O. EPPENSTEIN & F. ECKARDT.

TELEMETER.

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**1,107,503.**

Patented Aug. 18, 1914.

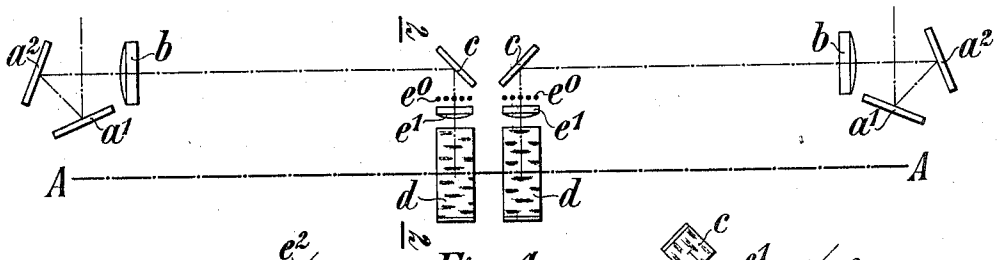



Fig. 1

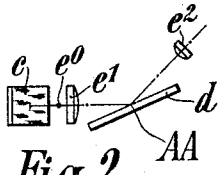



Fig. 2

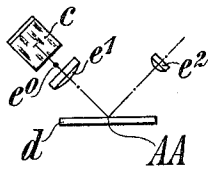



Fig. 3

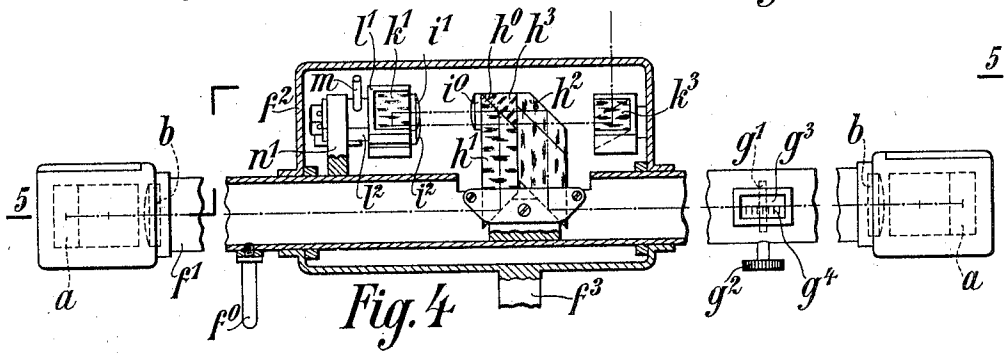



Fig. 4

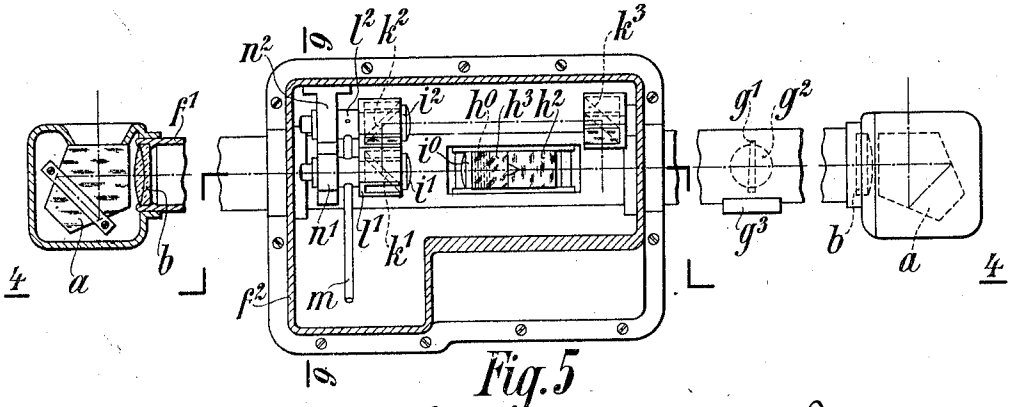



Fig. 5

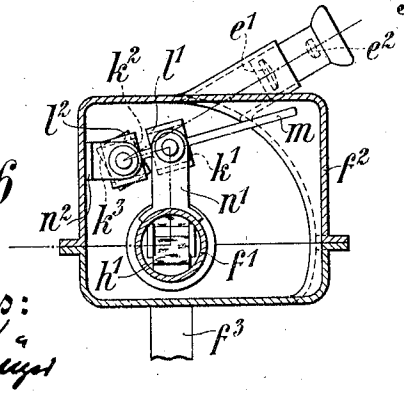



Fig. 6

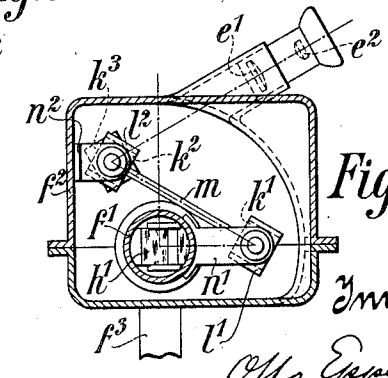



Fig. 7

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## TELEMETER.

1,107,503. Specification of Letters Patent. Patented Aug. 18, 1914.

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*To all whom it may concern:*

Be it known that we, OTTO EPPENSTEIN and FRIEDRICH ECKARDT, citizens of the German Empire, residing at Jena, Germany, have invented a new and useful Telemeter, of which the following is a specification.

The present invention relates to horizontal telemeters, in which the base-line employed, when ranges are being taken, belongs to the instrument. In the well-known telemeters of this type, when altering the elevation, the whole instrument is rotated in about an axis parallel to the base-line, so that the direction of the emerging rays (the direction of inspection) is altered along with the direction of the entering rays and by the same angle as the latter. In the new telemeter the direction of inspection is fixed and only the direction of the entering rays is variable in elevation. For this purpose the two objective reflecting systems are jointly rotatable in the plane perpendicular to the base-line. In order, however, to prevent the position of the images presented to the observer being influenced by the rotation of the objective reflecting systems, a compensating reflecting system is disposed behind these systems and is coupled to them in such a manner that it rotates through half as great an angle as the said systems. This may be effected by means of gearing or other well-known coupling means. The alteration in the position of the images presented to the observer, which is to be obviated by the said compensating system, consists in a displacement of these images each in its plane such displacement being perpendicular to the base-line, in so far as an intermediate reflecting system is jointly rotatable with the two objective reflecting systems, which permits the axial rays to emerge in a direction perpendicular to the base-line. When only the two objective reflecting systems are jointly rotatable, or when the intermediate reflecting system, while it participates in the rotation, permits the axial rays to emerge in the direction of the base-line, the alteration in the position of the images presented to the observer, which is to be obviated, consists in a rotation of these images each in its plane. Where the compensating system is to obviate such a rotation of the images in a coincidence telemeter, *i. e.* where the intermediate reflecting system is a separating prism system, the compensating system must be disposed in such a place that besides the said rotation of the single images a rotation of the line of coincidence in the plane of the images is also obviated; therefore, when the separating prism system is jointly rotatable with the objective reflecting systems, the compensating system must lie behind it, otherwise in front of it. The compensating system of a stereoscopic telemeter must consist of two part-systems, through each of which passes one of the two systems of ray-pencils coming from the objectives; the same holds good for the compensating system of a coincidence telemeter, when the said system lies in front of the separating prism system. The possibility of losing the adjustment of the instrument, when the objective reflecting systems are rotated, is lessened, by letting the intermediate reflecting system take part in the joint rotation of the two objective reflecting systems. The construction of the instrument is simplified, when the compensating system is disposed behind the intermediate reflecting system; in this case it must be rotatable about an axis parallel to the base-line and in the same sense as the objective reflecting systems. If the intermediate reflecting system be then formed in such a manner that it will permit the axial ray to emerge in the direction of the base-line and at some distance from the axis of rotation of the objective reflecting systems, gearing or similar means of coupling for causing the rotation of the compensating system through half the angle of rotation of the objective reflecting systems can be dispensed with, if the axis of rotation of the compensating system be caused to coincide with the axial ray emerging from this system and be given the same distance from the axis of rotation of the objective reflecting systems as is given to the axial ray emerging from the intermediate reflecting system. For when in such a case the compensating system consists of two system-parts disposed one behind the other, which each deflect the axial ray by 90° in one and the same plane and the front one of which is guided in the direction of the axial ray passing from it to the rear system part, and when the front system-

part is connected with the intermediate reflecting system so as to be rotatable about the axial ray emerging from the latter, the compensating system rotates during a rotation of the objective reflecting systems in the same sense as the latter and through half as great an angle.

In the annexed drawing: Figures 1 to 3 show the optical system of a stereoscopic telemeter according to the present invention. Fig. 1, in which the eye-lenses of the oculars are not shown, being a plan view with the objective reflecting systems so disposed as to permit the rays to enter the instrument in a horizontal direction, Fig. 2 a corresponding section on line 2—2 of Fig. 1 and Fig. 3 a similar section, belonging, however, to such a position of the objective reflecting systems that the rays entering the instrument are inclined downward. Figs. 4 to 7 are views of a constructional example of the telemeter according to the present invention, showing a coincidence telemeter, in the image-field of which the single image lying below the line of coincidence is inverted. In this example, Fig. 4 is an elevation partly in section along line 4—4 of Fig. 5, Fig. 5 a plan view, also partly in section, along line 5—5 of Fig. 4, and Figs. 6 and 7 cross sections on line 6—6 of Fig. 5. Fig. 6 corresponds to the position of the movable parts as shown in Figs. 4 and 5, where the rays enter the instrument in the horizontal direction, and Fig. 7 shows the same parts disposed for a vertical entrance of the rays.

In the first example, Fig. 1, behind the two optical squares $a^1$, $a^2$, which in this case form the objective reflecting systems, the objective lenses $b$ are disposed. Two reflectors $c$ form an intermediate reflecting system, which allows the axial rays to emerge in a direction perpendicular to the base-line. Each ocular is formed as an angled ocular with the aid of a mirror $d$ lying between the field-lens $e^1$ and the eye-lens $e^2$ and having its reflecting surface parallel to the base-line and contains in the front focal plane a measuring mark system $e^0$. All parts lying in front of the reflectors $d$ are assumed to be rotatable jointly with the objective reflecting systems, while the two reflectors $d$ forming in this case the compensating system are to be jointly rotatable and the eye-lenses $e^2$, which allow the rays to emerge in an inclined direction, are to be rigidly connected with the carrier of the telemeter. A straight line A A lying in the common reflecting plane of the reflectors $d$ is assumed as the axis of rotation of the parts, which are jointly rotatable with the objective reflecting systems. The reflectors $d$ are to be also rotatable about the same axis, provision being made, *e. g.* by suitably disposed gearing, for these reflectors to rotate in the same sense and through half as great an angle as the objective reflecting systems. In consequence of this arrangement the axial rays behind the reflectors $d$ coincide, in every position of the objective reflecting systems, with the axes of the eye-lenses, so that a displacement in their planes of the images presented to the observer will be obviated.

In the second example the two pentagonal prisms $a$, which form the objective reflecting systems, and the objective lenses $b$ lying behind them are rigidly fixed to a tube $f^1$, which is journaled in a casing $f^2$ in such a manner that it can be rotated about its axis by means of a handle $f^0$. A pivot $f^3$ on this casing serves for inserting the instrument in a tripod head. A glass wedge $g^1$, gearing $g^2$ for displacing the said wedge in the axial direction of the tube $f^1$ and a scale $g^4$ behind a window $g^3$ indicate the measuring device. The separating prism system $h^1$, $h^2$, $h^3$, in which the upper half of the cement layer between $h^1$ and $h^3$ is replaced by a separating layer $h^0$, which is reflecting on both sides, lets the axial ray emerge in the direction of the base-line and is also rigidly fixed to the tube $f^1$, so as to be rotatable jointly with the objective reflecting systems. The mixed ray-pencil system emerging from the separating prism system in the direction of the base-line is received by a collective lens $i^0$ and is transmitted by means of a reversing lens system, between the two members $i^1$ and $i^2$ of which the rays forming a pencil are parallel to one another, and three simple reflecting prisms $k^1$, $k^2$ and $k^3$, each of which deflects by 90°, to the ocular system $e^1$, $e^2$, from which the axial ray emerges in an upwardly inclined direction. The two prisms $k^1$ and $k^2$, which deflect the axial ray in one and the same plane and in the same sense, form in this case the compensating system. The prism $k^1$, which forms the front system-part, can slide by means of a hole in its mounting $l^1$ on a pin $m$, which is fixed to the mounting $l^2$ of the prism $k^2$ forming the rear system-part, so that the prism $k^1$ is guided in the direction of the axial ray passing from it to the prism $k^2$. The prism mounting $l^2$ is journaled in a bearing $n^2$ fixed to the casing $f^2$, the axis of which bearing coincides with the axial ray emerging from the prism $k^2$, so that the compensating system is rotatable about the axial ray emerging from it. Its axis of rotation and the axial ray emerging from the separating prism system are equidistant from the axis of the tube $f^1$. For coupling the compensating system with the objective reflecting systems there is fixed to the tube $f^1$ a bearing $n^1$, in which the prism mounting $l^1$ is rotatable, and the axis of which coincides with the axial ray emerging from the separating prism system. On the tube $f^1$ being rotated the prism $k^1$ slides on its guide and the compensating system rotates through an

angle, which—as a simple geometrical consideration will show—is half as great as the angle of rotation of the tube $f^1$, so that a rotation in its plane of the double image presented to the observer is obviated.

We claim:

1. Horizontal telemeter comprising an ocular system, two objective reflecting systems, means for rotating the said objective reflecting systems jointly about an axis parallel to the base-line, the axis of emergence of the said ocular system being adapted to maintain a fixed direction during such rotation, two objective systems disposed behind the said objective reflecting systems, an intermediate reflecting system and a compensating reflecting system, these two latter systems being also disposed behind the said objective reflecting systems, a measuring device and means for coupling the said objective reflecting systems and the said compensating system, these means being adapted to transmit half the rotation of the objective reflecting systems to the compensating system.

2. Horizontal telemeter comprising an ocular system, two objective reflecting systems, means for rotating the said objective reflecting systems jointly about an axis parallel to the base-line, the axis of emergence of the said ocular system being adapted to maintain a fixed direction during such rotation, two objective systems disposed behind the said objective reflecting systems, an intermediate reflecting system disposed behind the said objective reflecting systems and adapted to rotate about an axis parallel to the base-line through the same angle and in the same sense as the latter systems, a compensating reflecting system disposed behind the said intermediate system and adapted to rotate about an axis parallel to the base-line and in the same sense as the said other reflecting systems, a measuring device and means for coupling the said objective reflecting systems and the said compensating system, these means being adapted to transmit half the rotation of the objective reflecting systems to the compensating system.

3. Horizontal telemeter comprising an ocular system, two objective reflecting systems, means for rotating the said objective reflecting systems jointly about an axis parallel to the base-line, the axis of emergence of the said ocular system being adapted to maintain a fixed direction during such rotation, a measuring device, two objective systems disposed behind the said objective reflecting systems, an intermediate reflecting system disposed behind the said objective reflecting systems and adapted to rotate about an axis parallel to the base-line through the same angle and in the same sense as the latter systems and to let the axial ray emerge in the direction of the base-line and at some distance from the axis of rotation of the objective reflecting systems, a compensating reflecting system disposed behind the said intermediate system and adapted to rotate about the axial ray emerging from the said compensating system in the same sense as the said other reflecting systems, the axis of rotation of the said compensating system having the same distance from that of the said objective reflecting systems as the axial ray emerging from the said intermediate system, the said compensating system consisting of two system-parts disposed one behind the other and adapted each to deflect the axial ray through 90° in one and the same plane, a guiding member, on which the front system-part is guided in the direction of the axial ray passing from it to the rear system-part, connecting means between the said front system-part and the said intermediate system, adapted to render the former rotatable about the axial ray emerging from the latter.

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