G. N. WHISTLER & C. C. HEARN.

DEVICE FOR CORRECTING FOR THE EARTH'S CURVATURE AND ATMOSPHERIC REFRACTION ON A DEPRESSION POSITION FINDER.

APPLICATION FILED FEB. 23, 1905.

949,456.

Patented Feb. 15, 1910.

4 SHEETS—SHEET 1.

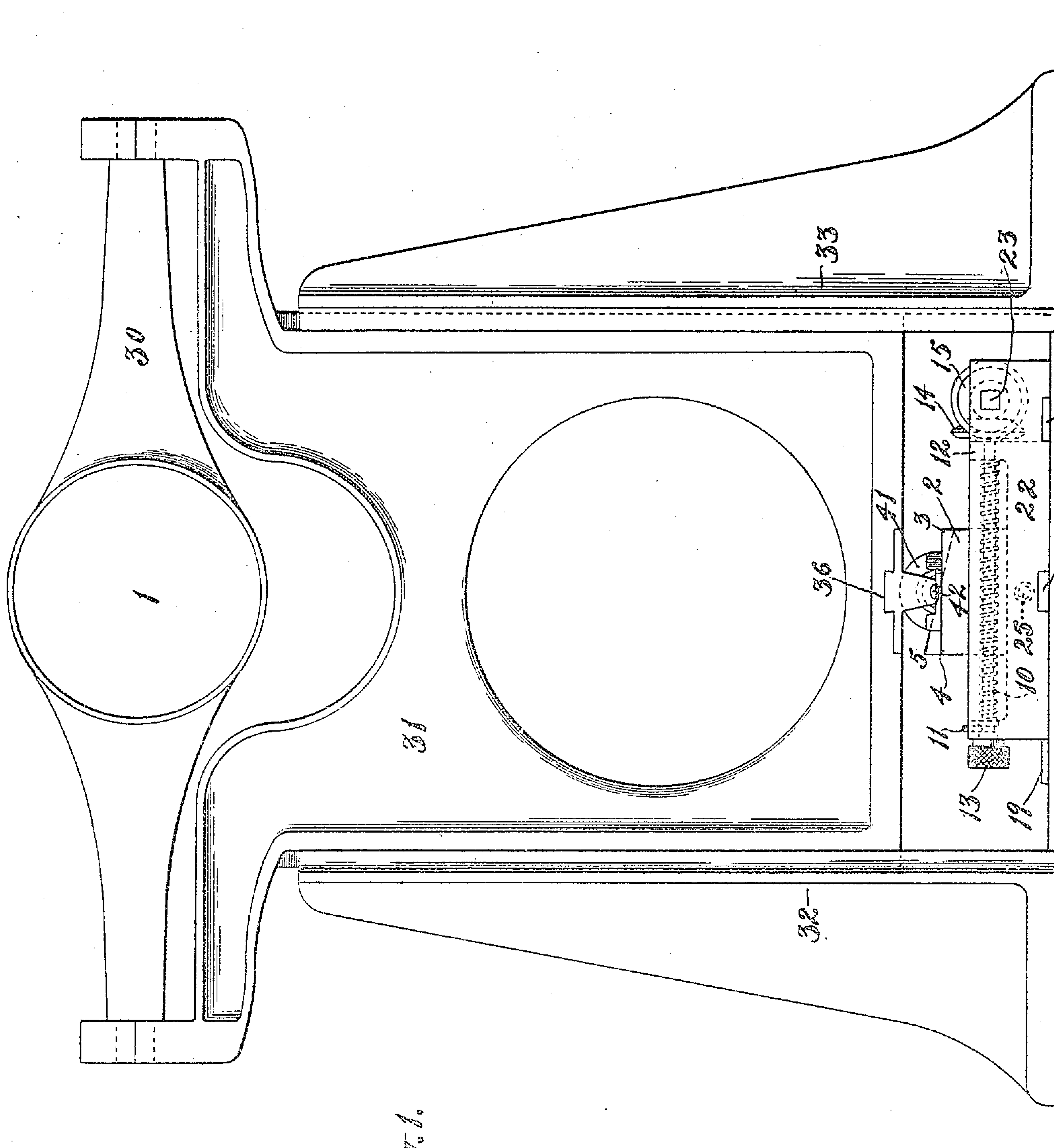


Fig. 1.

Witnesses:

F. G. Hachenburg.

Henry Thieme

Inventors:

Garland N. Whistler &

Clint C. Hearn

by attorneys

G. N. WHISTLER & C. C. HEARN.

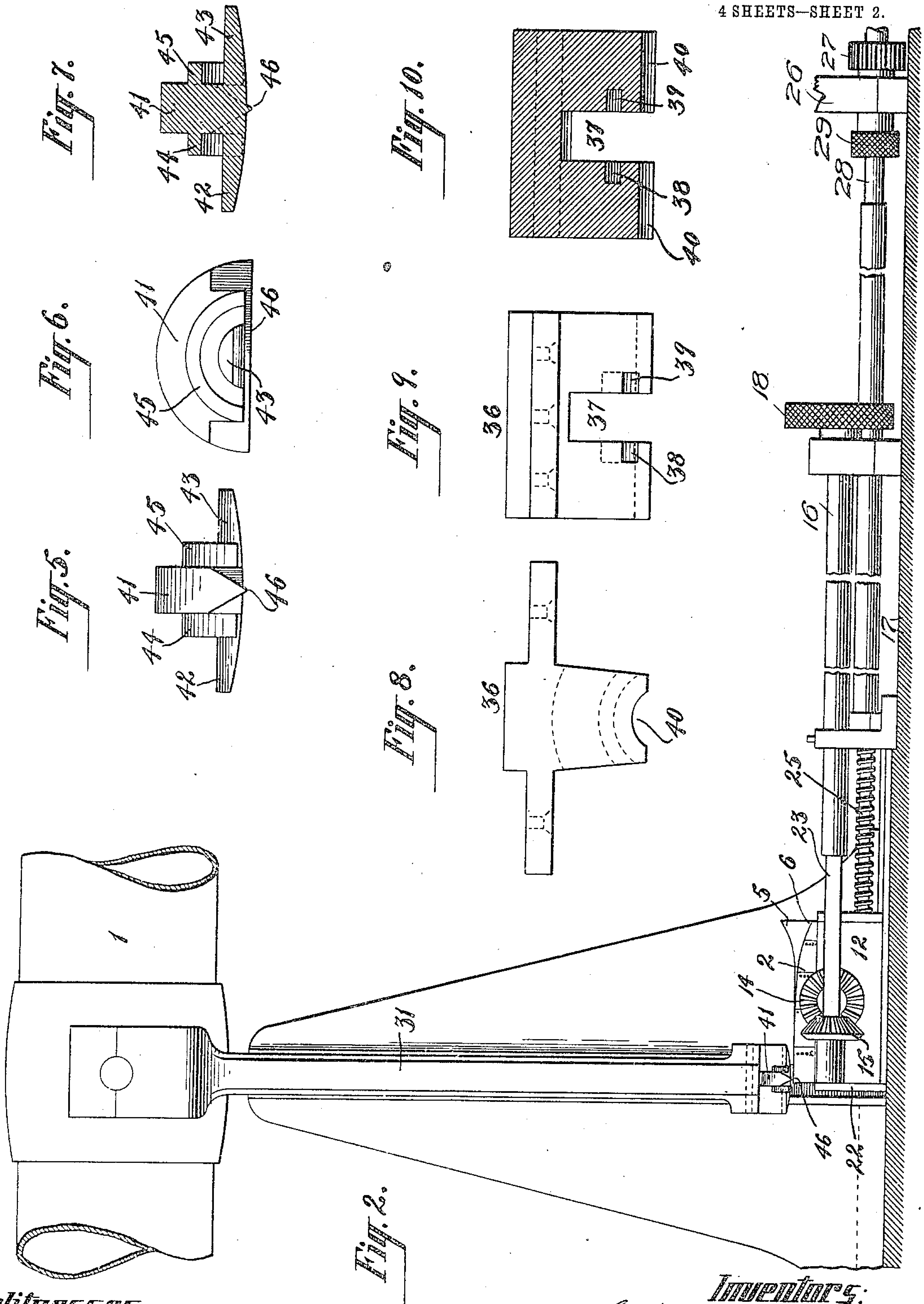
DEVICE FOR CORRECTING FOR THE EARTH'S CURVATURE AND ATMOSPHERIC REFRACTION ON A DEPRESSION POSITION FINDER.

APPLICATION FILED FEB. 23, 1905.

949,456.

Patented Feb. 15, 1910.

4 SHEETS—SHEET 2.



Witnesses:

F. G. Hachenberg.

Henry Thieme

Inventors:

Garland N. Whistler and

Albert C. Hearn

by attorneys

Brown & Seward

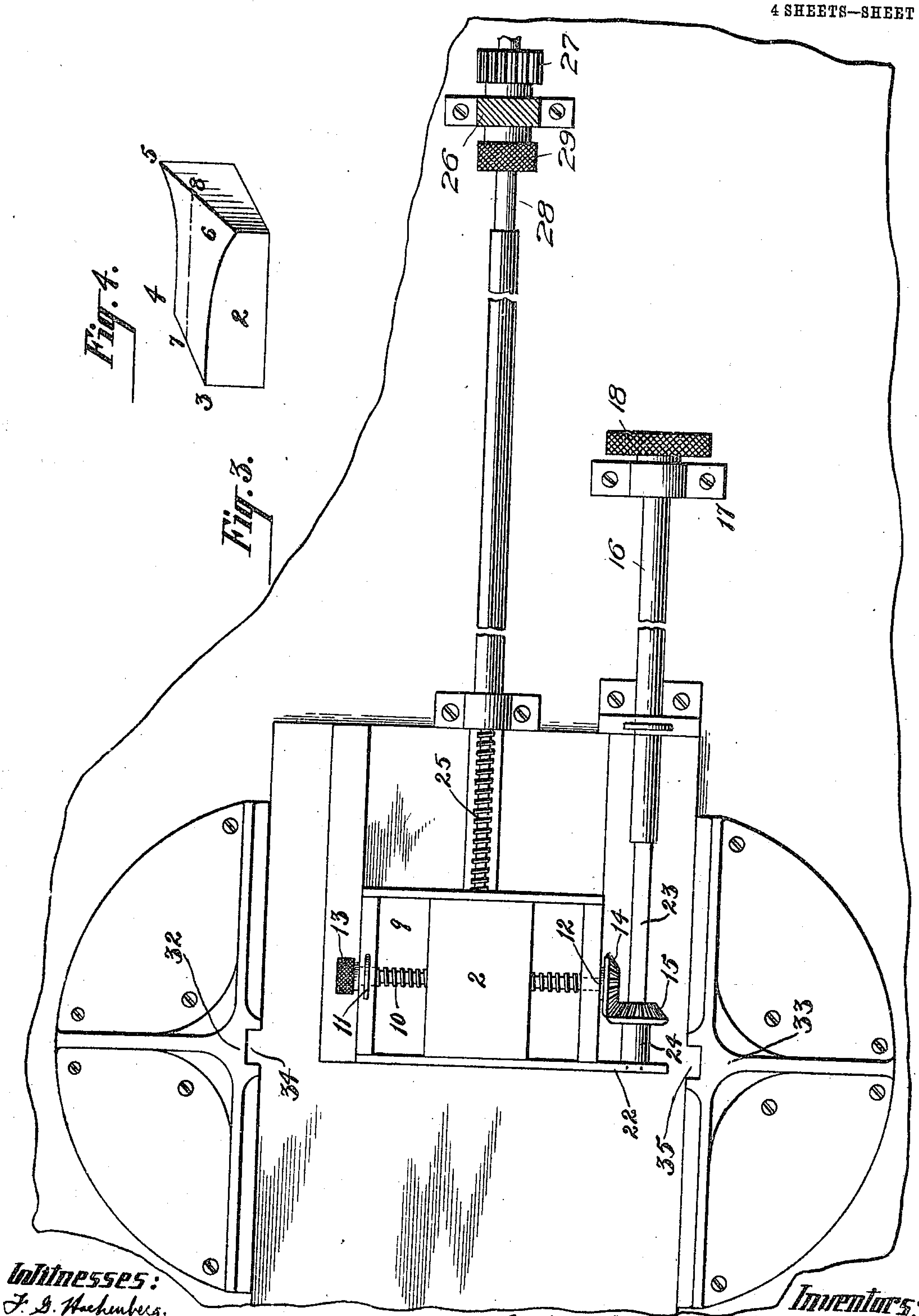
G. N. WHISTLER & C. C. HEARN.

DEVICE FOR CORRECTING FOR THE EARTH'S CURVATURE AND ATMOSPHERIC REFRACTION ON A DEPRESSION POSITION FINDER.

APPLICATION FILED FEB. 23, 1905.

949,456. Patented Feb. 15, 1910.

4 SHEETS—SHEET 3.



Witnesses:
F. G. Hackenberg.
Henry Thieme

Inventors:
Garland N. Whistler & Clint C. Hearn
by attorneys
Brown & Seward

G. N. WHISTLER & C. C. HEARN.

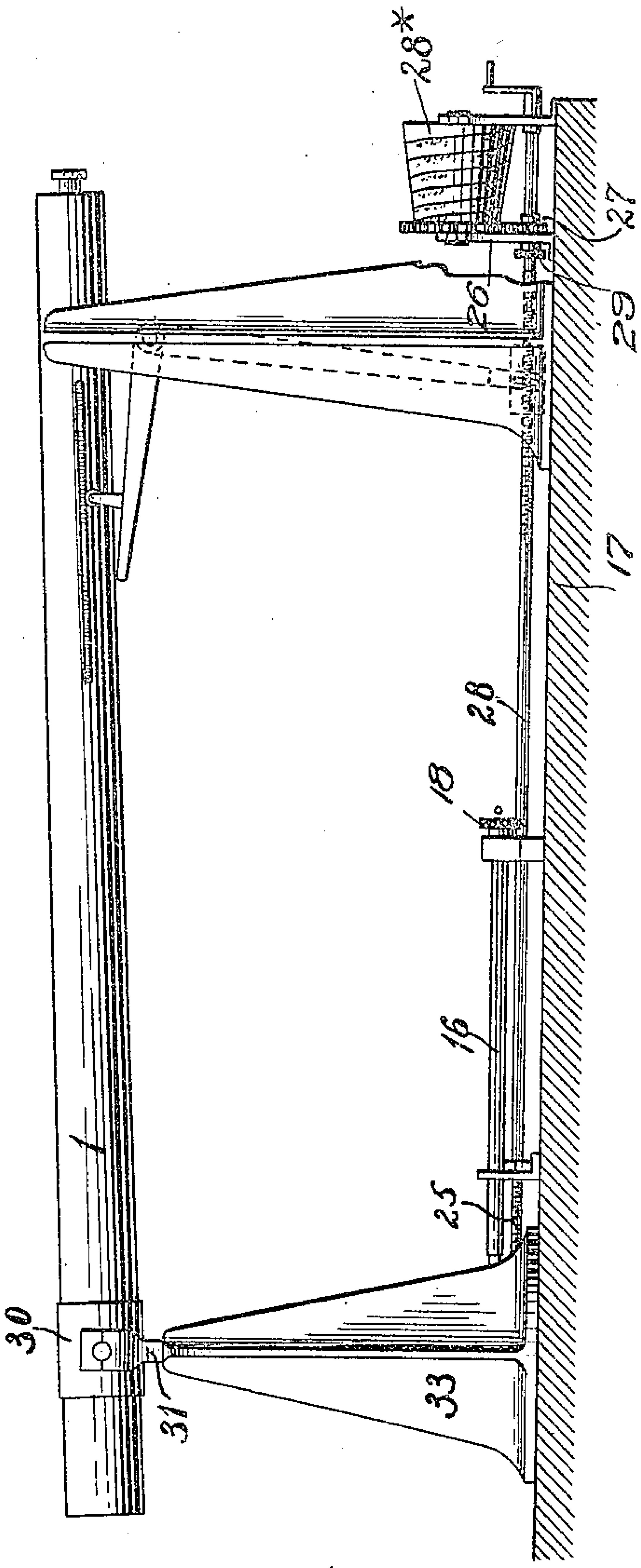
DEVICE FOR CORRECTING FOR THE EARTH'S CURVATURE AND ATMOSPHERIC REFRACTION ON A DEPRESSION POSITION FINDER.

APPLICATION FILED FEB. 23, 1905.

949,456. Patented Feb. 15, 1910.

4 SHEETS—SHEET 4.

Fig. 11.



Witnesses:

F. G. Hachenberg.

Henry Thieme.

Inventor:

Garland N. Whistler and

Clint C. Hearn

by attorneys

Brown & Seward

UNITED STATES PATENT OFFICE.

GARLAND N. WHISTLER AND CLINT C. HEARN, OF FORT MONROE, VIRGINIA, ASSIGNORS OF ONE-HALF TO ELLEN WHARTON WHISTLER AND ONE-HALF TO LAURA OVERAKER HEARN.

DEVICE FOR CORRECTING FOR THE EARTH'S CURVATURE AND ATMOSPHERIC REFRACTION ON A DEPRESSION POSITION-FINDER.

949,456. Specification of Letters Patent. **Patented Feb. 15, 1910.**

Application filed February 23, 1905. Serial No. 246,854.

To all whom it may concern:

Be it known that we, GARLAND N. WHISTLER and CLINT C. HEARN, citizens of the United States, and residents of Fort Monroe, in the county of Elizabeth City and State of Virginia, have invented a new and useful Device for Correcting for the Earth's Curvature and Atmospheric Refraction on a Depression Position-Finder, of which the following is a specification.

This invention relates to a device for correcting for the earth's curvature and atmospheric refraction on a depression position finder with the object in view of making the correction exact for all ranges without requiring further manipulation of the device after it has once been accurately adjusted.

In the accompanying drawings, Figure 1 is a view in end elevation of so much of a depression position finder as will serve to show the location and operation of the correcting device, Fig. 2 is a view of the same in side elevation, Fig. 3 is a top plan view, the telescope supporting slide being removed, Fig. 4 is a view in detail of the cam or warped faced block by means of which the correction is made, Figs. 5, 6, 7, represent the knife edge bearing in end elevation, in side elevation, and section respectively, Figs. 8, 9 and 10 represent end elevation, side elevation and section, respectively, the intermediate support for mounting the knife edge bearing and securing it to the telescope supporting slide, and Fig. 11 is a view in side elevation of a telescope and range wheel showing the relation of the depression position finder thereto.

It is to be understood that the depression position finder, in addition to the telescope indicated at 1, is to be provided with a range wheel or other device for indicating ranges corresponding to different angles of depression of the telescope and with an azimuth circle attached thereto in any approved manner for obtaining the direction to any visible object on the surface of the water, our present invention being directed to means for correcting the range for the curvature of the earth and atmospheric refraction on such an instrument.

The gist of our invention lies in a block of predetermined dimensions having a face presenting an infinite number of varying curves or lines so arranged as to effect the position of the telescope, when the range scale mechanism is operated, to produce the necessary correction for the particular range at which the scale mechanism is set. This block is represented in detail in Fig. 4. It is denoted as a whole by 2. In the present instance it is three inches long, one and one-half inches wide and its thickness is given below. Its base and four sides are planes, the base being a rectangle and the four sides located at right angles thereto. Its upper face bounded by the lines 3, 4,—4, 5,—5, 6, and 6, 3, is a warped or cammed surface generated by a right line 3, 4, or 5, 6, by directrices which are the arcs of hyperbolical curves, the equation of which is

$$y=\frac{c}{x}$$

the logarithm of c in the present instance being 9.04215–10—x the linear distance the actuating part moves and y the vertical distance through which the trunnions are moved by this device, both x and y being measured in inches, the said curves being located in parallel planes eight inches apart and curved in opposite directions, the line 7, 8, on the face of the block 2, being or corresponding to the line midway between the planes of the aforesaid curves and the side 4, 5, of said face being three-fourths inch from the line 7, 8, or three and one-fourth inches from the concave curve, and the side 3, 6, of said face being three-fourths inch from the line 7, 8, or three and one-fourth inches from the convex curve. The line 7, 8, is a right line one inch above the base of the block and the lines 4, 5, and 3, 6, are curved lines, the terminal 5 of the line 4, 5, being 1.0413 of an inch above the base and the terminal 6 of the line 3, 6, being .9587 of an inch above the base. These dimensions have been carefully calculated for practical use in correcting ranges from zero to twelve thousand yards for a particular instrument and the same principles would govern in providing a warped surface for still greater ranges.

The equation

$$y=\frac{c}{x}$$

is a general equation in which c may have any value, and x and y any relative values, depending upon the particular instrument for which the block may be designed. For a particular instrument in which the working radius is 24 inches and the travel of the block is three inches during a change of range from zero to 12000 yards, the equation assumes the definite form:

$$y=\frac{0.013774}{x},$$

x having the limiting values, $\frac{1}{6}$ inch and 3 inches; or the equation may be written in a more convenient form:

$$\log. y=8.13906-10-\log. x.$$

This equation could be used in the construction of both curves if one is considered as inverted after it is constructed, but to be more accurate, the equation of the upper curve is 4—5:

$$d-y=\frac{0.013774}{x},$$

in which d is a constant and equal to twice the value of y in the first equation when $x=3$. And in this particular case, the particular equation becomes:

$$.0734-y=\frac{0.013774}{x}.$$

In the block, the plane determined by the lines 3—4 and 7—8 is parallel to the horizontal plane containing one of the axes of coordinates, and is 0.0367 of an inch above it; it cuts the curves at the point whose coordinates are: $y=.0367$, $x=3$ (inches). The curves are both tangent to their assymtotes at infinity. One curve (whose equation is $y=\frac{c}{x}$) is tangent to its axes of coördinates which are its assymtotes, the vertical axis being in a plane common to both, the horizontal being in the horizontal plane 0.0367 in. below the line 7—8 and parallel to it. The horizontal assymtote of the other curve is 0.0367 inch above the line 7—8 and is parallel to it.

The following are the corresponding coordinates of eight points which may be used in plotting these curves:

$y=$ .66, .33, .1632, .1101, .0736, .0551, .0441, .0367,

when—

$x=$ .1667, .3333, .6667, 1.0000, 1.5000, 2.0000, 2.5000, 3.0000.

2nd Curve.

$y=-.5866$, $-.2566$, $-.0918$, $-.0367$, $-.0002$, $+.0183$, $+.0293$, $+.0367$.

when—

$x=$ .1667, .3333, .6667, 1.0000, 1.5000, 2.0000, 2.5000, 3.0000.

The vertical motion given to the end of the telescope whose support rests upon this correcting block—given by this block in its horizontal movement, compensates for the errors due to refraction and curvature of the earth, the telescope being pivoted at the other end. Both ends of the telescope are pivoted in vertical slides, or rather, one end is pivoted and the other rests on a slide which is pivoted to its vertical slide. One slide is operated by the range mechanism, the other by the correction block.

The block 2 fits accurately between the front and rear walls of a box 9 and is permitted a lateral movement in said box. This lateral movement or adjustment is effected by means of a screw 10 engaged with the block and swiveled in the opposite ends of the box 9 as at 11, 12. The screw 10 has a milled wheel 13 at one end for operating it and at the opposite end is provided with a bevel pinion 14 which intermeshes with a bevel pinion 15 on a shaft 16 mounted in suitable bearings on the base 17 of the instrument, the shaft 16 being provided with a milled wheel or disk 18 for operating it and hence the adjusting screw 10.

The box 9 carrying the block 2 and its adjusting screw is mounted to move bodily backward and forward along the base 17 and is guided in its movement by ways 19, 20, 21. An extension 22 on the box receives the squared end 23 of the shaft 16 and presses against the end of the hub 24 of the bevel gear wheel 15 to slide the latter along the shaft as the box is moved and thus keep the bevel gear wheels in engagement. A screw 25 swiveled in suitable bearings in the present instance the bearing 26, is engaged with the box 9 and when rotated serves to move the box back and forth along its ways. For purposes of adjustment the bearing 26 may be temporarily removed and the driving pinion 27 slid along the squared portion 28 of the screw shaft (see Fig. 2) to throw the said pinion out of gear with the range wheel 28* (see Fig. 11), to permit the screw 25 to be turned by the milled disk 29, without disturbing the range wheel, and to set the block 2 in the proper relation to said range wheel. The shaft which carries the screw 25 and which is shown broken away in Fig. 2, is extended in the complete instrument as shown in Fig. 11 to operate both the range mechanism and block and it is obvious that the driving pinion 27 may be secured against rotation on the shaft either by a squared portion of the shaft, as shown at 28, Fig. 2, or by the common feather and groove attachment as may be desired.

The telescope 1 is mounted by means of a yoke 30, in the upper end of a vertically sliding frame 31 which is held between two uprights 32, 33, fixed to the base 17 and provided with grooves 34, 35, for the reception of suitable tongues on the opposite sides of the frame 31. This vertically sliding frame 31 carrying the telescope, is supported on the warped face of the block 2, as follows: An intermediate supporting block 36 is fixed to the bottom of the frame 31 and provided with a lateral recess 37 for the reception of the body of a knife edge bearing. In the opposite walls of the recess 37 there are provided curved grooves 38, 39, and the lower ends of the block 36 on opposite sides of the recess 37 are made concave as shown at 40 to receive trunnions on the knife edge bearing.

The knife edge bearing is semi-cylindrical, the body portion 41 being of a width to fit loosely in the recess 37 in the block 36. Trunnions 42, 43, are shaped to seat in the concave bearings 40 and curved flanges 44, 45, projecting from opposite sides of the body 41, are adapted to enter and travel in the curved grooves 38, 39, in the piece 36. A straight knife edge 46 extends below the bottoms of the bearing piece and rests on a rectilinear element of the warped surface of the block 2 forming the sole support for the weight of the frame 31 and subjecting it to the changes in the height of the different portions of the warped surface as the block 2 is moved beneath it. The straight edge of the knife edge bearing rests throughout its length on the surface of the block 2 in a position at right angles to the line 7, 8.

The lateral movement of the block 2 under the action of the screw 10 will tend to raise and lower the telescope carrying slide 31 save only when the knife edge rests on the line 3, 4, which only happens at an extreme which would require the target to be placed under the instrument and hence does not occur in practice.

To adjust the instrument to correct for curvature of the earth and atmospheric refraction, first set the instrument so that it reads the range to a datum point. Set the index on the height scale of the instrument to account for its actual height above water level taking account of the reading of the tide gage in determining the height. Direct the telescope on the datum point, and then adjust for the water line by screw 10. The block is now in position for accommodating itself to all ranges under the action of the screw 25 controlled by the range wheel.

To adjust the screw 25 in the beginning, the instrument may be set to read 12000 yards and the screw 25 (its pinion 27 having been slid out of engagement with the range wheel by removing the bearing 26) may be turned to make the knife edge coincide with the 12000 yard line on the block 2. The pinion 27 may then be slid back again into engagement with the range wheel and the bearing 26 secured in place. As the range wheel is moved to direct the aim at the apparent position of the target it will automatically adjust the block 2 in such position that the index on the range scale will read the distance to the actual position of the target.

What we claim as our invention is:

1. In a depression position finder, a block having a warped or cam bearing surface, a telescope support and means for transmitting variations in said surface to the telescope support.

2. In a depression position finder, a block having a warped or cam face presenting an infinite number of curves, a telescope supported on said face and means for adjusting the block in a horizontal plane.

3. In a depression position finder, a block having a warped or cam face presenting an infinite number of curves, a telescope supported on said face and means for adjusting the block in different directions in a horizontal plane.

4. In a depression position finder, a block having a warped or cam face, a rocking knife edge resting on said face, a telescope supported on said rocking knife edge and means for adjusting said block in a horizontal plane.

5. In a depression position finder, a block having a warped or cam face, a telescope supported on said face, a range wheel, range scale mechanism and means for placing the said warped faced block under the control of the range scale mechanism to correct for the curvature of the earth and atmospheric refraction when the range scale mechanism is set at the apparent range.

6. In a depression position finder including a telescope, a block having its face generated by a right line controlled by concave and convex curves of a predetermined form, means for supporting the telescope of the depression position finder in vertical adjustment on said surface and means for moving the said block in a horizontal plane.

7. In a depression position finder, a block having a warped or cam face, a telescope supported on said face, a block support, means for moving the block support together with the block in one direction in a horizontal plane and means for moving the block on its support in a direction at right angles thereto in a horizontal plane.

In testimony, that we claim the foregoing as our invention, we have signed our names in presence of two witnesses, this 11th day of January 1905.

GARLAND N. WHISTLER.
CLINT C. HEARN.

Witnesses:
J. WM. LATHAM,
R. C. WINNA.