March 25, 1924. 1,488,010

H. KOURKENE

SURVEYING TRANSIT

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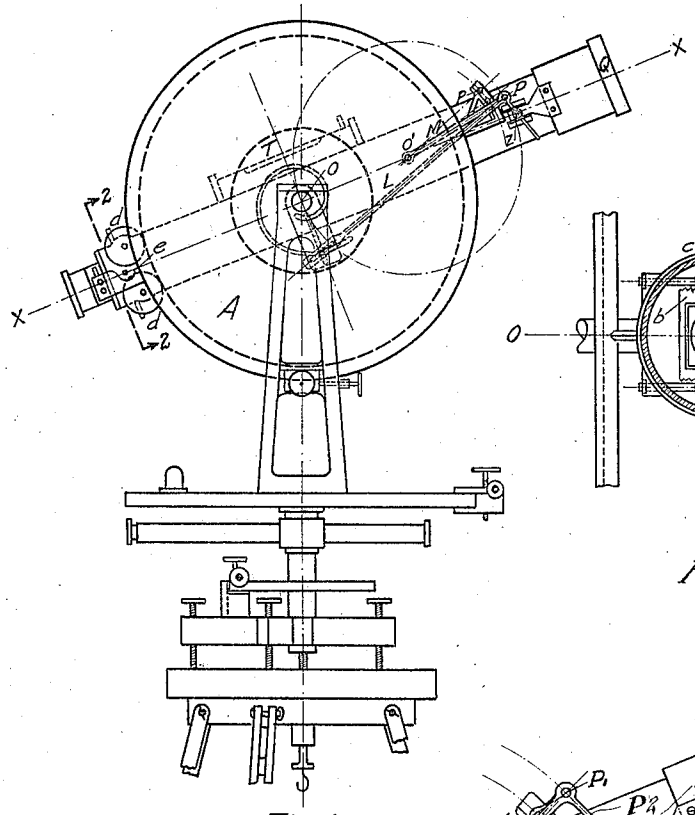


Fig. 1

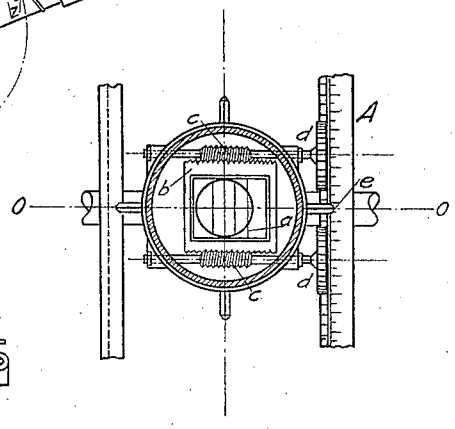


Fig. 2

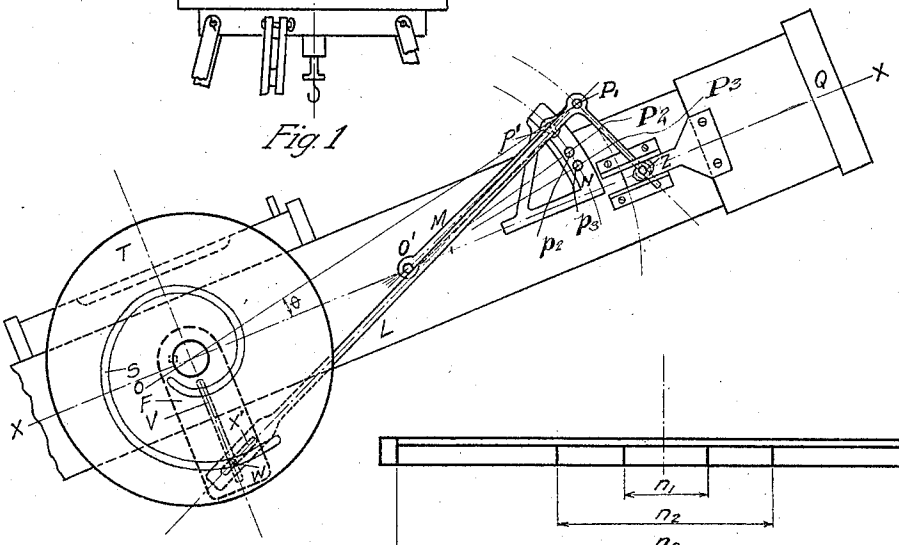


Fig. 3

Fig. 4

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UNITED STATES PATENT OFFICE.

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SURVEYING TRANSIT.

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To all whom it may concern:

Be it known that I, HAÏG KOURKENE, a citizen of the Republic of Armenia, residing at 40 Avenue Pasteur, Becon-les-Bruyeres, Seine, France, have invented a new and useful Surveying Transit Especially Adapted to the Accurate Determination of Distances, of which the following is a specification.

My invention relates to improvements in transits in which distances have been heretofore determined by applying fixed coefficients to lengths intercepted on a stadia rod between fixed cross hairs in the reticule, the intercepted lengths being estimated by eye and the focusing done by hand; the objects of my improvements being (1) to obtain much closer approximations of distances than heretofore obtainable by having fixed lengths on the rod intercepted between one movable and one fixed cross hair in the reticule, (2) to have the distances read directly on a circular disk forming part of the instrument itself and (3) to obtain automatic focusing thus eliminating the errors due to parallax and greatly reducing the fatigue to the instrument man.

The Kourkene transit, applying the general principles described below, is shown in the accompanying drawing in which:

Fig. 1 is a side elevation of the transit;

Fig. 2 is a cross section through the telescope along the line 2—2 Fig. 1, showing the reticule with its fixed and movable cross hairs and the mechanism by means of which the movable cross hair is controlled by the rotation of the large disk A.

Fig. 3 is a side view of the lever arm, the disk A being removed;

Fig. 4 is a front view of the surveying rod.

Similar letters refer to similar parts throughout the several views.

The Kourkene transit may be like customary transits in construction and application except for three points which are new and which form the basis of my invention:

1. *The reticule* (*Fig. 2*).—The reticule is equipped with one vertical and one horizontal cross hair as in the usual surveying instrument and in addition three stadia cross hairs (vertical in the present form) two fixed and the third movable (*a*). The movable cross hair is located on a carriage (*b*) which may be shifted laterally by the rotation of two long screws (*c*). These in turn are operated by two wheels (*d*) both in mesh with the large circular disk A.

2. *The large disk* (*A*).—The large disk which controls the position of the movable cross hair, rotates about the axis O on the two vertical supports just as does the telescope itself. The disk A, however, rotates independently of the telescope.

The relation between the diameters of the large disk (A) and of the small wheels (*d*) on the one hand, and the thread of the screws (*c*) controlling the movable cross hair (*a*) on the other, is such that the interval between the movable cross hair and the fixed stadia cross hair which is farthest away from it; stadia cross hairs is a known function of the angle α through which the disk (A) has been rotated from its origin. This origin is located on the telescope (at *e*) and marks the point from which the angle α of the disk is measured.

Distances are determined by rotating the disk (A) until the stadia cross hairs coincide with the extremities of a certain fixed length (n_1, n_2, or n_3) on the rod (Fig. 4) placed at the point whose distance from the instrument is desired. This distance is evidently a function of the resulting interval between the movable cross hair and the fixed cross hair farthest away from it and therefore also a function of the angle through which the disk has been rotated. In the particular instrument illustrated, it has been assumed that when α is equal to zero, the movable cross hair *a* coincides with the fixed stadia cross hair which is nearest the movable cross hair; in other words when α is equal to zero, the interval between the fixed stadia cross hairs (which interval I will designate as *h*) is equal to the interval between the movable cross hair and the fixed cross hair used for measuring on the surveying rod.

The disk (A) has been graduated according to the above principles so that the distance from the forward focal point of the objective is read directly on the disk opposite the index (*e*) on the telescope. To this reading is added the focal length of the objective and the distance from the objective

to the vertical axis of the instrument thus obtaining the true distance. This correction is constant practically.

The formula giving the relation between the distance to be determined and the angle α is as follows:

$$(1)\quad D=\frac{pn}{1+k\frac{\alpha}{\pi}} \text{ whence } \alpha=\frac{pn-D}{D}\frac{\pi}{k}$$

In which: f being the focal length of the objective and h the interval between the two fixed stadia hairs or, as explained above, the interval between the movable cross hair a and the measuring fixed hair when α is equal to zero,

$$p=\frac{f}{h}$$

n is the fixed distance intercepted on surveying rod.

D is the distance from the surveying rod to the forward focal point of the objective.

α is the angle through which the disk has been rotated in order that the stadia hairs (one fixed and one movable) shall coincide with the extremities of n.

k is a constant whose value will be given later.

It is evident that if $\alpha=0$ in formula (1), $D=pn$. For values of D less than pn, α will be positive and for values of D greater than pn, α will be negative. Negative values of α I call β. As the disk can not conveniently have more than one complete circle of graduations, it results that α and β will meet at some point on the disk and the graduations for their corresponding values of D will coincide at this point. These maximum values of α and β I call α_1 and β_1, and their corresponding values of D, I call D_1 and D_2.

Under these conditions the formulas for α_1, β_1 and k are as follows:

$$(2)\quad \alpha_1=\frac{2D_2(pn-D_1)}{pn(D_2-D_1)}\pi$$

$$(3)\quad \beta_1=\frac{2D_1(D_2-pn)}{pn(D_2-D_1)}\pi$$

$$(4)\quad k=\frac{pn(D_2-D_1)}{2D_2D_1}$$

From the formulas (1) to (4) the disk may be completely graduated. The value chosen for $\frac{D_2}{D_1}$ should preferably not be less than 2 nor greater than 3. If in formula (1), we designate the member $k\frac{\alpha}{\pi}$ as m, said formula is reduced to the simpler expression

$$(1^a)\quad D=\frac{pn}{1+m}$$

and this can be used for graduating the scale on the disk A. It may be added that the coefficient $\frac{\alpha}{\pi}$ is in direct ratio to the translation movement of the movable reticule member, and mh is the distance of translation of the movable cross hair (a). Therefore m is the ratio of the distance to which the movable reticule member a has been shifted, to the interval between the two fixed stadia hairs, or to the distance at which the fixed measuring reticule member is from the movable reticule member when the latter is in its original or zero position.

In order to measure values of D greater than D_2 or less than D_1 it is simply necessary to choose a new distance (n') on the rod and multiply the reading on the disk by the coefficient $\frac{n'}{n}$. It is evident therefore that the instrument is adapted to the determination of any distance within its focal range.

3. *Automatic focusing.*—The rotation of the disk (A) for the purpose of determining distances, at the same time causes a movement of translation in the objective Q such that the moment the cross hairs coincide with the extremities of n, the rod sighted is in perfect focus regardless of its distance from the instrument. This is obtained in the following manner.

In the steel plate T which is rigidly fastened to the disk (A) is cut a spiral of Archimedes S of which the equation is given below. In the plate F, which is attached to the telescope and rotates with it, is cut a slot V perpendicular to the axis about which the telescope rotates. A pin W slides in this slot V and in the spiral S.

The elbow lever L is fulcrumed at P and the pin W passes through the slot X′ situated at the extremity of its longer arm. The shorter arm of the lever which as shown is at right angles to the longer, passes through the pin Z which is journalled in the carriage containing the objective Q. In any event, such objective and the pin Z will move in unison lengthwise relatively to the body of the telescope. It results from this arrangement that the position of the objective with respect to the axis (O) of the telescope bearings on the supports and hence with respect to the reticule of the telescope, is determined by the position of the lever L which in turn is controlled by the disk A.

The spiral S is so calculated that when the disk A has been rotated through the angle α necessary to obtain the coincidence of the cross hairs in the reticule with the extremities of n on the rod, at that moment the position of the objective is such that the rays of light coming from the rod sighted will converge and therefore be focused on the plane of the reticule.

The equation of the spiral is:

$$(5)\quad Y=\frac{fh\left(1+k\frac{\alpha}{\pi}\right)}{n\tan\theta}$$

where:

Y is the distance from the axis O down to the spiral S measured perpendicular to the axis X—X of the telescope.

θ is the angle POX between the axis of the telescope and the line joining O and P.

f, h, k, and n, are the same as previously indicated and

α is the angle for which the formula is given in equation (1).

It is evident that if various values of n are used, the focusing will no longer be automatic unless tan θ vary accordingly such that Y will remain unchanged. In order to secure this condition, successive pivot points P_1, P_2, and P_3 are so chosen that $n_1 \tan\theta_1 = n_2 \tan\theta_2 = n_3 \tan\theta_3$.

In practice the position of the fulcrum P is controlled by placing said fulcrum on an arm M pivoted to the telescope body at a point O′ which is the center of the circle passing through O and P, the pivot axis O′ intersecting the optical axis of the telescope. The arm M, which serves for shifting the fulcrum P, and also as a guide for the lever L, is itself guided by the circular arc N secured rigidly to the body of the telescope and can be moved along this arc simply by turning a small pinion wheel (not shown in the drawing). This pinion would be journalled in the arm M and in mesh with teeth on the arc N. The arc is equipped with holes p_1, p_2, and p_3 and a pin pressed or controlled by a light spring and passing through M, is adapted to enter any one of these holes thus making M immovable with respect to the telescope. Whenever the arm M is thus locked to the telescope, P becomes fixed at a corresponding point the position of p_1, p_2, and p_3 being so calculated that P_1, P_2, and P_3 will have the required positions for the correct operation of the instrument.

The rod.—The rod preferably horizontal, is painted in visible and contrasting colors so that the various lengths of n (that is to say, n_1, n_2, or n_3) can be clearly distinguished through the telescope. A horizontal line is painted close to one edge for the purpose of sighting for determining altitudes. The rod is equipped with appropriate accessories, such as one or more tripods for support, a spirit level to keep it horizontal and a suitable attachment for enabling the rod man to place the rod perpendicular to the line of sight.

In the above specifications as well as in the accompanying drawing I have limited my description to an instrument the reticule of which is equipped with vertical stadia hairs requiring the use of a surveying rod placed horizontally over the point sighted. A very slight modification in the transmitting mechanism would be required if it were desired to use horizontal stadia hairs requiring a vertical rod. My invention therefore applies equally well to either system.

I claim:

1. An optical instrument mounted to swing about an axis transverse to its optical axis, and provided with a reticule member movable transversely to said optical axis, a member rotatable independently of said instrument about the axis on which said instrument swings, co-operating index features located on said rotatable member and on said instrument, and an operative connection from said rotatable member to said movable reticule member to shift the latter as said rotatable member is turned about the axis on which the instrument swings.

2. An optical instrument provided with a reticule member movable transversely to the optical axis of the instrument, an actuating member movable relatively to the instrument and operatively connected with the movable reticule member to shift the latter, and indicating means co-operating with said actuating member to indicate, for each adjustment of said actuating member and of the movable reticule member, the distance, measured along the optical axis of the instrument, from an optical point of such instrument to a sighted object of known size, whatever position such optical axis may occupy relatively to the horizontal.

3. An optical instrument provided with a reticule member movable transversely to the optical axis of the instrument, actuating mechanism for shifting said movable reticule member, said actuating mechanism including a rotary member, and indicating means co-operating with said rotary member, to indicate, for each adjustment of said rotary member and of the movable reticule member, the distance, measured along the optical axis of the instrument, from an optical point of said instrument to a sighted object of known size, whatever position such optical axis may occupy relatively to the horizontal.

4. An optical instrument provided with a reticule having two fixed members and a member movable transversely of the optical axis of the instrument, actuating mechanism for shifting said movable reticule member, and indicating means co-operating with said actuating mechanism, said indicating means including a scale graduated according to the formula

$$D=\frac{pn}{1+m},$$

where D are the graduation numbers indi-

cating the distance from an optical point of the instrument to a surveying rod or other sighted object of known dimensions, p is the ratio of the focal length of the objective of the instrument to the distance between the two fixed reticule members, n is the fixed distance intercepted on the surveying rod or other sighted article of known dimensions, and m is the ratio of the distance through which the movable reticule member has been shifted by said actuating mechanism, to the distance between the two fixed reticule members.

5. An optical instrument provided with a reticule having two fixed members and a member movable transversely of the optical axis of the instrument, actuating mechanism for shifting said movable reticule member, said mechanism having a rotary operating member, and indicating means co-operating with said rotary operating member, said indicating means including a scale graduated according to the formula

$$D = \frac{pn}{1 + k\frac{\alpha}{\pi}},$$

where D are the graduation numbers indicating the distance from an optical point of the instrument to a surveying rod or other sighted object of known dimensions, p is the ratio of the focal length of the objective of the instrument to the distance between the two fixed reticule members n is the fixed distance intercepted on the surveying rod or other sighted article of known dimensions, k is a constant for each particular instrument, and α is the angle through which said rotary operating member has been rotated in order to bring the movable reticule member and one of the fixed reticule members to coincide with the extremities of said intercepted distance n.

6. An optical instrument provided with a reticule having a fixed measuring member and a member movable transversely of the optical axis of the instrument, actuating mechanism for shifting said movable reticule member, and indicating means co-operating with said actuating mechanism, said indicating means including a scale graduated according to the formula

$$D = \frac{pn}{1 + m},$$

where D are the graduation numbers indicating the distance from an optical point of the instrument to a surveying rod or other sighted object of known dimensions, p is the ratio of the focal length of the objective of the instrument to the distance at which the said fixed measuring reticule member is from the movable reticule member when the latter is in its original or zero position, n is the fixed distance intercepted on the surveying rod or other sighted object of known dimensions, and m is the ratio of the distance through which the movable reticule member has been shifted by said actuating mechanism, to the distance at which said fixed measuring reticule member is from the movable reticule member when the latter is in its original or zero position.

7. An optical instrument provided with a reticule having a fixed measuring member and a member movable transversely of the optical axis of the instrument, actuating mechanism for shifting said movable reticule member, said mechanism having a rotary operating member, and indicating means co-operating with said rotary operating member, said indicating means including a scale graduated according to the formula

$$D = \frac{pn}{1 + k\frac{\alpha}{\pi}},$$

where D are the graduation numbers indicating the distance from an optical point of the instrument to a surveying rod or other sighted object of known dimensions, p is the ratio of the focal length of the instrument to the distance at which said fixed measuring reticule member is from the movable reticule member when the latter is in its original or zero position, n is the fixed distance intercepted on the surveying rod or other sighted object of known dimensions, k is a constant for each particular instrument, and α is the angle through which said rotary operating member has been turned when the said fixed measuring reticule member and said movable reticule member coincide with the extremities of said intercepted distance n.

8. An optical instrument having an objective and a measuring reticule relatively movable to different distances from each other, said reticule having a member movable transversely of the optical axis of the instrument, and an operative connection by which the transverse movement of said reticule member is caused to be simultaneous with a variation of the distance between the objective and the reticule.

9. An optical instrument of variable focus provided with a reticule member movable transversely to the optical axis of the instrument, and a focusing device operatively associated with said movable member.

10. An optical instrument having an objective adjustable lengthwise of the instrument's optical axis, a measuring reticule having a member movable transversely to the said axis, and an operative connection between said member and said objective to vary the distance between the reticule and the objective in harmony with the adjustment of said member.

11. An optical instrument having an objective adjustable lengthwise of the instrument's optical axis, a measuring reticule having a member movable transversely to the said axis, a rotary member having a guide formed according to a spiral of Archimedes, a guide carried by the instrument and extending toward the center of said spiral guide, a lever fulcrumed on the instrument and having a pin engaged by both of said guides, a connection from said lever to said objective to shift the latter, and an operative connection between said rotary member and the movable reticule member.

12. An optical instrument having an objective adjustable lengthwise of the instrument's optical axis, a measuring reticule having a member movable transversely to said axis, a support on which said instrument is mounted to swing, a rotary member connected operatively with said movable reticule member and mounted to turn about the same axis about which the instrument swings, but independently of said instrument, a guide extending on the instrument radially from the axis of said swinging movement, at right angles to the optical axis of the instrument, a guide located on said rotary member and curved according to a spiral of Archimedes having its center upon said axis of the swinging movement, and a connection, controlled by both of said guides, for shifting the objective when said rotary member is turned relatively to the instrument.

13. An optical instrument having an objective adjustable lengthwise of the instrument's optical axis, a measuring reticule having a member movable transversely to said axis, a rotary member having a spiral guide, a guide carried by the instrument and extending at an angle to said spiral guide, a lever fulcrumed on the instrument and having a pin engaged by both of said guides, a connection from said lever to said objective to shift the latter, and an operative connection between said rotary member and the movable reticule member.

14. An optical instrument having an objective adjustable lengthwise of the instrument's optical axis, a measuring reticule having a member movable transversely to said axis, a support on which said instrument is mounted to swing, a rotary member connected operatively with said movable reticule member and mounted to turn about the same axis about which the instrument swings, but independently of said instrument, a guide extending on the instrument in a direction receding from the axis of said swinging movement, another guide located on said rotary member and likewise receding from said axis, and a connection, controlled by both of said guides, for shifting the objective when the said rotary member is turned relatively to the instrument.

15. An optical instrument having an objective adjustable lengthwise of the instrument's optical axis, a measuring reticule having a member movable transversely to said axis, and a lever fulcrumed on said instrument and having operative connections with said movable reticule member and with said adjustable objective, the said fulcrum being movable to different positions to vary its action.

16. An optical instrument having an objective adjustable lengthwise of the instrument's optical axis, a measuring reticule having a member movable transversely to said axis, a lever fulcrumed on said instrument and having operative connections with said movable reticule member and with said adjustable objective, said fulcrum being adjustable to a plurality of definite different positions, to vary the action of the lever, and a surveying rod or the like having thereon a plurality of sets of indications, each set corresponding to one of the adjustments of said lever fulcrum.

Nice, March 20th, 1922.

HAÏG KOURKENE.