

CROSS REFERENCE

Aug. 2, 1932.

K. PETSCHENIG

1,869,502

APPARATUS FOR MECHANICALLY SOLVING RECTANGULAR TRIANGLES

Filed June 3, 1929

5 Sheets-Sheet 1

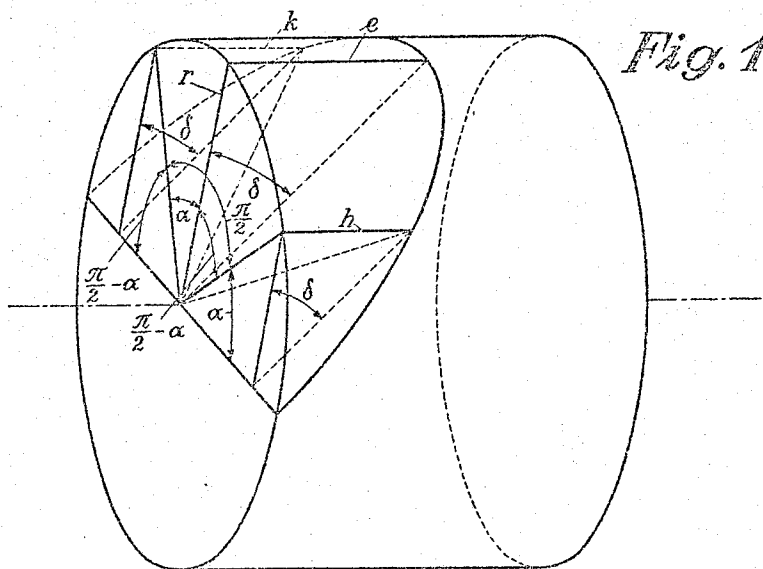


Fig. 1

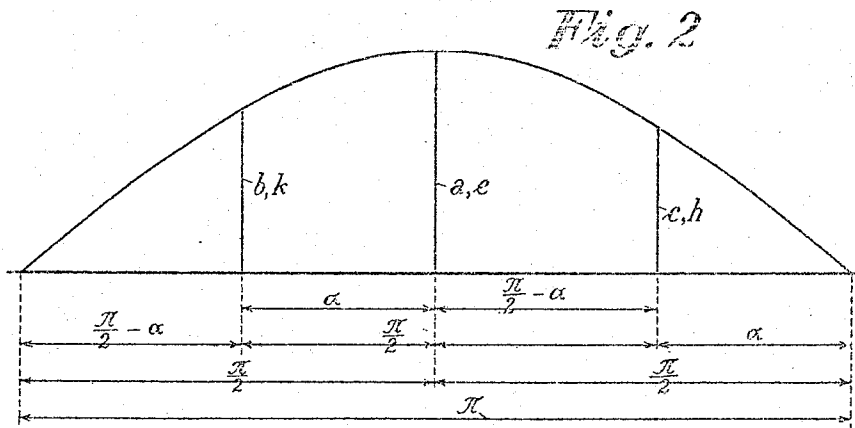


Fig. 2

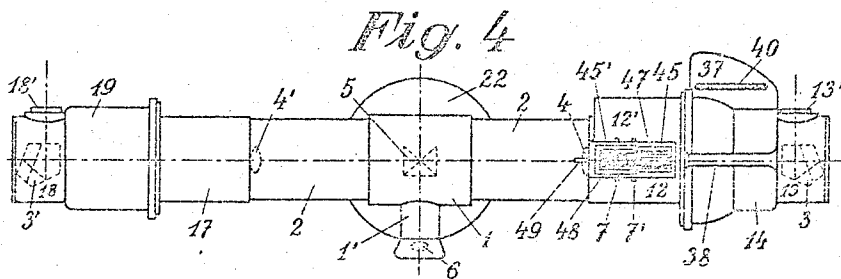


Fig. 4

INVENTOR

Karl Petschenig

by

L. P. Perry, C. A. & L. P. Perry

Att. 45

Aug. 2, 1932.

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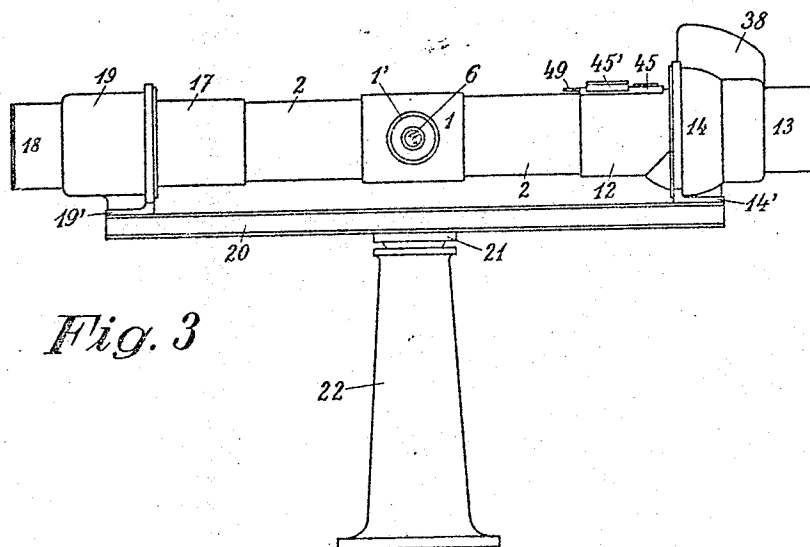
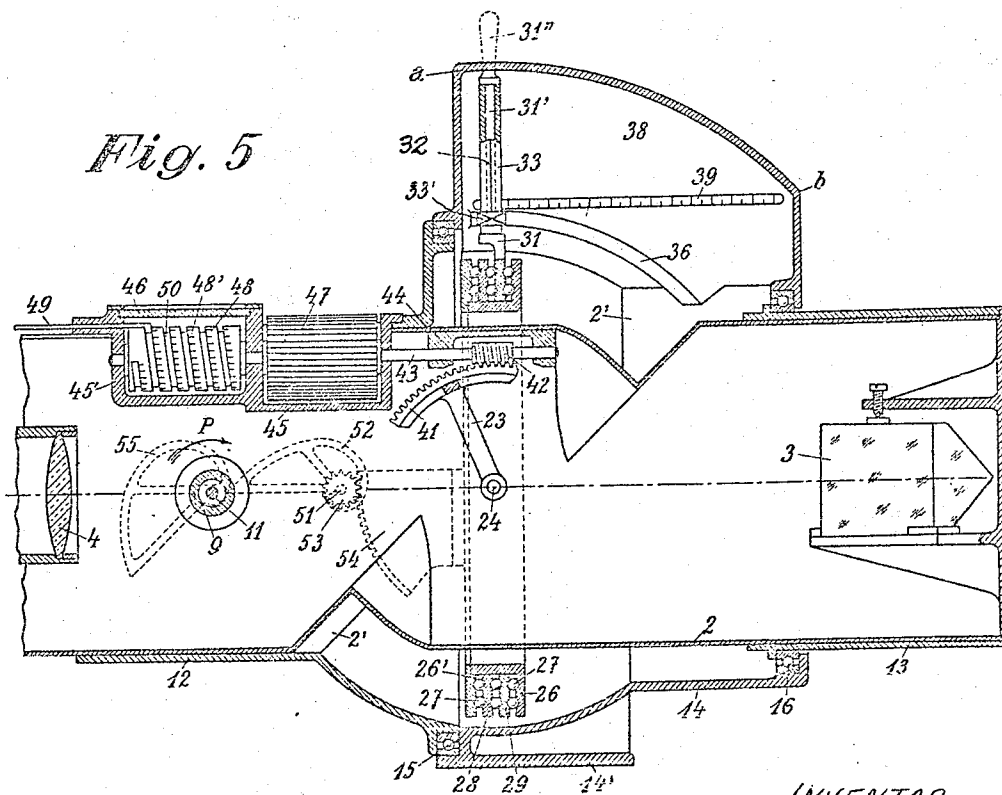


Fig. 3



INVENTOR.

Karl Fetschenig

Layzell Pass, Card + Lamm
64
Att '45

Att 45

Aug. 2, 1932.

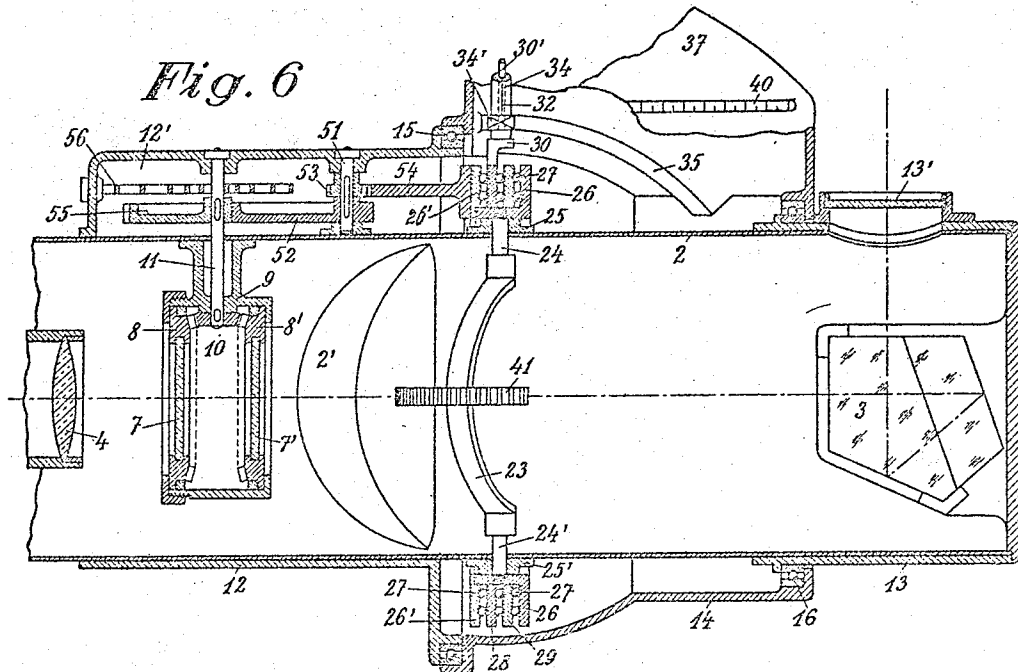
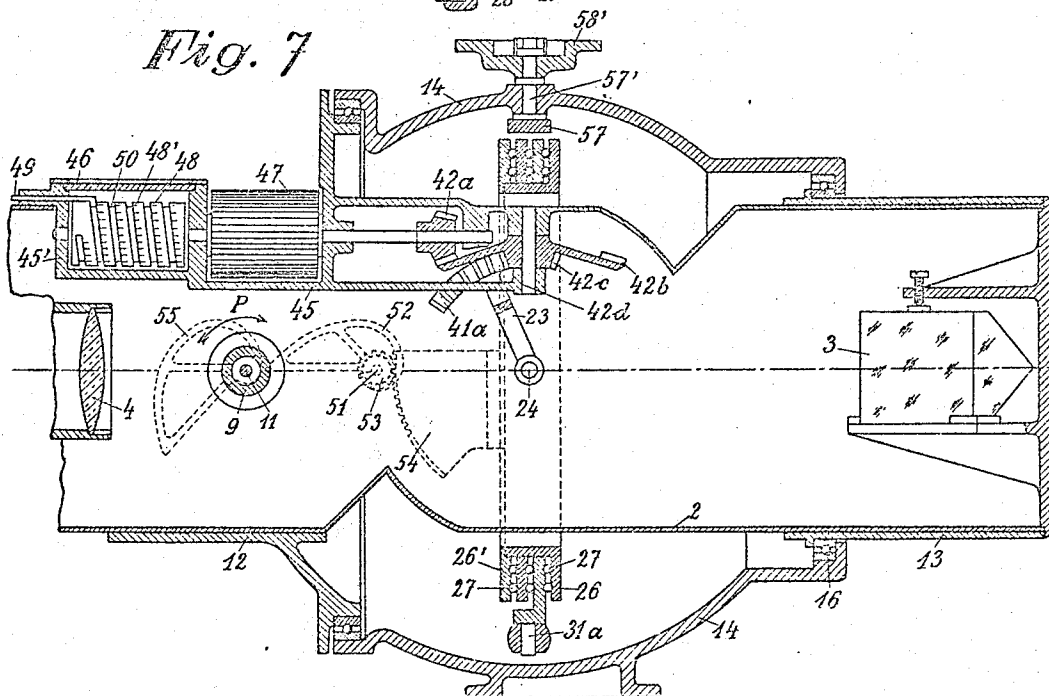
K. PETSCHENIG

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INVENTOR

Kari Petschenig

64

By *August Papp* *Carl & Papp*
Attys

Aug. 2, 1932.

K. PETSCHENIG

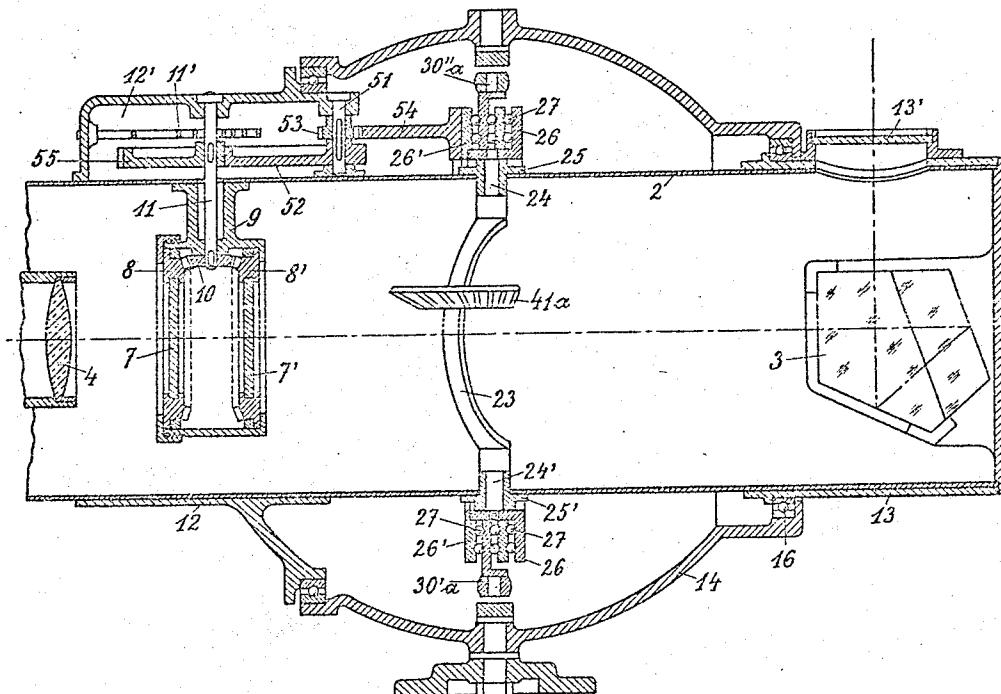
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Fig. 8



INVENTOR.

Karl Petschenig

64
Raymond P. Pavy, Carl & Lauger
Att'ys

Aug. 2, 1932.

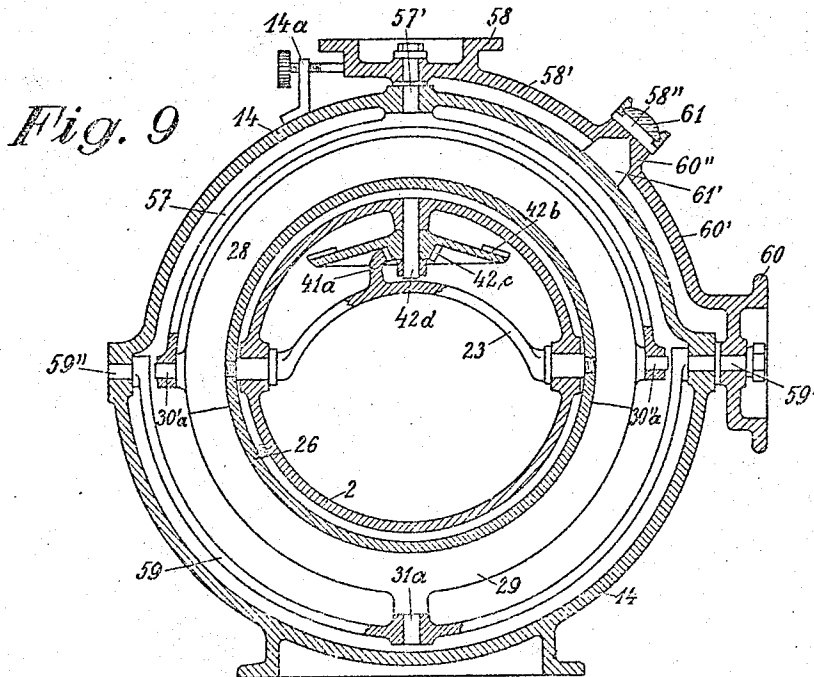
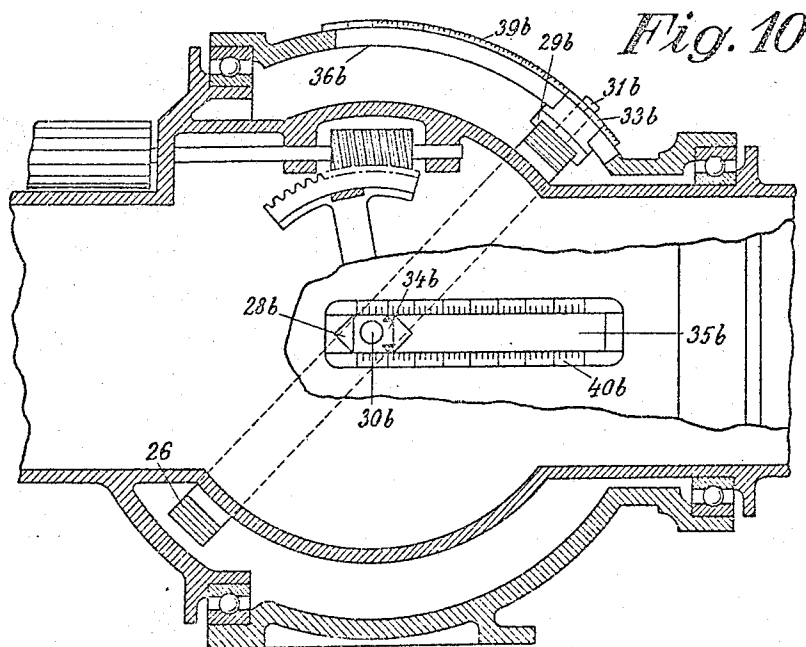
K. PETSCHENIG

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5 Sheets-Sheet 5



INVENTOR
Karl Petschenig
by
Langner Pany Card & Langner
ATT'YS.

UNITED STATES PATENT OFFICE

KARL PETSCHENIG, OF VIENNA, AUSTRIA, ASSIGNOR TO THE FIRM: AKTIENGESSELLSCHAFT C. P. GOERZ OPTISCHE ANSTALT, AKCIOVA SPOLECNOST K. P. GOERZ OPTICKÝ ÚSTAV, OF BRATISLAVA, CZECHOSLOVAK REPUBLIC

APPARATUS FOR MECHANICALLY SOLVING RECTANGULAR TRIANGLES

Application filed June 3, 1929, Serial No. 367,952, and in Germany June 7, 1928.

The invention relates to a range finder and has for its object to provide a range finder which will give not only the range itself, but also its horizontal and vertical projections, that is to say the horizontal distance of the target from the point of observation and the linear height of the target above the level of the point of observation or at least one of these projections. With this object in view the present invention consists in a novel attachment to a range finder hereinafter more fully set forth, reference being had to the annexed drawings in which Figs. 1 and 2 are diagrams, serving for explaining the geometrical principle on which the present invention is based. Fig. 3 is a side elevation and Fig. 4 a plan view of a first embodiment of the invention. Fig. 5 is a vertical and Fig. 6 a plan section of parts of the embodiment shown in Figs. 3 and 4. Figs. 5 and 6 are drawn on a larger scale. Fig. 7 is a vertical section of a second embodiment of the present invention. Fig. 8 is the plan section corresponding to Fig. 7, Fig. 9 is a transverse section of Figs. 7 and 8 and Fig. 10 is a vertical section of a part of a third embodiment of the present invention.

Let us assume that the range finder is directed to the target, its axis being horizontal and the straight line from the point of observation to the target being perpendicular to this horizontal axis and let us further assume that the axis of the range finder is the axis of a cylinder having a circular base of the radius r as shown in perspective in Fig. 1. The line of intersection of a plane passing through a diameter of the base circle of the said cylinder at an angle δ with this base circle in an ellipse, the lengths h and k of generatrices of the cylinder between points of the base circle and the ellipse depend not only of the angle δ but also of the angle α between the radius of the selected point of the base circle and the diameter common to the base circle and the ellipse the

equation being $h=r \sin \alpha \tan \delta$. The length k of the generatrix from the end of a radius perpendicular to the radius corresponding to the generatrix h is defined by the equation

$$k=r \sin \left(\alpha + \frac{\pi}{2} \right) \tan \delta = r \cos \alpha \tan \delta.$$

The length e of the generatrix between the base circle and the ellipse, the radius of this generatrix being perpendicular to the diameter of intersection of the base circle and the ellipse is defined by $e=r \tan \delta$. If now e is proportioned to the distance of the target from the point of observation then we have $H=e \sin \alpha$, $h=e \cos \alpha$, that is to say the length h represents the projection of the distance e on the radial plane passing through the radius of the generatrix k while the length k represents the projection of the distance e on the radial plane of the generatrix h . If now the radial planes of the generatrices h and k are permanently horizontal and vertical respectively, then the length h represents the linear height of the target above the level of the point of observation while the length k represents the horizontal distance of the target from the point of observation. Fig. 2 shows a development of the cylindrical surface into the plane of the drawings. The ellipse appears as a sine curve with the base circle as the abscissæ axis. The maximum ordinate of the sine curve is a , $e=r \tan \delta$ while the ordinates l , k and e , h of the sine curve corresponding to the angles α and

$$\frac{\pi}{2} - \alpha$$

are $e \sin \alpha$ and $e \cos \alpha$ respectively and $a^2 + b^2 = e^2$.

Assuming now that the base circle of the cylinder Fig. 1 is a ring rotatable around a diameter directed to the target and further assuming that this ring is turned around the said diameter through an angle δ , the ring

being so deformable that it can be transformed into a plane ellipse in the cylindrical surface, and assuming moreover that $r \tan \delta = e$ is proportional to the distance of the target from the point of observation and that the radial plane of the generatrix h is horizontal and the radial plane of the generatrix k is vertical then the length h directly gives the horizontal distance and the length k the linear height of the target. Nothing is changed in this respect if the ring representing the base circle of the cylinder in Fig. 1 is not deformable but rigid. The axial excursions of the outer ends of h and k are again in the ratio of $\sin \alpha$ to $\cos \alpha$, only the excursion e is changed into $r \tan \delta$.

Of course both or only one of the lengths h and k may be read on suitable scales. Similarly other sectors, for instance the instantaneous speed of a point moving in space may be decomposed into components perpendicular to each other and the values of these components may be found provided the absolute value of this speed and its direction be given.

The range finder Figs. 3 to 6, selected as an example of embodiment of the invention has a tubular casing 2 provided with a sleeve and an eyepiece attachment 1', the optical parts, two entering prisms 3 and 3' for the pencils of light, two objectives 4 and 4', a uniting prism 5 for the pencils of light and an eye piece 6 being mounted in such casing in the known manner. For compensating for variations of the parallactic angle at the target serves a pair of rotatable wedges 7, 7' mounted in a frame 8, 8' rotatable in a compensating casing 9 and interposed between the prism 3 and the objective 4. The frames 8, 8' are provided with bevel wheels engaging into a bevel wheel 10. This bevel wheel 10 is keyed to a shaft 11 passing through the casing 2. The shaft 11 is journaled on the one hand in the compensator casing 9, and on the other hand in a sleeve 12 surrounding the casing 2 provided with a gearing chamber 12'. A pointer casing 14 is rotatably mounted by means of ball bearings 15 and 16 on this sleeve 12 and on a second sleeve 13 located at the end of the range finder casing 2 and carrying a light entering socket piece 13' closed by a glass plate. The part of the range finder casing containing the prism 3' and objective 4' is equipped in a similar manner with sleeves 17 and 18 together with light entering socket piece 18' and a casing 19 mounted on such sleeves. The casings 14 and 19 are provided with projections 14' and 19' respectively (Fig. 3) by means of which the range finder is supported on a carrier 20 which in turn is capable of rotating around the vertical axis of a column 22 by means of a bearing plate 21.

A yoke 23 is rotatably mounted in bearings 25 and 25' in the casing 14 by means of

two journal pins 24 and 24'. The journal pins 24 and 24' are screwed into a ring 26 angular in transverse section and provided with a covering ring 26' two rings 28, 29 being mounted by means of balls 29 on such ring 26 and capable of rotating around the axis of the same. The rings 28, 29 carry each a projection 30 and 31 respectively, the projections end in thin cylindrical pins 30' and 31' respectively having radial axes, sleeves 33 and 34 respectively being rotatably mounted on such pins and provided with divisions 32. The sleeves 33 and 34 have quadrangular projections 33' and 34' slidably arranged between guide ribs 35 and 36 respectively. The guide ribs 35, 36 are arcs of circles in two planes perpendicular to each other and passing through the axis of the casing and being concentric to a point upon the said axis. The guide ribs 35, 36 are cast on the inner wall of two wings resembling hollow projections 37 and 38 so arranged at an angle of 90° relatively to each other on the casing 14 that the projection 37 points horizontally to the front whereas the projection 38 points vertically upwards. The front wall of the projection 38 has a longitudinal slot closed by a glass strip 39 with a linear longitudinal scale. Correspondingly a longitudinal slot provided in the top wall of the projection 37 is closed by a glass strip 40 having a linear longitudinal scale (Fig. 4).

The yoke 23 carries a worm wheel segment 41 engaging a worm 42 mounted on a shaft 43 rotatable in a bearing 44. Besides the shaft 43 is supported in a driving gear casing mounted in the range finder casing 2 and consisting of an open part 45 and of a part 45' closed by a glass 46. In the open part 45 the shaft 43 carries a knurled roller 47 while in the other part 45' a cylindrical body 48 is mounted which carries a range scale 48' drawn thereon helically. A following pointer 49 guided in the part 45' of the casing engages into a groove 50 provided in the cylindrical body 48 along the scale 48'.

Besides the shaft 11 also a shaft 51 parallel thereto passes through the gear chamber 12'. It carries a noncircular cam wheel 52 and a gear wheel 53 engaging with a toothed segment 54 mounted on the covering ring 26'. The cam wheel 52 engages with a noncircular cam wheel 55 keyed on the shaft 11. A spiral spring 56 fastened at one end in the casing 12' and at the other end to the shaft 11 tends to force the cam wheel 55 in the direction of the arrow P towards the cam wheel 52. The limits of the rotary movement of the yoke 23 rotatable around the journal pins 24 and 24' are suitably enlarged by two processes 2' provided in the casing 2.

When using the embodiment of the apparatus just described, the target is closely followed by turning the range finder casing or tube around its horizontal axis and by turn-

ing the carrier 4 around the column 22 that is to say a vertical axis. Thereby the axis 24, 24' of the ring 26 is constantly kept directed to the target. By turning the drum 47 the two images of the range finder shown are brought to coincidence or in other words the range finder is adjusted to the distance of the target from the point of observation. Thereby on the one hand the ring 26 is turned around its axis 24, 24' by the toothed segment 41 and on the other hand the wedges of the pair of wedges 7, 7' are turned relatively to each other. The ratio of leverages of the gearing between the drum 47 and the toothed segment 41 on the one hand and the pair of wedges 7, 7' on the other hand is such that when the two images of the range finder are brought to coincidence or in other words the range finder is adjusted to the distance sought the axial excursion of that point of the ring 26 which is located in the plane perpendicular to the axis 24, 24' is proportioned to the distance measured by adjusting the range finder. Then as has been hereinbefore explained the pointer 32 moving along the side 40 located in the horizontal plane indicates the instantaneous linear height of the target above the level of observation and the pointer 33 moving along the scale 39 located in the vertical plane indicates the horizontal distance of the target from the point of observation. Thus in the embodiment of the invention as above described the absolute distance and the horizontal distance of the target from the point of observation and also the linear height of the target above the level of the point of observation are determined simultaneously.

In most cases the movement of the target will be horizontal. If, therefore the height and horizontal distance of the same has been once determined only the latter will vary in optically pursuing the target. In this case it is suitable for the purpose to effect the actuation of the gearing not by turning the knurled roller 47 adjusting the direct distance, but by turning the radial journal pin 31 measuring the horizontal distance for which purpose such journal pin is extended to form a handle 31'' and projects from the casing 38 provided with a slot extending from *a* to *b*, the same as the journal pin 30' is extended to form a handle not seen in the drawings and projects from a slot of the casing 37, the arrangement being such that this journal pin carrying the mark for the target height is capable of being clamped in position in the slot in order that in optically pursuing the target with an adjusted height the coincidence of the partial images of the target or the measuring mark is solely maintained by adjusting the altitude angle of the target, that is to say by tilting the line of sight. Moreover, of course, the self locking worm gearing 41, 42 must be replaced by a non-self-locking bevel wheel 41*a*, 42*a* (Figs.

7, 8, 9) with the interposition of a double toothed intermediate wheel 42*b*, 42*c* which is rotatably mounted on a radial shaft 12*d* journaled in the tiltable part of the casing 2.

Instead of the two rectilinear glass window scales 39 and 40 also two circular scales in two planes at right angles to each other may be used which approximately contact in one point where the reading mark may be provided which they have in common and which is fixed to the casing. In this case the ring 28 is preferably provided with two trunnions 30'*a* 30''*a* (Figs. 8, 9) on which a semicircular fork 57 is pivoted which is journaled by means of a vertical journal pin 57' in a non-tiltable part 14 of the casing for turning horizontally. On such journal pin 57' a scale carrier 58' is secured which is provided with a rim 58 serving as a handle and carries a circular height scale 58'' for the target. In order to enable the coincidence of the partial images of the target or the measuring mark to be brought about solely by the optical pursuit of the target, the scale 58' must be locked in position by a set screw 14*a* mounted in the casing. The ring 29, however, is provided with one journal pin only which extends vertically downwards and engages into the bore of a semicircular fork 59 which in turn is pivotally mounted by means of two horizontal trunnions 59' and 59'' in the nontiltable casing 14. To the trunnion 59 is secured the scale carrier 60' provided with a ring 60 serving as a handle and carrying a circular scale 60'' for the horizontal distances. Above the point of contact of the scale 60'' with the height scale 58'' for the target a reading loupe 61 is mounted in a yoke 61' secured to the casing 14 such loupe being provided with a reading mark drawn in it and perpendicular to the periphery of the scale.

With this arrangement the measurements of the target may be effected at will by actuating the knurled roller 47 or the two handle rims 58 for adjusting for the height and 60 for adjusting for the horizontal distance of the target.

In the simplest constructional form shown in Fig. 10 on the rotatable ring 26, as shown made in one piece, two sliding sectors 28, 29 are circumferentially guided each being provided with a radial journal pin 30*b*, 31*b*, while on each of the said journal pins a prismatic mark carrier 33*b*, 34*b* is rotatably mounted and is guided in a guide groove 35*b*, 36*b* provided in the casing which is in the shape of a segment of a sphere. Along the groove 36*b* in the vertical central plane the circular scale 39*b* for the horizontal distances is provided while along the groove 35*b* in the horizontal central plane the scale 40*b* for the height of the target is provided. The coupling of the rotatable ring 26 with the op-

crating gear for the measuring wedges is the same as in Figs. 5 and 6.

What I claim is:

1. A range finder comprising a casing, a carrier supporting the said casing and adapted to turn around a vertical axis and means for adjusting the range finder to the absolute distance of the target from the point of observation in combination with sleeves secured to the said carrier and forming bearings for the said range finder casing the axis of these bearings being horizontal, a ring surrounding the said casing and adapted to turn around an axis journaled in the said casing and forming a diameter of the said ring means for turning the said ring around its diametrical axis, a driving gear operatively connected to the said means for adjusting the range finder to the absolute distance of the target from the point of observation and to the said means for turning the ring around its diametrical axis, the ratio of leverages between the said driving gear and the said ring turning means on the one hand, and the said driving gear and the said means for adjusting the range finder on the other hand, being such that the axial excursion parallel to the axis of the finder of the points of the ring located in a plane perpendicular to its diametrical turning axis, is proportional to the absolute distance of the target from the point of observation, at least one pointer and at least one scale for the said pointer, one of the last named two elements, viz., the pointer and the scale, being rigidly connected to one of the said sleeves while the other is movable relatively thereto.

2. A range finder comprising a casing, a carrier supporting the said casing and adapted to turn around a vertical axis and means for adjusting the range finder to the absolute distance of the target from the point of observation in combination with sleeves secured to the said carrier and forming bearings for the said range finder casing the axis of these bearings being horizontal, a ring surrounding the said casing and adapted to turn around an axis journaled in the said casing and forming a diameter of the said ring means for turning the said ring around its diametrical axis, a driving gear operatively connected to the said means for adjusting the range finder to the absolute distance of the target from the point of observation and to the said means for turning the ring around its diametrical axis, the ratio of leverages between the said driving gear and the said ring turning means on the one hand, and the said driving gear and the said means for adjusting the range finder on the other hand, being such that the axial excursion parallel to the axis of the finder of the points of the ring located in a plane perpendicular to its diametrical turning axis, is proportional to the absolute distance of the target from the point

of observation, two scales secured to the said sleeves in planes perpendicular to each other and passing through the axis of the said casing, two pointers operatively connected to the said ring, each of the said pointers moving along one of the said scales.

3. A range finder comprising a casing, a carrier supporting the said casing and adapted to turn around a vertical axis and means for adjusting the range finder to the absolute distance of the target from the point of observation in combination with sleeves secured to the said carrier and forming bearings for the said range finder casing the axis of these bearings being horizontal, a ring surrounding the said casing and adapted to turn around an axis journaled in the said casing and forming a diameter of the said ring, means for turning the said ring around its diametrical axis, a driving gear operatively connected to the said means for adjusting the range finder to the absolute distance of the target from the point of observation and to the said means for turning the ring around its diametrical axis, the ratio of leverages between the said driving gear and the said ring turning means on the one hand, and the said driving gear and the said means for adjusting the range finder on the other hand, being such that the axial excursion parallel to the axis of the finder of the points of the ring located in a plane perpendicular to its diametrical turning axis, is proportional to the absolute distance of the target from the point of observation, two scales secured to the said sleeves one being located in a horizontal plane, and the other in a vertical plane both of these planes passing through the axis of the casing, and two pointers operatively connected to the said ring, each of the said pointers moving along one of the said scales.

4. A range finder comprising a casing, a carrier supporting the said casing and adapted to turn around a vertical axis and means for adjusting the range finder to the absolute distance of the target from the point of observation in combination with sleeves secured to the said carrier and forming bearings for the said range finder casing the axis of these bearings being horizontal, a ring surrounding the said casing and adapted to turn around an axis journaled in the said casing and forming a diameter of the said ring means for turning the said ring around its diametrical axis, a driving gear operatively connected to the said means for adjusting the range finder to the absolute distance of the target from the point of observation and to the said means for turning the ring around its diametrical axis, the ratio of leverages between the said driving gear and the said ring turning means on the one hand, and the said driving gear and the said means for adjusting the range finder on the other hand, being such that the axial

excursion parallel to the axis of the finder of the points of the ring located in a plane perpendicular to its diametrical turning axis, is proportional to the absolute distance of the target from the point of observation, at least one ring freely revoluble in the said ring coaxially thereto, there being at least one guide slot provided with a scale in a plane passing through the axis of the casing in one of the said sleeves, and at least one pointer guided in the said guide slot and extending radially from the said freely revoluble ring.

5. A range finder comprising a casing, a carrier supporting the said casing and adapted to turn around a vertical axis and means for adjusting the range finder to the absolute distance of the target from the point of observation in combination with sleeves secured to the said carrier and forming bearings for the said range finder casing the axis of these bearings being horizontal, a ring surrounding the said casing and adapted to turn around an axis journaled in the said casing and forming a diameter of the said ring means for turning the said ring around its diametrical axis, a driving gear operatively connected to the said means for adjusting the range finder to the absolute distance of the target from the point of observation and to the said means for turning the ring around its diametrical axis, the ratio of leverages between the said driving gear and the said ring turning means on the one hand, and the said driving gear and the said means for adjusting the range finder on the other hand, being such that the axial excursion parallel to the axis of the finder of the points of the ring located in a plane perpendicular to its diametrical turning axis, is proportional to the absolute distance of the target from the point of observation, two rings located side by side in the said ring, said rings being revoluble coaxially thereto, there being two guide slots each provided with a scale one of the said guide slots being located respectively in vertical and horizontal planes passing through the finder axis in one of the said sleeves, two pointers each being associated to and radially extending from one of the said freely revoluble rings, and each being guided in one of the said guide slots.

6. A range finder comprising a casing, a carrier supporting the said casing and adapted to turn around a vertical axis and means for adjusting the range finder to the absolute distance of the target from the point of observation in combination with sleeves secured to the said carrier and forming bearings for the said range finder casing the axis of these bearings being horizontal, a ring surrounding the said casing and adapted to turn around an axis journaled in the said casing and forming a diameter of

the said ring means for turning the said ring around its diametrical axis, a driving gear operatively connected to the said means for adjusting the range finder to the absolute distance of the target from the point of observation and to the said means for turning the ring around its diametrical axis, the ratio of leverages between the said driving gear and the said ring turning means on the one hand, and the said driving gear and the said means for adjusting the range finder on the other hand, being such that the axial excursion parallel to the axis of the finder of the points of the ring located in a plane perpendicular to its diametrical turning axis, is proportional to the absolute distance of the target from the point of observation, two rings freely revoluble in the said ring, and coaxially therewith a first yoke supporting one of the said freely revoluble rings, and rotatable around the diametrical axis of the first named ring, a second yoke for supporting the other freely revoluble ring around a diametrical axis revoluble thereto, the said driving gear comprising a hand wheel operatively connected to the one, and a hand wheel operatively connected to the other yoke, scales attached to the said hand wheels, and pointers secured to the said sleeve.

In testimony whereof I have affixed my signature.

KARL PETSCHENIG.