A NEW EXTENSIBLE LEVELLING STAVE.

Dr. Köplitz, Mine Surveyor, of Herne, describes in the *Allgemeine Vermessungs-Nachrichten*, Liebenwerda, No. 2, 11th January 1934, p. 40, a new extensible levelling stave the numbering of which remains consecutive even when its extensible part is not completely drawn out; it may be extended at will from decimetre to decimetre and clamped thus by means of springs, the consecutive numbering being always automatically ensured by means of a steel band, graduated in decimetres, which surrounds the prolongation of the levelling stave. During the lengthening, the numbering on the band rests on the front side of the prolongation, whilst during the housing it disappears on the rear side. So that the band may slide easily round the prolongation, two roller-guides are carried one at each end of the latter.

Although this levelling stave is in the first place intended for underground survey work it may also be used for certain land surveying work, the defects of the ordinary folding stave being completely eliminated in this new design.

The new flexible-band extensible levelling stave is made by the firm of R. Reiss G. m. b. H., Liebenwerda (District of Halle), Germany, and it may be procured from the firm of Gebr. Wichmann G. m. b. H., Düsseldorf, Adlerstrasse, 78; a detailed prospectus may be had on request.

THE HAMMER - FENNEL TACHEOMETER

The Hammer-Fennel Tacheometer is not a new instrument. It has seen much useful service for the past 25 years. A new model, however, was brought out in 1927 embodying improved optical principles in the telescope (*). Its special feature is, that by taking readings on to a graduated staff held vertically at a point, the horizontal distance and the difference of height between the instrument and the point are at once obtained without any further computation. The device which enables this result to be obtained is very simple, and is illustrated in Fig. 2. The dotted lines in the figure are inserted for explanatory purposes, and do not exist on the diagram of the device.

The instrument itself, Fig. 1, consists of an internal focussing telescope 11 inches long, with an object glass of 1.4 inches aperture, and a magnification of 24. The telescope cannot be transited, but it can be rotated on its axis 30° on either side of the horizontal plane. The horizontal circle, of 5 inches diameter, is graduated to 10 minutes and read by a single microscope to 1 minute. There are two levels on the vernier plate and a double level on the telescope. A trough compass is attached to one of the standards. There is no vertical circle, its place being taken by the case which encloses the special device shown in Fig. 2.

The device itself consists of a diagram of curves on a plate-glass *G*. This diagram, or rather a portion of it at a time, appears inverted in the telescope. *ZZ* is the zero-curve, and is a segment of a circle which has *O*, the axis of the telescope, as its centre. *DD* is the distance-curve; + *HC* the portion of the height-curve indicating an elevation, and - *HC* the portion indicating a depression. This diagram is brought into the field of view of the telescope by means of two prisms and an intervening lens (see Figs. 3 & 4).

Looking now into the telescope, a fixed horizontal wire is seen stretching across the top of the field. The right half of the field is otherwise quite clear. On the left appears a portion of the diagram cut off sharp by the perpendicular edge of one of the prisms. This forms the line which is brought into coincidence with the edge of the staff held at some distant point, the fixed wire being at the same time made to bisect the zero line of the staff. As the telescope is moved about its axis the diagram appears to move across the left half of the field of view. The zero-curve is always tangent to the fixed wire at the point of intersection with the vertical edge of the prism.

(*) *Otto Fennel Söhne - Werkstätten für geodätische Instrumente - Königstor 16, Kassel.*

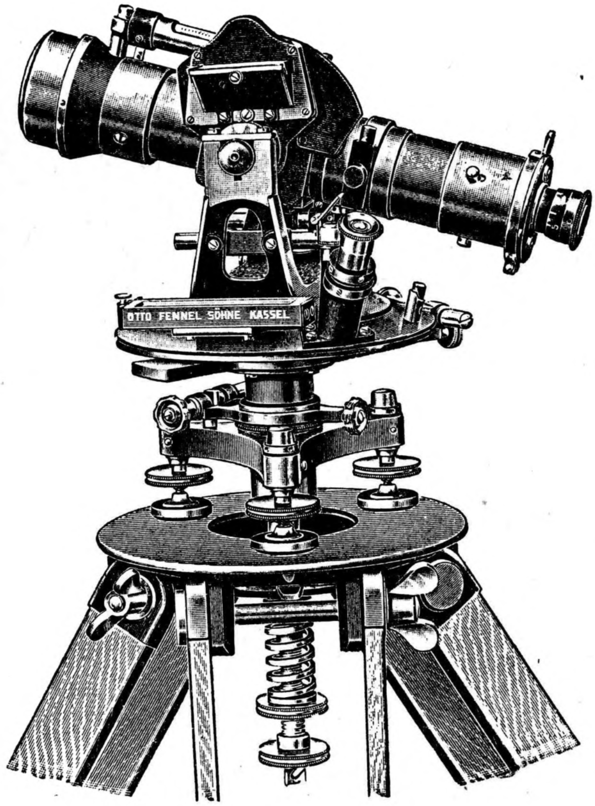


FIG. 1

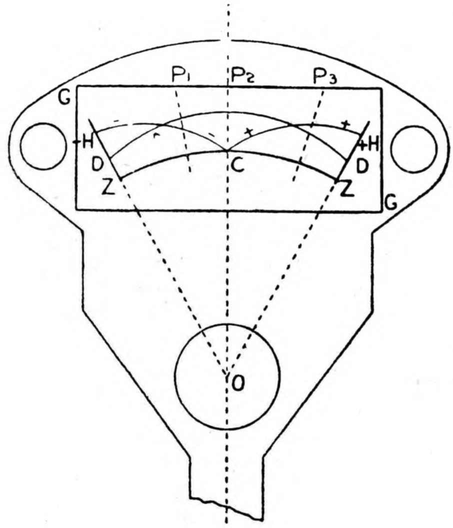


FIG. 2

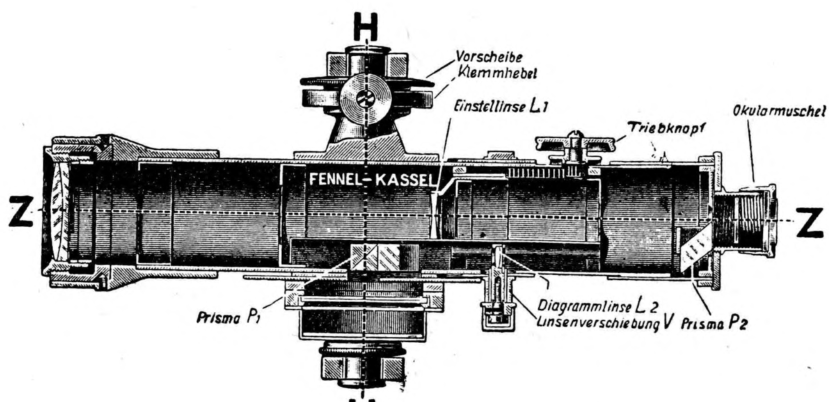


FIG. 3

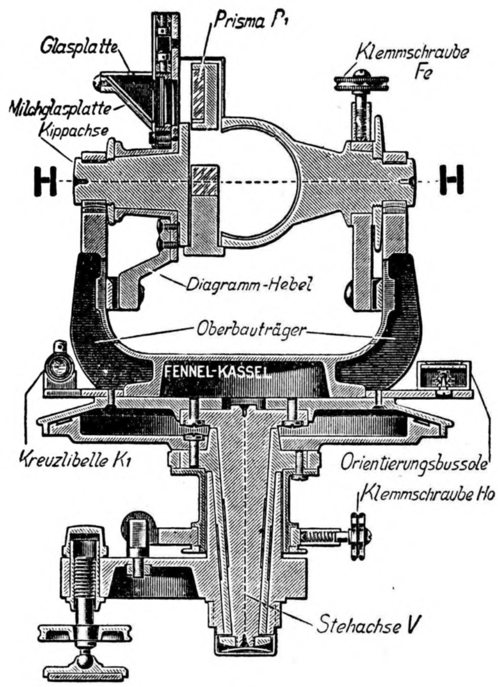


FIG. 4

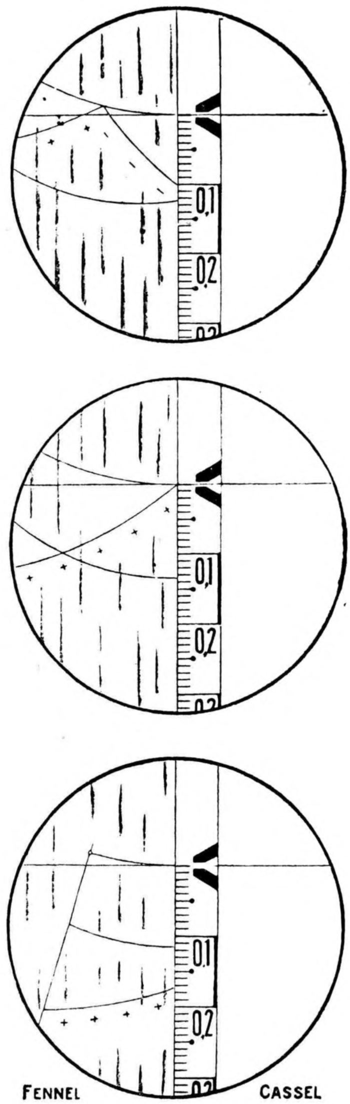


FIG 5

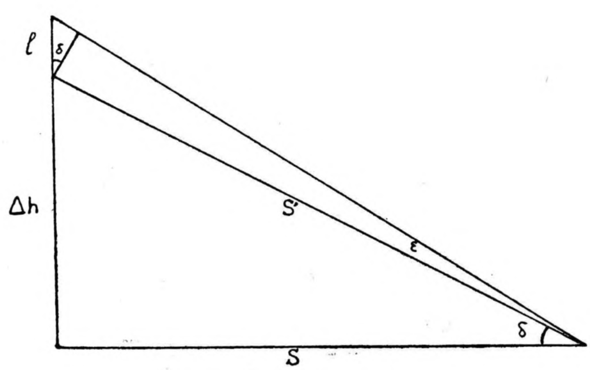


FIG. 6

The first view shown in Fig. 5 is taken to a depressed object. Here the distance-curve strikes the staff at 0.124 metres, which, multiplied by 100, at once gives the horizontal distance of the distant point, i. e. 12.4 metres. The — height-curve strikes at 0.100 m., which, multiplied by the constant factor 20, gives the difference of height, i. e. a depression of 2.00 m. In this case the vertical prism edge is indicated by the dotted line OP_1 in Fig. 2, the section of the diagram immediately to the right being visible in an inverted position in the telescope.

In the second view of Fig. 5, the telescope is truly horizontal, i. e. the distant point is at the same level as the instrument station, while the horizontal distance is 13.5 m. This position is indicated by the line OP_2 in Fig. 2, the point C now falling on the zero mark of the staff.

In the third view the right-hand end section of the diagram is seen in the telescope, the position of the vertical line being indicated by OP_3. The horizontal distance of the observed point is here 11.5 metres, and its elevation above the instrument station is $+ 0.173$ m. $\times 20 = 3.46$ m. It should be mentioned that a special staff, which has the zero graduation mark 1.4 m. from its base, is used with this instrument.

Thus this auto-reduction tacheometer is of simple design, and easy to read and manipulate. It only remains to enquire into the accuracy of its results. In JORDAN's *Handbuch der Vermessungskunde*, 8th ed., Vol. II, the limit of accuracy in distance is given as 1 in 300, and heights are obtained to within about 8 inches. The instrument, therefore, is not to be regarded as a precision tacheometer, but for certain classes of setting-out work and topographical surveying it is evidently a most convenient instrument, and will result in much saving of time and labour. The weight of the instrument is 12 ½ lbs, and with the tripod 22 lbs. Its price is 1250 Reichmarks.

In the ordinary tacheometer the distance of the two horizontal threads of the reticule corresponds generally to $\frac{1}{100}$ of the focal length of the object glass of the telescope.

If l is the length intercepted between them on the stadia scale, then we have (Fig. 6), with the usual notations:

$$S' = 100\, l \cos \delta$$
$$S = 100\, l \cos^2 \delta$$
$$\Delta h = 100\, l \cos \delta \sin \delta$$

In the HAMMER-FENNEL Tacheometer, curve DD of the diagram (Fig. 2) is the S-line; the broken curve $+HC$ and $-HC$, the Δh-line.

The line DD enables the $\frac{1}{100}$ of the horizontal distances to be read straight off on the staff for any inclination of the telescope included between $\pm 30^\circ$; the Δh-lines enable the $\frac{1}{20}$ of the difference of height Δh to be read straight off on the staff.

In general, in Fig. 6, we have

$$\frac{S'}{l} = \frac{\cos(\delta+\varepsilon)}{\sin \varepsilon}, \text{ whence}$$
$$\frac{S}{l} = \frac{\cos(\delta+\varepsilon)\cos\delta}{\sin\varepsilon}$$

In the case of horizontal graticule wires, angle ε is determined by the relation,

$$\tan \varepsilon = \frac{a}{f} = \frac{\text{linear value of the distance of the threads}}{\text{focal length of the object glass}}$$

whence $a = f \tan \varepsilon$

In the HAMMER-FENNEL Tacheometer the condition has been imposed that $S = k.\, l$, that is

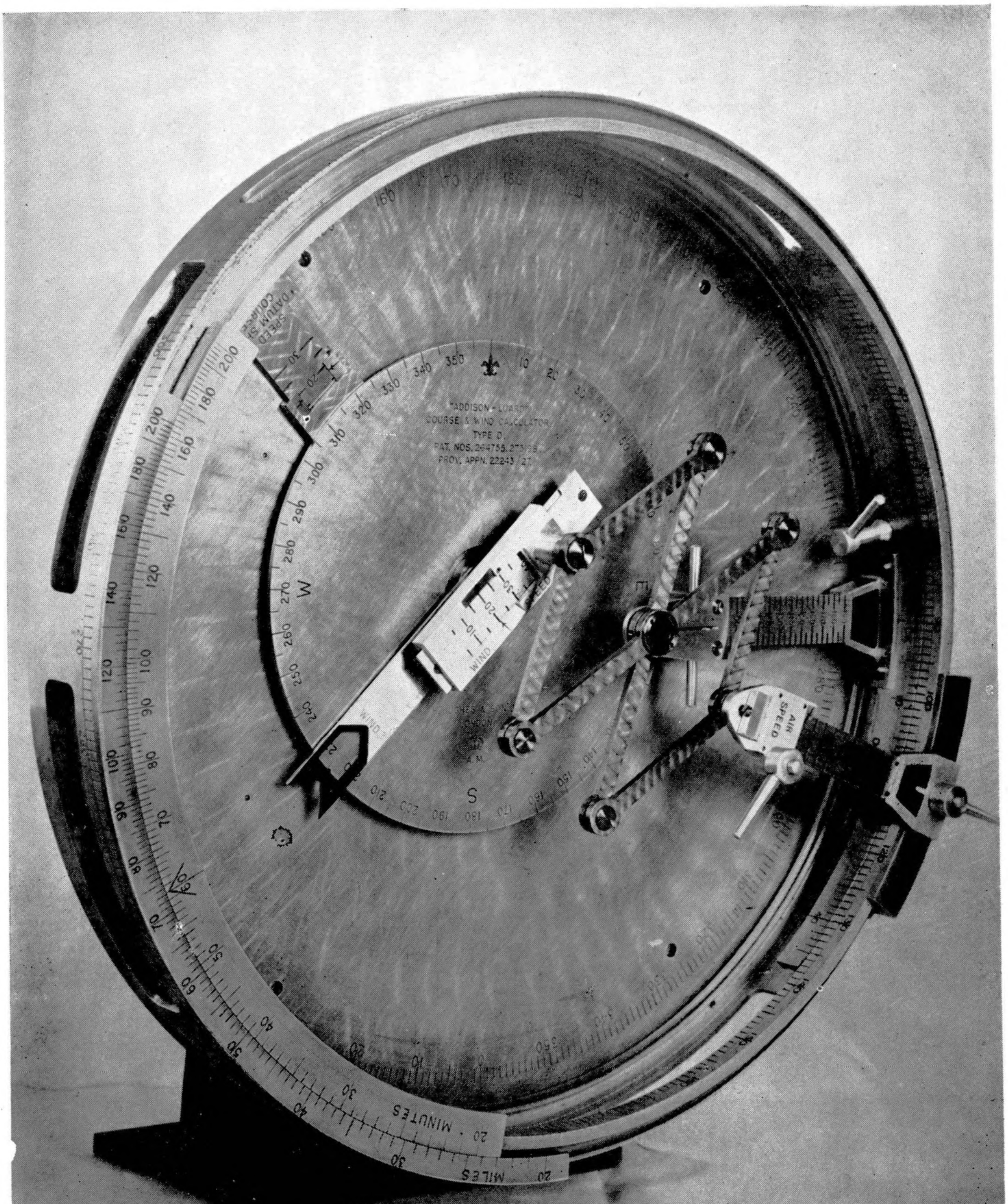
$$k = \frac{\cos(\delta+\varepsilon)\cos\delta}{\sin\varepsilon}$$

whence

$$\tan \varepsilon = \frac{\cos^2\delta}{k + \sin\delta\cos\delta}$$

and

$$a = \frac{\cos^2\delta}{k + \sin\delta\cos\delta} f \qquad (1)$$



The "Addison-Luard" Course and Wind Calculator Type "D"

Le Calculateur de la Route et du Vent "Addison-Luard" Type "D"

This formula gives, in terms of the inclination δ, the variable value of the distance to be given an imaginary thread of the reticule in order that the distance S remain proportional to the intercepted length on the staff.

On the other hand, in a general way, we have:

$$\Delta h = l \frac{\cos(\delta + \varepsilon) \sin \delta}{\sin \varepsilon}$$

and in the HAMMER-FENNEL Tacheometer the condition has been imposed that $\Delta h = k_1 l$

whence $$\tan \varepsilon_1 = \frac{\sin \delta \cos \delta}{k_1 + \sin \delta}$$

and $$a_1 = \frac{\sin \delta \cos \delta}{k_1 + \sin \delta} f \qquad (2)$$

This formula gives, in terms of the inclination δ (positive or negative), the variable value of the distance to be given an imaginary thread of the reticule in order that the difference of height Δh remain proportional to the length intercepted on the staff.

For the HAMMER-FENNEL Tacheometer Model No. A 350 the following values have been given the constants in equations (1) and (2).

$$f = 334.78 \text{ mm.}, \quad k = 100, \quad k_1 = 20$$

which give for a and a_1 numerical values which serve to make the graticular diagram of Fig. 2.

As a result of the swinging of the telescope about its horizontal axis O and of the eccentricity OC of the deflecting prism, the values of a and of a_1 must be protracted from circle ZZ of radius $OC = r$ which represents the zero.

Constructively we have taken $r = 30$ mm.

Curve DD (Fig. 2) is obtained by carrying from the centre O, for each inclination of δ, the vectors $r + a$ inclined by δ; and the $+HC$ and $-HC$ curves are obtained by carrying from the centre O the vectors $r + a_1$ inclined by $\pm \delta$ with reference to the vertical OC.

This construction is made on a large scale and then reduced by photography, in order to obtain the diagram of the reticule.

Through the agency of the reflecting prisms (Figs. 3 and 4), the image of the diagram becomes visible in the left half of the field of view. The whole of the right portion of the field remains available for sighting.

The missing vertical thread in the graticule plane of the HAMMER-FENNEL Tacheometer is replaced by the vertical edge of the prism P_2 (Fig. 4) which cuts sharply the image of the diagram in the eyepiece. It is brought into contact with the longitudinal edge of the staff.

The horizontal thread is replaced by the zero-curve ZZ at its point of intersection with the vertical separation. This point must be made to coincide with the zero on the staff, specially marked at exactly 1.4 m. from its base by means of 2 heavy short black lines inclined to one another and easily distinguishable.

The staff is 4 metres high when unfolded; it is provided with a spirit level, two handles and struts to help to hold it truly vertical.

The reader will find fuller information in Professor Georg SCHEWIOR's pamphlet entitled *Tachymeter Hammer-Fennel*, 66 pages, 57 illustr., Kassel, 1930.

THE "ADDISON-LUARD" COURSE AND WIND CALCULATOR TYPE "D".

This appliance is specially designed for use in transoceanic aircraft flying; by its means the navigator can solve all velocity triangles concerned with the effect of the wind on his machine without the necessity of actually plotting these triangles. If the wind is already known, the instrument immediately shows the relationship between Course, Air