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W. F. Stanley & Co. Limited
(INCORPORATING HEATH NAVIGATIONAL LTD.)
33 Avery Hill Road, New Eltham, London SE9 2BW
Telephone 01-850 5551 Telegrams "Turnstile" London
Telex 896414 AB.WFSTLY G

Mr. E. Cordon
48 Brookhill Leys Road
West Wood,
Nottingham.

W F STANLEY

LONDON

1st November 1982 Our Ref : JLR

Mr. E. Cordon
48 Brookhill Leys Road,
Wast Wood,
Nottingham.

Dear Sir,

With reference to your letter dated the 13th October concerning theodolites.

Please find enclosed a booklet for the use and adjustment of theodolites.

We regret that we no longer manufacture these old instruments so this is the only information we can supply.

We assure you of our best attention at all times.

Yours faithfully
W.F. STANLEY & CO LTD

J. Ross. (Mrs)

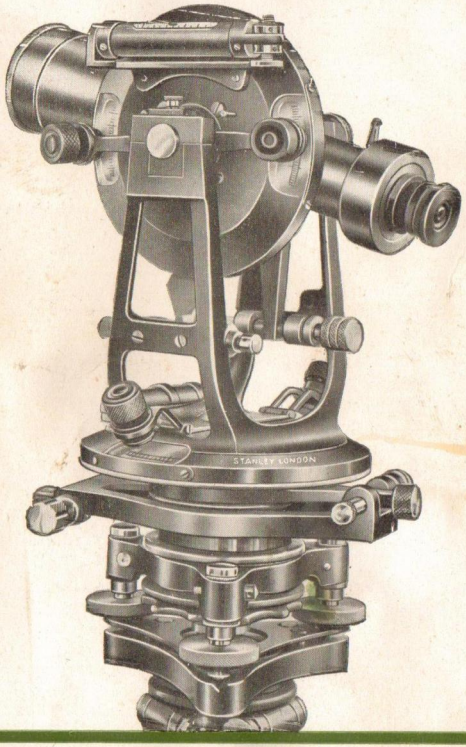
J.L. ROSS
Sales Office

Enc:

Some notes on the use and adjustment of

STANLEY

THEODOLITES



IMPORTANT

Before removing any instrument from its case it is advisable to note exactly how it lies in its packings ; it should always be replaced in precisely the same way, and if this be done the lid will close quite freely without the slightest strain.

Theodolites should be kept clean externally as far as possible. Dust and dirt on the outside of an instrument will find its way inside sooner or later. When using an instrument in a particularly dusty location, such as a demolition site, keep a soft camel hair dusting brush in the case—it is better than a duster.

STANLEY

W. F. STANLEY & Co. LTD.

Some notes on the use and adjustment of

THEODOLITES

HEAD OFFICE

WAREHOUSE AND MAIN WORKS :
NEW ELTHAM, LONDON S.E.9
Phone: ELTham 3836

STANLEY
TRADE MARK
W. F. STANLEY & Co. LTD

BRANCHES

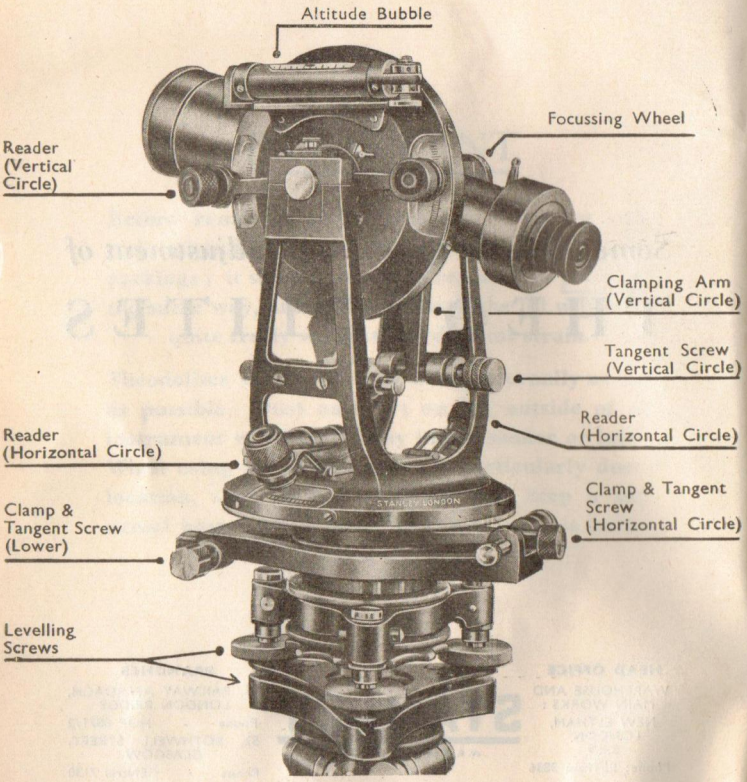
13, RAILWAY APPROACH, LONDON BRIDGE
Phone - HOP 0871/2
52, BOTHWELL STREET, GLASGOW
Phone - CENtral 7130

HEAD SHOWROOMS

79/80, HIGH HOLBORN, LONDON, W.C.1
Telegrams : "Geodetic, Phone, London"
Telephone : HOLborn 2684

Codes Used :

"PRIVATE" (see *Catalogue*), **"A.B.C.," "BENTLEYS," "LIEBERS," "MARCONI," "WESTERN UNION."**


Altitude Bubble
Focussing Wheel
Reader (Vertical Circle)
Clamping Arm (Vertical Circle)
Tangent Screw (Vertical Circle)
Reader (Horizontal Circle)
Reader (Horizontal Circle)
Clamp & Tangent Screw (Horizontal Circle)
Clamp & Tangent Screw (Lower)
Levelling Screws
STANLEY LONDON

Notes on the care, use and adjustment of STANLEY THEODOLITES

Although some of the following instructions deal with minor repairs, such as removing grit from the axes, involving the taking down of portions of the instrument, such tasks are better performed by skilled mechanics and, when possible, it cannot be too strongly urged that the instrument should be returned to the maker for the purpose. It is realised, however, that there are times when the services of an instrument maker are not available, and to cover any contingencies that might arise the necessary instructions for such minor repairs have been included.

THE GRADUATED CIRCLES.

The Circles must never be touched with abrasives of any kind. The silver being soft and the dividing very fine, any application of even the finest abrasive, such as plate or metal polish, will soon erase the divisions. Apart from this, a polished surface is difficult to read. All our Circles are left with a grey matt finish. If Circles must be cleaned, then use only a soft rag and the finest oil. To blacken the divisions a little black oil paint from a tube can be applied on the finger.

As both the graduated Circles and the verniers have to be correctly centred on their bearings—an operation which can be performed only by an experienced craftsman—they should on no account be unscrewed from their seatings.

AXES OR CENTRES.

The Axes, or Centres, are vital members of the instrument and should only be taken apart when absolutely necessary. If, however, the instrument does not revolve freely, and it becomes necessary to take it down, for the purpose of relubricating the Axes :—

First remove the whole of the telescope assembly by removing the screws securing the horizontal axis in its bearings, and both vertical Circle tangent spring boxes. Then remove the spring boxes and springs from both upper and lower plate clamps by unscrewing the milled spring boxes. Next unscrew

cap to vertical axis. Detach the levelling system (tribrach, parallel screws and wall plate complete) from the upper members by unscrewing the clamping wheel which controls the centering movement. Then remove the exposed retaining screw. **In instruments where the horizontal circle is totally enclosed** it will also be necessary to remove the bracket which combines the upper and lower plate clamps, together with the underneath plate which encloses the horizontal circle. This clamp is held in position by retaining screws which are easily removable, and the plate is secured with screws round the edge.

N.B.—The upper-plate end of the double clamp is always assembled under the 270° division of the circle.

The centres can now be taken apart. As the horizontal circle is tapered off to a knife edge, separated from the vernier only by a distance which is the equivalent of the thickness of a piece of tissue paper, their removal must be effected with the utmost care, otherwise irreparable damage may be done.

TO CLEAN THE CENTRES.

The old lubricant should be removed with a little petrol if necessary, but only the cleanest rag must be used, lest grit or dirt be left behind. A tapered stick with a piece of rag round it is a handy tool for cleaning the inner surface.

After cleansing, the centres should be relubricated with the finest refined mineral oil ; if this is unobtainable, medicinal paraffin may be used.

It cannot be too strongly emphasised that the axes should be taken apart as seldom as possible and preferably by an Instrument Maker.

COINCIDENCE OF VERTICAL AXES.

If there is any reason to suspect that the instrument has had a fall or suffered any ill usage likely to affect the vertical axes, the following test should be applied :—

Set the instrument up truly vertical and release both horizontal clamps. Then, holding the instrument by the telescope uprights with the left hand, rotate the horizontal circle and intermediate centre, pulling it round with the

right hand about 20° at a time, by means of the frame carrying the clamps. During this operation the bubble should remain in the centre for all positions of the circle. Any slight movement, however, should not exceed half the circle reading.

N.B.—Both hands must be removed from the instrument before any observation of the bubble is taken.

TELESCOPE.

All our Theodolite Telescopes are inverting, *i.e.*, the image is seen upside down. Erecting Eyepieces can be supplied if desired at the current catalogue price, but are not recommended. They will upset the balance of the Telescope and entail loss of light. Inverting Telescopes have a further advantage in that for a given length of Telescope they are more powerful.

LENSES.

If it becomes necessary to remove the lenses for cleaning, the greatest care should be exercised to see that they are replaced in exactly the same position with the same surface outermost and the same surfaces of the doublet in contact.

It will be found on some instruments that thin sheet metal spacers are inserted between the two components of the object-glass, these must be replaced in the same position and the object-glass retaining ring so assembled that the three projections on it come directly over these spacers.

The object-glass cell is fitted with a key to engage a groove in the rim of each lens to prevent their moving.

In some instruments the object-glass screws out, in others it has a slide-in fitting.

Lenses should be washed in either alcohol or ether and afterwards dried on a soft clean chamois leather or clean cotton handkerchief.

In the case of Internal Focussing Telescopes, the central focussing lens can be cleaned, after removal of the object-glass and diaphragm, with a small leather on the end of a stick.

N.B.—When object-glasses are removed all adjustments must be checked.

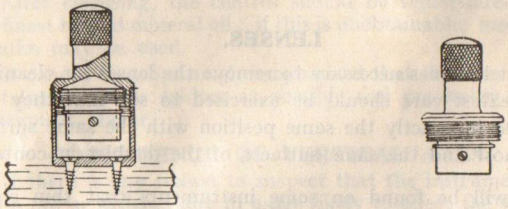
MAGNETIC COMPASS

When not in use, the needle of the compass should always be lifted off its pivot by means of the lifter provided. If the needle is left swinging, the agate centre and steel pivot will become damaged.

SLIDING TRIBRACH (Centering System).

Most of our Theodolites are provided with a sliding tribrach, *i.e.*, the tribrach has an opening in the centre to permit horizontal movement for centering of the instrument over a station. After centering, the instrument is clamped by means of the clamping wheel, Fig. 1 (centering clamp).

SPARE DIAPHRAGM CONTAINER AND EXTRACTOR.



Showing method of packing in box **Extractor with diaphragm**

Fig. 2

All our latest Theodolites are supplied with a spare Diaphragm, this is screwed into an extractor which in turn screws into a metal box attached to the lid of the case.

THEODOLITE DIAPHRAGMS

A1 WEB | A2 WEB | B1 GLASS | B2 GLASS | B3 GLASS

Unless otherwise ordered, all our theodolite diaphragms are etched on glass. Any of the patterns illustrated above could be supplied if specified at the time of ordering, but unless otherwise ordered, B.3 is supplied. This is a Government pattern used in Service instruments, and enables the telescope to be pointed with a minimum of obscuration of the target.

Glass diaphragms have the further advantage that they help to keep the telescope free from dirt and damp, and thus are an added measure of protection.

Spiders web diaphragms can be supplied if specified at the time of ordering, but have the disadvantage that they are fragile, and difficult to replace.

STADIA DIAPHRAGM.

Stadia Diaphragms for direct distance measurement can be had in either form. The stadia lines are spaced to subtend 1 ft. on the staff for every 100 ft. of distance. To this reading the constant, if any, shown in the lid of the instrument box must be added.

EXAMPLE.—Say the upper line or point reads 2.05 ft. and the lower 3.90 ft., then the distance which the stadia intercepts, viz., 1.85 multiplied by 100, plus the constant, is the distance between instrument and staff in feet.

3.90
−2.05

$1.85 \times 100 = 185$ ft.

THE TRIPOD.

Inaccuracies often attributed to the instrument are ultimately found to be due to some trifling defect in the tripod.

The tripod should therefore be examined from time to time to ensure that there is no shake in the head due to the bolts working loose.

On the other hand, should the legs become too stiff, the bolts should be removed and greased, otherwise there is a danger of straining the head of the stand.

The shoes of the stand should also be examined occasionally to see that they are firmly attached to the legs and do not shake.

PARALLEL SCREWS.

The parallel screws of the "Eltham" Theodolite are provided with dust excluders, and the adjustment for wear is effected by means of capstan headed adjusting screws on the tribrach. The parallel screws are connected to the wall plate by a strong spring plate.

The instrument should always be operated **with the parallel screws screwed up as far as possible.** If care is taken in setting up the stand, it should not be necessary to give any screw more than a turn or so.

TO FOCUS THE TELESCOPE.

Before any attempt is made to focus the telescope on the staff, the adjustment for **parallax** should be made. This adjustment is to ensure that the image of the staff is viewed exactly in the plane of the diaphragm. If it is not made correctly, a **parallax error** will result which will seriously affect the accuracy of the readings.

Procedure.

Rack the telescope out so as to throw the image in the telescope right out of focus. The eyepiece should now be carefully focussed upon the lines of the Diaphragm. To avoid eyestrain, the eyepiece should be screwed outwards beyond the focus position and focussed by screwing it inwards.

It is a considerable help if a piece of white paper is held in front of the object-glass at an angle of 45° to reflect the light into the telescope and illuminate the diaphragm while focussing.

Most of our eyepieces are graduated in dioptres, so that once the operator has carefully ascertained his focus, the eyepiece can be set to the correct focus immediately.

The adjustment for **parallax** having now been made, the telescope can be focussed on the staff by the focussing wheel. If now the eye be moved up and down, as far as the range of the eyepiece will permit, and the diaphragm lines remain fixed with relation to the image of the staff, **parallax** is absent. If, however, when the eye is moved, the lines of the diaphragm appear to move away from the divisions of the staff, there is a **parallax** error, i.e., the image of the staff is either in front of or behind the diaphragm, and this must be put right by carefully following the foregoing instructions again.

HOW TO READ A VERNIER SCALE.

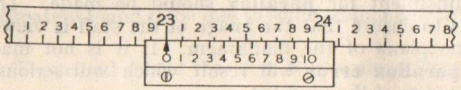


Fig. 4

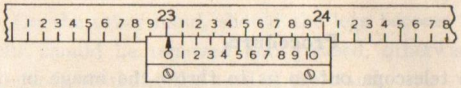


Fig. 5

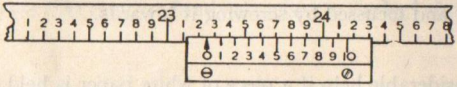


Fig. 6

A vernier scale is a supplementary shrunk scale by means of which the angular position of any point in the space between two lines of a main scale can be accurately determined. Figs. 4–6 show a very simple type of vernier, i.e., the decimally divided vernier. It will be seen, Fig. 4, that the space occupied by nine divisions on the main scale is divided into ten parts on the vernier. Thus each vernier division is nine-tenths of a main scale division.

If the first line on the vernier, which is the index or zero line from which the readings are taken, is made to coincide with a line on the main scale, the next vernier line will be one-tenth of a main scale division short of the corresponding line on the main scale. The second line will be two-tenths short, and so on.

From this it will be seen that if each line on the vernier is brought opposite and made to coincide with its nearest main scale line in turn, the arrow at the zero of the vernier will advance by intervals of one-tenth of a division, the number of the coincident vernier line indicating the distance of the arrow from the last line in tenths of a division. Thus readings to one-tenth of a division can be made easily and accurately without confusing the eye with a closely divided circle.

The direction for reading the vernier may be summarised as follows :—

Note the position of the arrow on the vernier ; read the nearest main division and subdivision, and then, finally, the division on the vernier which coincides will give the final figure.

Any kind of equally divided scales, straight line or circular, can be read by mean of a vernier scale. If it is required to read the scale in either direction, then the vernier must be figured to read in each direction from the zero point.

The above example has been chosen for its simplicity to describe the principle, but Fig. 7 is an example of a typical Theodolite vernier reading to 20 seconds.

A 20-second reading usually has divisions of 20 minutes on the circles and these are subdivided into minutes and thirds by means of the vernier. The following is an illustration of this, showing a reading of 28 degrees 40 minutes on the circle and 12 minutes 20 seconds on the vernier, giving a total of 28° 52′ 20″.

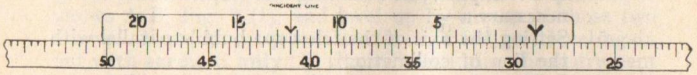


Fig. 7

THEODOLITE ADJUSTMENTS.

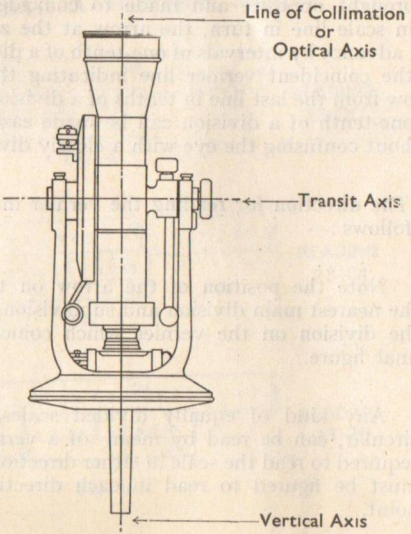


Fig. 8

The Theodolite adjustments may be detailed as follows :—

1. The adjustment of the horizontal plate bubble.
2. Setting the line of collimation of the telescope at right angles to the transit axis.
3. Setting the transit axis at right angles to the vertical axis so that the telescope will follow a plumb line.
4. Adjusting the vertical circle Zero to the vernier bubble.

If the instrument is fitted with a telescope bubble or a compass, the following two adjustments will be necessary :—

5. Setting the axis of the telescope bubble parallel with the line of collimation.
6. Setting the compass in the magnetic meridian.

THE ADJUSTMENT OF THE HORIZONTAL PLATE BUBBLES.

Our latest pattern Theodolites are provided with one plate bubble only, the bubble on the vernier being disposed at right angles to it. The two are used together to set the instrument up with the main axes vertical.

The plate bubble should be adjusted by revolving the inner vertical axis, the outer centre being clamped, as angular measurements are taken using the inner axis.

The operation of setting up the Theodolite with its axes vertical and the adjustment of the plate bubbles is usually described as being performed simultaneously. Although this can be done by an expert, it is far easier to do the two operations separately, *i.e.*, to set up the instrument vertical and then to adjust the bubble by means of its adjusting nuts to bring the air bell in the centre.

The bubble can be used equally well for setting up the instrument whether in or out of adjustment, the only difference being that when the instrument is truly vertical, instead of the air bell being in the centre it will be out of centre by an amount equal to its own error in all meridians.

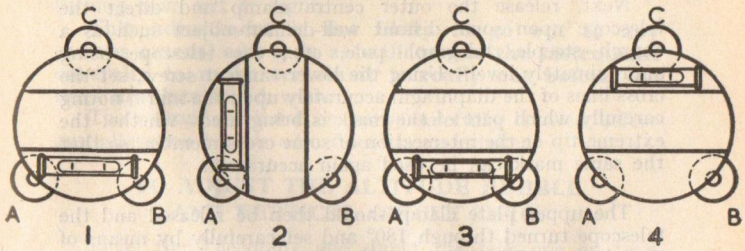


Fig. 9

Dispose the instrument with the plate bubble parallel to screws A B, Fig. 9 (1), and level up by means of those two screws. Next, turn instrument through 90° and level again but **with screw C only** (2), this will verticalise the instrument roughly in all meridians.

Now turn over screws A B once more (3) and level exactly. Next turn through 180° (reverse position over same pair of screws) (4), if bubble moves off centre adjust for half error only by means of screws A B. Turn through 90° and **repeat by means of screw C only.**

It should now be possible to turn the instrument into any position with the air bell remaining in the same position (if in adjustment this position will be central). If out of centre, correct by means of the adjusting nuts. It is usually necessary to repeat this adjustment to get it exactly right.

SETTING THE LINE OF COLLIMATION AT RIGHT ANGLES TO THE TRANSIT AXIS.

After setting the instrument up level, set the horizontal circle verniers at 0° or 360° and 180°. If the verniers read differently, set to the mean of the two readings.

Next, release the outer centre clamp and direct the telescope upon some distant well-defined object such as a church steeple, telegraph pole, etc., the telescope being approximately level. Using the lower tangent screw, set the cross lines of the diaphragm accurately upon the mark, noting carefully which part of the mark is being used—whether the extreme tip or the intersection of some cross member, so that the same mark can be used again accurately.

The upper plate clamp should then be released and the telescope turned through 180° and set carefully by means of the clamp and tangent, using a mean setting as before if necessary. If the telescope is now transited it should come back exactly on the mark. If it does not, and appears displaced to right or left, the collimation is out by half the error shown and should be corrected half by means of the horizontal diaphragm screws (after removing the screwed cover) and half by means of the lower Tangent Screw, Fig. 1. The test should then be repeated.

To set the Transit Axis at right angles to the vertical axis so that the telescope will follow a plumb line.

Proceed as follows :—

Set the instrument up level, and sight the telescope on to a well-defined mark at a high altitude, about 45°, then clamp both horizontal plate clamps. Depress the telescope to sight a mark on the ground as low as possible immediately below this point. Mark the spot with a well-defined cross on a postcard or with the levelling staff placed horizontal on the ground.

Next release the upper-plate clamp, turn the instrument through 180°, transit the telescope and repeat, setting first on the high mark. If on depressing the telescope the intersection on the diaphragm does not coincide with the lower mark, then the mean of the two readings is the true plumb point below the upper mark, and the transit axis is out.

To correct this error, use the trunnion adjusting nuts on the upright immediately below the trunnion. The upper nut raises the Y under the trunnion if turned from right to left with the tommy pin ; the lower nut must first be released by turning with a right-to-left motion. When the necessary adjustment has been completed, the lower nut is clamped by turning from left to right.

This adjustment is not likely to go out to any serious extent, and it is as well to test the instrument carefully to make certain it is really out before the nuts are interfered with.

The instrument must be **very carefully** levelled before any alteration to this adjustment is undertaken.

TO ADJUST THE ALTITUDE BUBBLE AND VERTICAL CIRCLE ZERO.

Level the Theodolite and direct the telescope on to a levelling staff held erect at from 80 ft. to 100 ft. The altitude bubble should then be levelled with the zero adjustment screw and the telescope set to zero by the vertical circle tangent screw, making a mean setting if necessary. A reading is then taken on the staff with the middle line of the diaphragm, Fig. 9a (1).

The telescope should then be transited and turned through

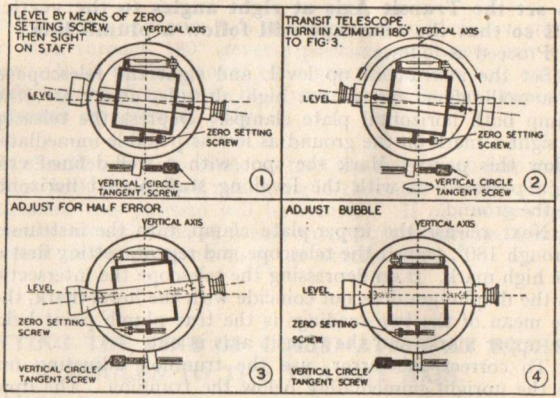


Fig. 9a

180° and a second reading taken, Fig. 9a (2 and 3). The mean of the two readings is the true level, and if the instrument is correctly adjusted the two readings should be the same. If it is not, correct as follows :—

Set the centre line of the diaphragm to the mean reading by means of the vertical circle tangent screw. Then set the verniers to zero by the zero setting screw, finally level the bubble by means of the adjusting collets, Fig. 9a (4).

N.B.—In this adjustment it is very necessary to see that the instrument is correctly levelled (page 13).

TO ADJUST A THEODOLITE FOR HORIZONTAL COLLIMATION HAVING A BUBBLE ATTACHED TO THE TELESCOPE.

Level the Theodolite and direct the telescope on to a levelling staff held erect at 80-100 ft. Level the telescope bubble by means of the vertical circle tangent screw and note the reading on the staff.

Next transit the telescope and turn through 180° and read the staff again.

Transit the telescope and turn through 180° once more to bring bubble on the top of the telescope again. Then bring the telescope to the mean of the two readings and level the bubble by means of the adjusting collets and the adjustment is complete.

The compass is adjusted so that when the telescope is pointing along the magnetic meridian towards the North, and the horizontal circle is set so that vernier " A " reads 360°, the compass will read zero.

In the case of the circular compass instrument, when the telescope is pointing North, the compass will read 360° irrespective of vernier setting.

Should it be necessary at any time to remove the compass dial, care must be taken to see that the indicating point fitted just in front of the reader is not damaged.

Micrometer Reading Theodolites

MICROMETER THEODOLITE ADJUSTMENTS.

The foregoing instructions for Vernier Theodolites apply equally well to Micrometer Theodolites with the addition of the following instructions relative to the actual micrometers themselves.

As in the case of vernier reading instruments, measurements are taken from opposite sides of the circle to eliminate instrumental errors.

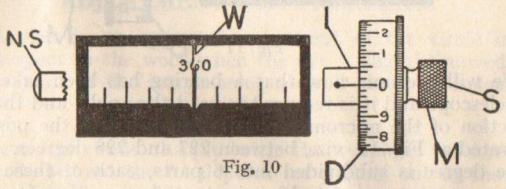


Fig. 10

In a Micrometer Theodolite the divisions of the circle are viewed through a powerful microscope, and the spaces between the divisions are measured by a movable web or webs, the movements of which are controlled by an accurate screw, to which is attached a divided drum.

Two webs are used rather more than one because it has been found in practice that it is easier and more accurate to straddle a mark or point with a pair of webs than it is to obtain coincidence with a single web. The fiducial point is a V or notch located in the zero position, and the angular distance between the zero position and the nearest division is read by turning the drum until the movable webs move from zero to a position where they straddle the next division on the circle.

There are two adjustments to the Theodolite Micrometers:—

(1) Adjustment for parallax.

(2) To set the drums to read zero when the movable webs are straddling any two diametrically opposite divisions.

It is not at all necessary that the V notches be set exactly 180° apart as they only serve to show that the zero setting on the drum is not one turn or space out, and all readings are taken from the drum and webs.

TO READ AN ANGLE WITH A THEODOLITE MICROMETER CORRECT TO 10 SECONDS.

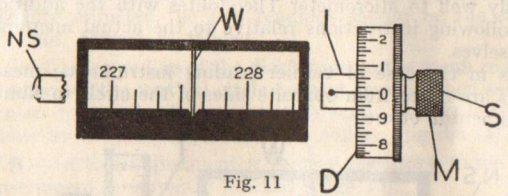


Fig. 11

We will presume now that a bearing has been taken by the telescope and it is required to read the angle, and that on inspection of the micrometer it is seen to be in the position illustrated at Fig. 11, viz., between 227 and 228 degrees. Now as the degree is subdivided into 6 parts, each of these subdivision must represent 10 minutes of arc, therefore the pointer is situate between 227° 30′ and 227° 40′. It is now necessary to measure exactly the distance of the webs from the division 227° 30′, which is done in the following manner, by means of the micrometer head D.

This micrometer is adjusted so that one complete revolution of the head causes the pointer to exactly travel over the space of one division on the circle.

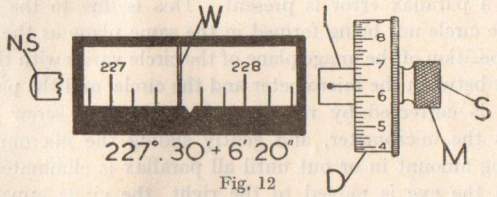


Fig. 12

The head itself is divided into 10 primary parts which indicate single minutes and these are subdivided into 6 parts of 10 seconds each ; therefore in order to measure the exact position of the webs in Fig. 11, it is only necessary to turn the head D until the webs are exactly over the previous division of the circle (as shown in Fig. 12) and read the distance on the micrometer head D. In this case the head has been turned through six main divisions of 1 minute = 6 minutes and 2 subdivisions of 10 seconds = 20 seconds, giving a total reading of 6′ 20″, this added to the circle reading of 227° 30′, gives 227° 36′ 20″, which is the correct reading of the angle.

ADJUSTMENT FOR PARALLAX.

Parallax is an apparent movement of the circle image with respect to the webs when the eye is slightly moved and is the result of the image being formed above or below the webs.

Focus the webs sharply with the eyepiece by screwing outwards beyond the focal point (or pulling out in the case of the old-fashioned sliding eyepiece) and screwing (or pushing) in again slowly and carefully until the focus position is reached **and no further.** It cannot be too strongly emphasised that failure to focus the eyepiece accurately may, in itself, result in a parallax error.

If, after the eyepiece of the micrometer has been carefully focussed on the movable webs, the circle appears to move with respect to the webs when the eye is moved from side to side, a parallax error is present. This is due to the image of the circle not being formed in the same plane as the webs. The position of the image plane of the circle varies with the distance between the micrometer and the circle, and the parallax error is corrected by releasing the tightening screw which holds the micrometer, and gently sliding the micrometer a trifling amount in or out until all parallax is eliminated. If, when the eye is moved to the right, the circle appears to move in the same direction, this indicates that the micrometer is too far from the circle and vice versa.

N.B.—All instruments are carefully corrected for parallax by the makers and should not need any further adjustment.

TO TEST AND, IF NECESSARY, READJUST THE DRUMS.

When the movable webs are exactly central with respect to any two opposite divisions (*e.g.*, 180° and 360° or 90° and 270°) the drums should read zero. If it is necessary to reset them, the screw S should be released, when it will be found a simple matter to reset the drum by holding the spindle stationary with the milled head M, whilst turning the drum D to zero.

TO SET THE NOTCHES.

With the drums set at zero and the webs exactly straddling two diametrically opposite divisions (*e.g.*, 180° and 360°) the notches, if not accurately positioned, can be adjusted by means of the screw N S, Fig. 10, actuated by a small screw-driver.

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