are used in opposite pairs antagonistically.

Squaring the Reticle

The reticle lines should be horizontal and vertical and may be made so by rotating the complete reticle mount. This is held by four screws to the telescope and may be seen if the adjustment cover is unscrewed. To check the adjustment first level the instrument and observe a levelling staff. First point the telescope so that the staff is read at the left hand end of the horizontal line and then adjust the tangent screw so that it is read at the right hand end. Any change in reading indicates that the reticle is out of square and the mount should be

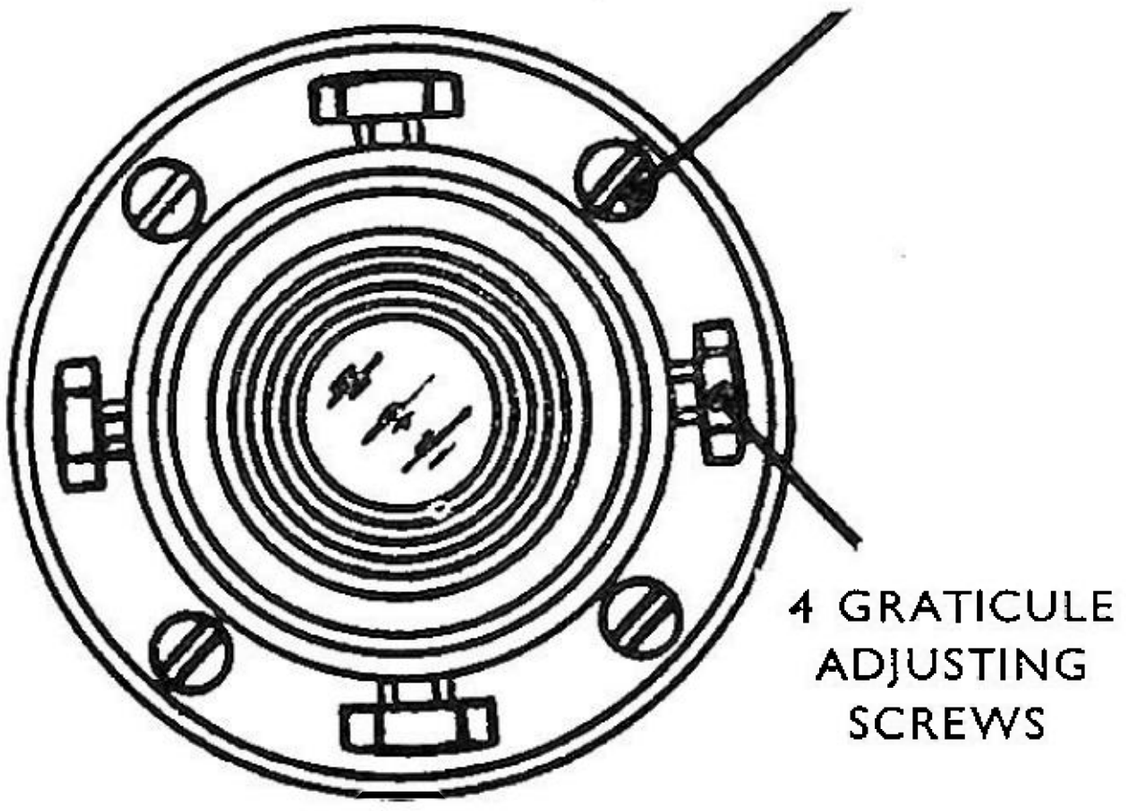

Fig. 5.

rotated to a position where no change in reading can be observed.

Level of the Line of Sight

The level of the line of sight is checked in the usual manner for a telescopic level, by setting up the instrument midway between two levelling staves and booking the differences in level. The instrument is now set up outside the staves but in line with them and the difference in level again observed. Any lack of agreement is due to the line of sight not being level.

In the case of the Autoset Level this is corrected by moving the reticle up or down until the same difference in level is observed as was booked when the instrument was midway between the staves. Should the error be large it may be necessary to adjust the position of a balance weight on the pendulum the procedure for doing which is described in the section on the stabiliser.

Wear Adjustments

There is a wear-adjusting screw for the tangent screw on the telescope body adjacent to the clamp lever, and for each levelling screw on the tribrach.

Stabiliser

The stabiliser is a unit assembly fixed by three screws to the telescope body between the reticle and focusing lenses. It is revealed by removing the reticle adjustment cover and then unscrewing the cylindrical cover in front of it. It consists of a fixed roof-prism under which are two prisms on a swinging mount. This mount is suspended by four metallic tapes in the form of a cross spring flexure pivot.

Below the prisms, the swinging mount has a cylindrical hole enclosed by end caps, and inside is a damping piston secured by two ears projecting through slots in the body to the roof prism support. The oscillations of the pendulum are damped by the resistance of the air flowing through the annular space around the piston.

As the instrument is tilted, the relative displacement between the telescope axis and the swinging prisms causes a deflection to the light rays such that points in space imaged on the reticle centre always lie on a horizontal plane. Furthermore, even though the instrument may be tilted these points are always on the same horizontal plane no matter in which direction the instrument is pointed.

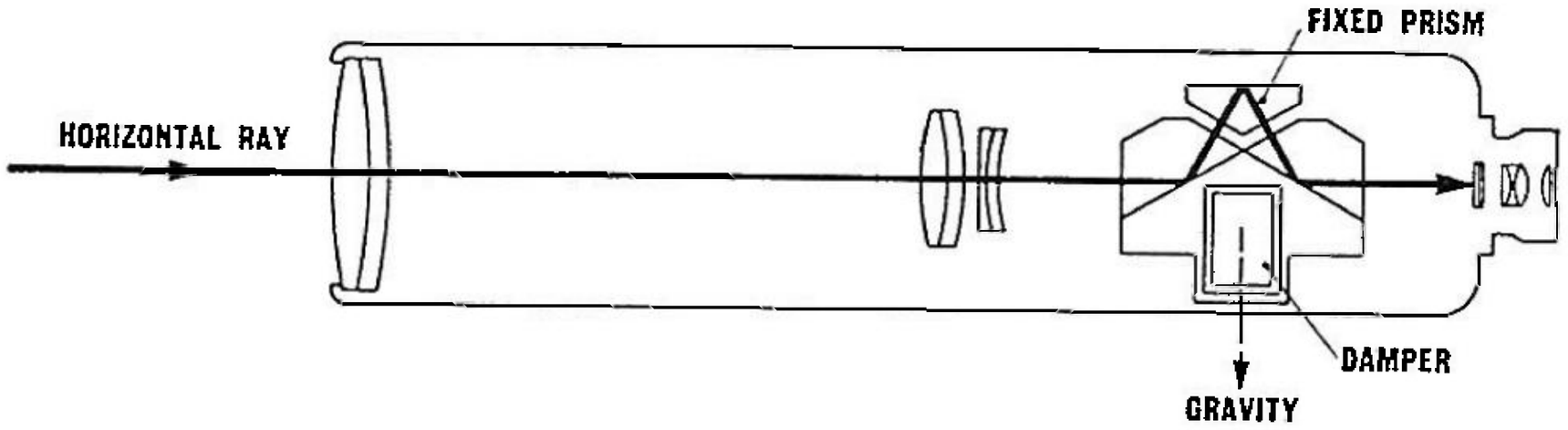

Fig. 6. Telescope Level.

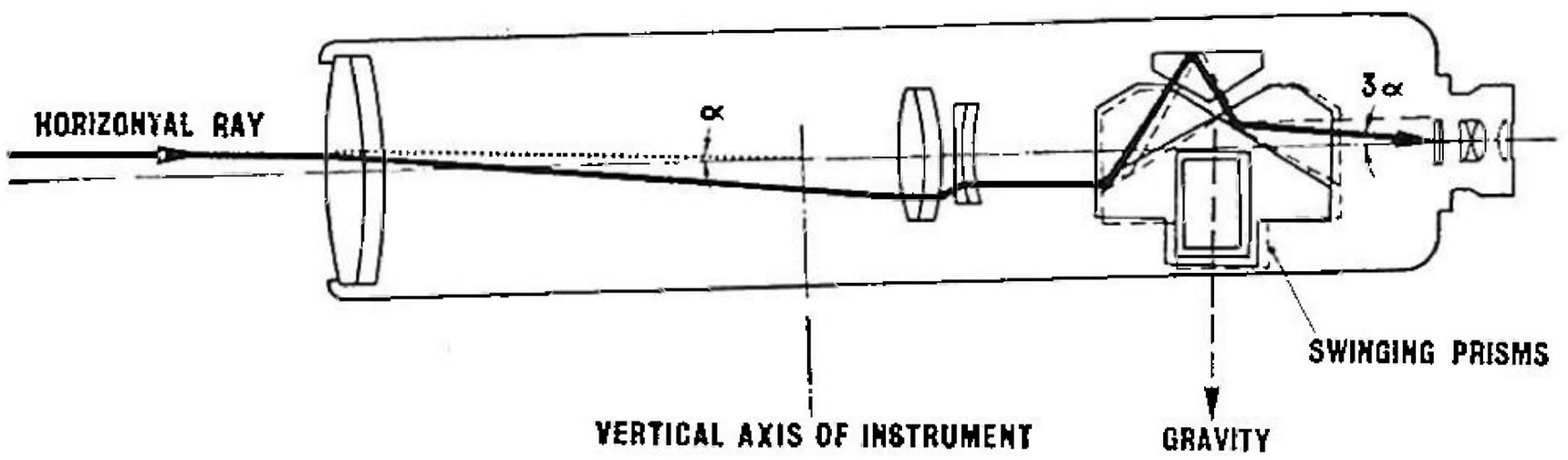

Fig. 7. Telescope Tilted.

The damping piston also provides the end stops for the swing. Underneath the pendulum body are two dovetail slots in which are rider weights and adjustment to these, controls the position of balance and hence level of the line of sight.

This and a longitudinal adjustment to the position of the stabiliser are the only adjustments to the unit, and normally they should not be touched by the user at all.

The reason for using them could be as follows:

1. *COMPENSATION.* If, after the instrument has been levelled and a staff observation made, it is found that by tilting the instrument forwards or backwards

there is a greater change in reading than that attributable to the change in instrument height, the stabiliser requires adjusting longitudinally. If the reading follows the direction of tilt, the stabiliser must be displaced forwards, i.e. towards the objective, and if the reverse is the case, it must be displaced towards the eyepiece. The displacement necessary is likely to be in the order of $\frac{1}{100}$ inch only.

2. *BALANCE WEIGHTS.* The balance weights should only be adjusted if it should be found that an excessive movement of the reticle is necessary in order to level the line of sight. Before making this adjustment it is advisable to make the reticle centre lie on the optical axis and this is done by removing the four screws holding the eyepiece and reticle mount to the telescope end and revolving it whilst observing a suitable mark. If the reticle centre moves round in a circle the hexagonal-headed adjusting screws should be adjusted until the centre remains approximately on the same point when the mount is turned round. Having done this, replace the screws and square the reticle lines. Now adjust the balance weights under the pendulum so that the line of sight is very nearly level according to the two-staff test. This operation is difficult to carry out in the open if a breeze is blowing due to its effect upon the pendulum, when the cover is removed. Finally make the line of sight exactly level by adjusting the reticle mount.

SPECIFICATION

Telescope Magnification	*×32*
Telescope Aperture	*$1\frac{9}{16}$ inches*
Angular Field of View	*1° 20′*
Short Focusing Distance	*6 feet*
Stadia	*1:100 or 0·3:100*
Addition Constant	*0*
Resolving Power	*0·01 feet at 1000 feet*
Range of Stabiliser	*± 20 minutes*
Horizontal Circle Diameter	*3 inches*
Graduations	*10 minutes (0·2 grades)*