No. 702,835. Patented June 17, 1902.

J. WADDELL.

RANGE FINDING AND SURVEYING INSTRUMENT.

(Application filed July 2, 1901.)

(No Model.) 4 Sheets—Sheet I.

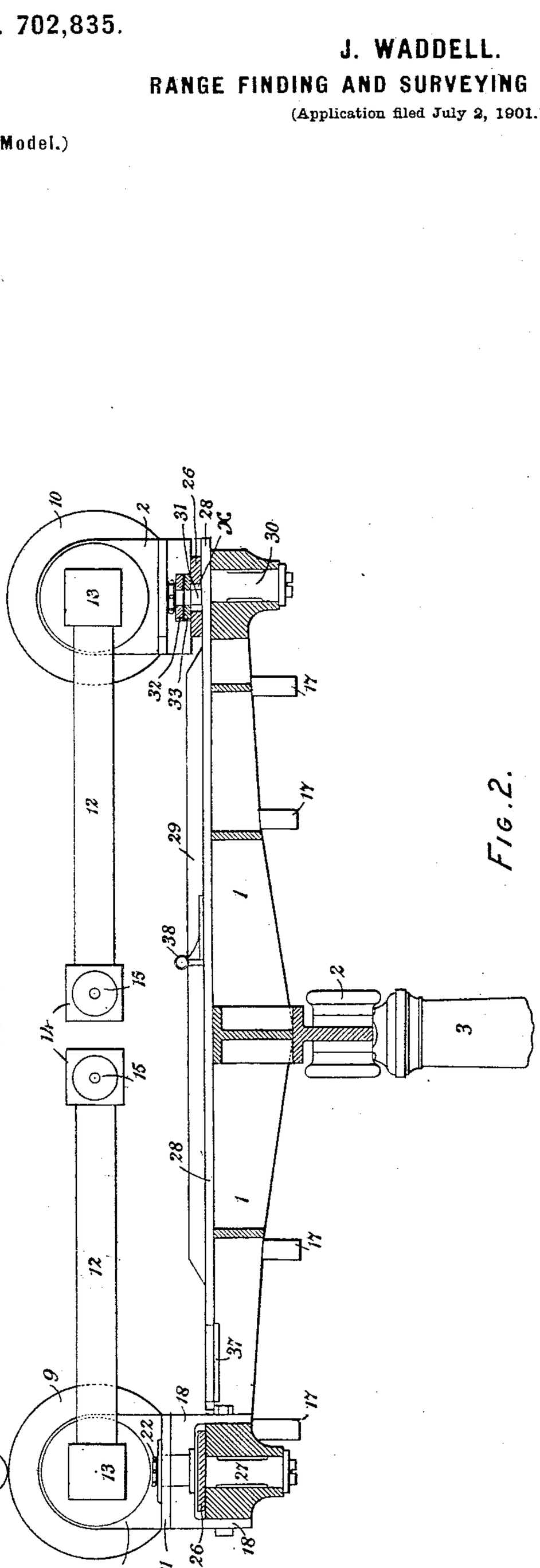

FIG. 1.

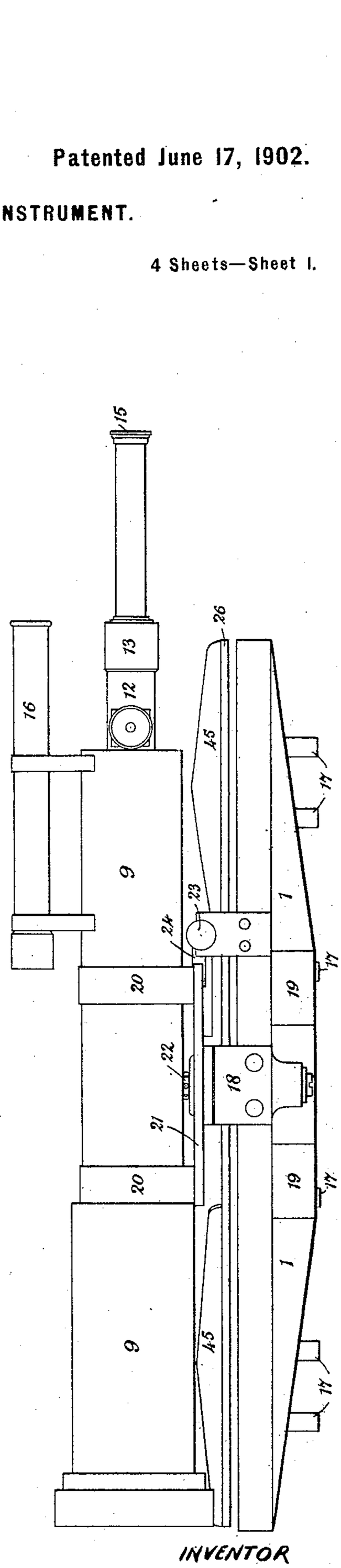

FIG. 2.

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FIG. 3.

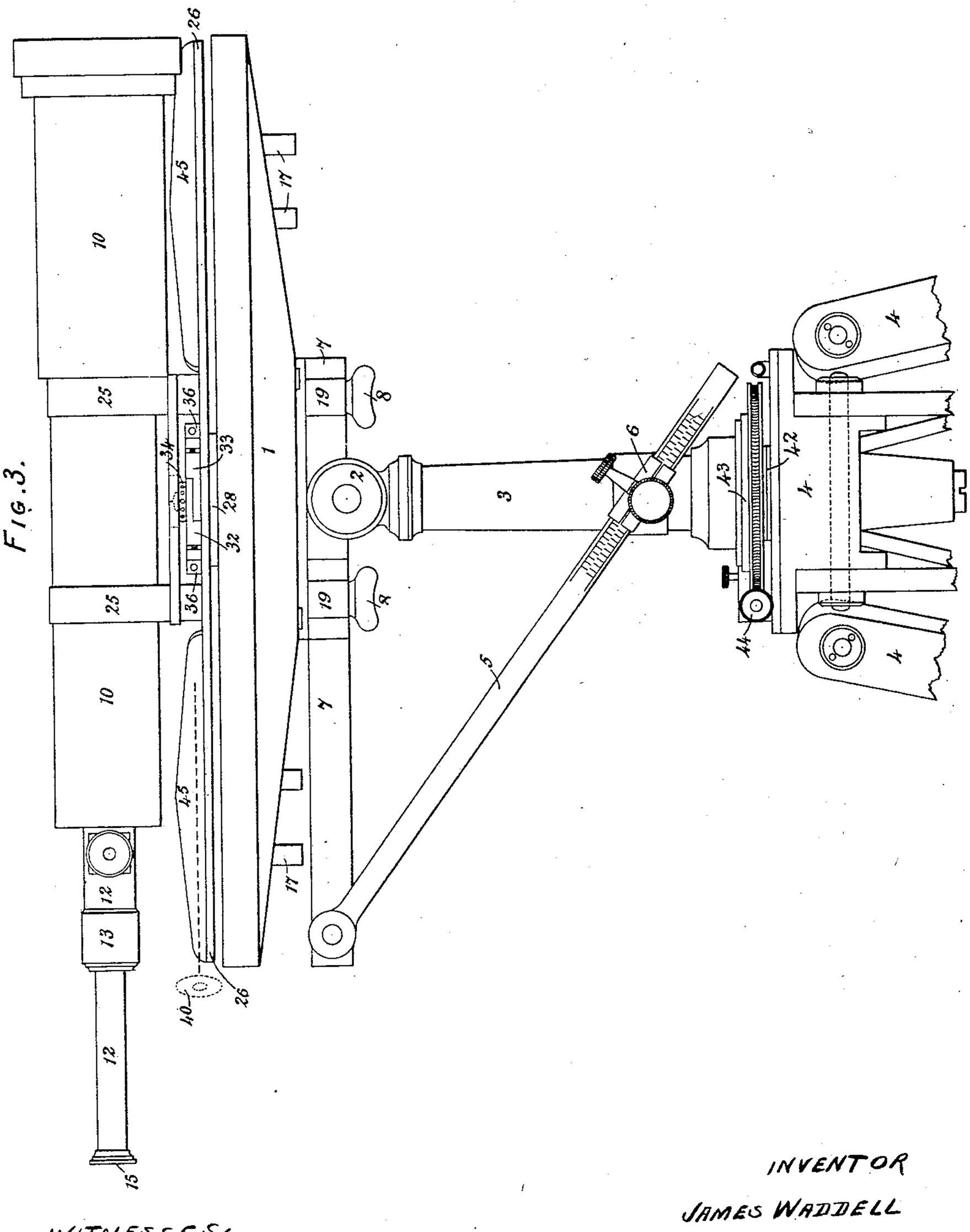

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FIG. 4.

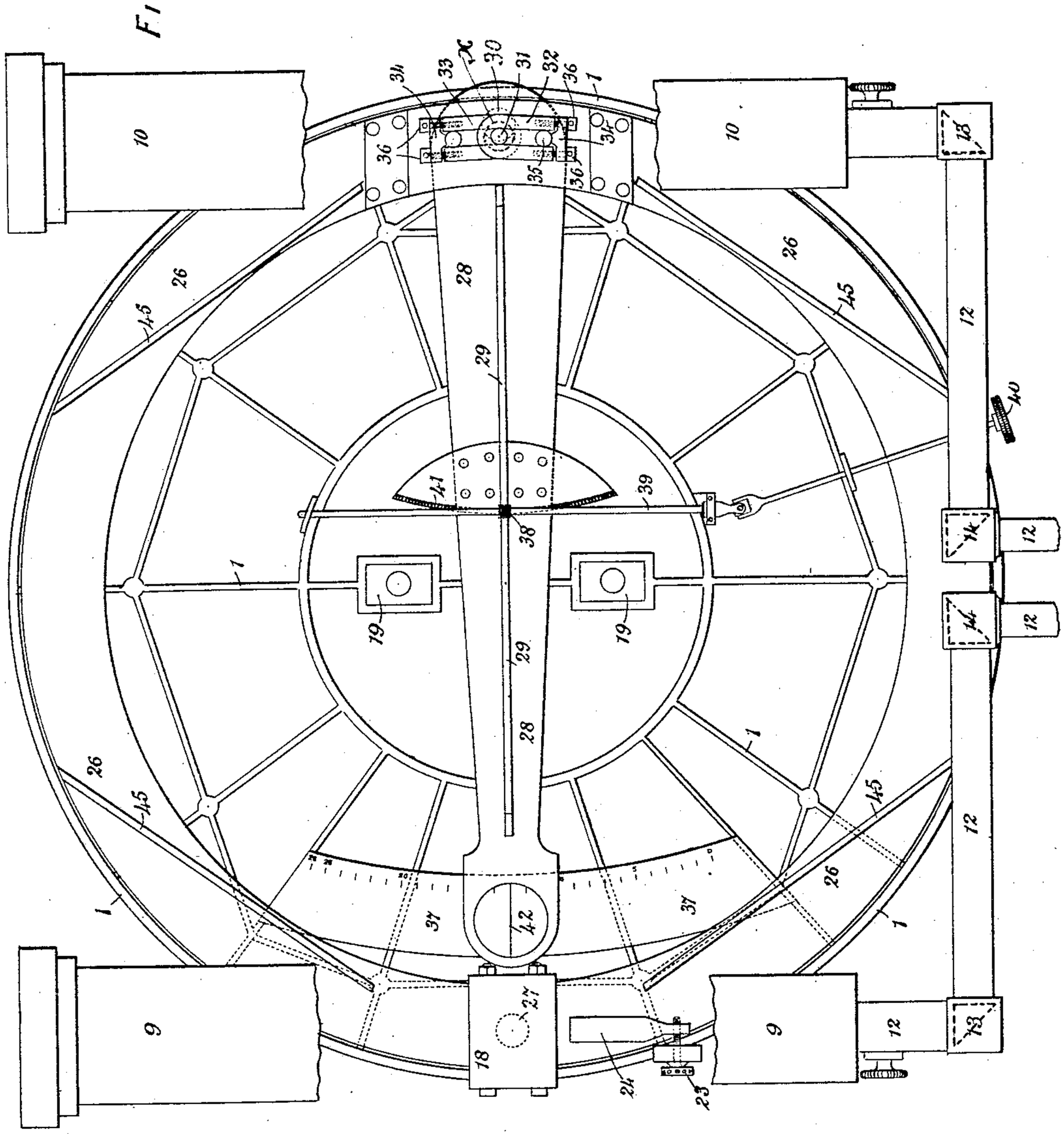

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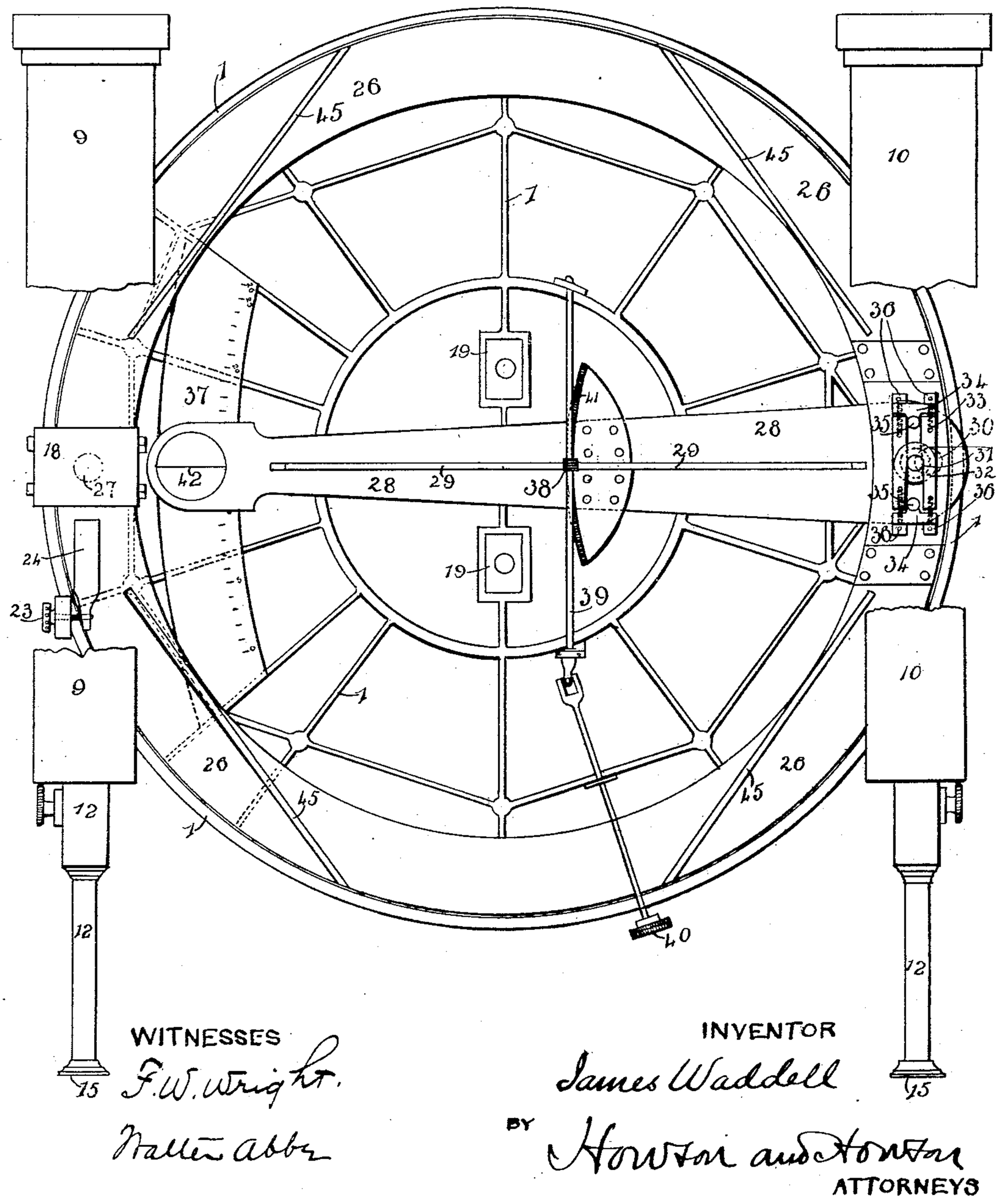
FIG. 5.



WITNESSES

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UNITED STATES PATENT OFFICE.

JAMES WADDELL, OF GLASGOW, SCOTLAND.

RANGE-FINDING AND SURVEYING INSTRUMENT.

SPECIFICATION forming part of Letters Patent No. 702,835, dated June 17, 1902.

Application filed July 2, 1901. Serial No. 66,890. (No model.)

To all whom it may concern:

Be it known that I, JAMES WADDELL, civil engineer, a subject of the King of Great Britain and Ireland, residing at Glasgow, Scotland, have invented certain new and useful Improvements in Range-Finding and Surveying Instruments, (for which an application for a patent has been made in Great Britain, No. 22,248, dated December 7, 1900,) of which the following is a specification.

The objects of this invention are improvements in or relating to optical instruments for range-finding and other measuring and surveying purposes, such as a telemeter or range-finder for military, naval, and marine use, also for pioneer surveying and leveling, astronomical and angle measuring, and such like purposes.

Referring to the drawings, which form part of this specification, Figure 1 is an elevation, partly in section, of the instrument from the front or observer's point of view. Fig. 2 is an elevation of the left-hand side without the pillar. Fig. 3 is an elevation of the right-hand side, showing the instrument attached to the pillar of a tripod and fitted with an adjusting stay-rod; and Fig. 4 is a plan in which some parts are shown broken away. Fig. 5 is a view similar to Fig. 4, but with straight telescopes, one for each of two observers.

As arranged for range-finding purposes by a single observer the instrument is mounted on a frame 1 (shown in section in Fig. 1) of open metal work, preferably circular and made of aluminium and carried by a swivel-joint 2 on the top of the pillar 3 of a tripod 4 of a construction such as is ordinarily used with small astronomical telescopes, and as shown in Fig. 3 the frame 1 is stayed by a rod 5, jointed to a cradle 7, carried by the swivel-joint 2 on the top of the pillar 3, to which the frame 1 is secured by the screws 8, screwing into the hollow box-bearings 19, the rod 5 being held in the desired position by the clamp 6 on the pillar 3. Feet 17 are formed on the lower side of the frame 1, so that it may rest in its case or on any flat surface without straining. On this frame 1 three telescopes 9, 10, and 16, each having cross-lines in its field, are mounted in the manner to be described, two of these, 9 and 10, being formed with double-elbowed tubes 12, so that the objective lenses are at a greater distance apart than the oculars, right-angled prisms with their hypotenuse surfaces silvered or other reflectors at an angle of forty-five degrees being placed at the elbow-joints 13 and 14 to reflect the images of the object observed from the objectives to the oculars 15. If the instrument is intended for use by two observers, straight telescopes without prismatic reflectors will be used instead of those with elbowed tubes, the other arrangements and construction being similar.

A small telescope 16, hereinafter called the "finder," of large field and low power, is mounted on the top of one of the telescopes, so that when the object being observed is visible on its cross-lines an image of the object will also be visible on the cross-lines of the elbowed telescope 9 below, which is hereinafter called the "follower." The follower 9 is carried, by means of its mountings 20, on a plate 21, which has a small oscillatory movement on the arched bracket 18, which is secured to the frame 1 by bolts for the purpose of accurate adjustment on its axis and is retained in position by a capstan-headed screw 22. The follower 9 is adjusted by means of its adjusting-screw 23, screwing into the tongue-piece 24, secured to the plate 21, until its line of collimation crosses the line of collimation of the other elbowed telescope 10, hereinafter called the "ranger," when both are directed to a point at a convenient known distance, which the ranger is set to indicate by the arm 28. The ranger telescope 10 is rigidly secured by the mountings 25 on a flat annular plate or ring 26, formed with stiffening-ribs 45, hereinafter called the "ranger-ring." This ranger-ring 26, which passes through the arched bracket 18 of the follower 9, has a small oscillating motion on a vertical axis or stud 27, depending from it and entering a socket in the frame of the instrument at the side opposite to that on which the ranger 10 is mounted.

An arm 28, formed with a stiffening-rib 29, is fitted to oscillate on an axis or stud 30, depending from it and entering a socket in the frame 1 at the same side as the ranger 10 and directly opposite the socket of the ranger-ring axis 27, and this arm lies partly beneath the ranger-ring 26 and on the frame 1 of the instru-

ment and extends nearly across the frame. A vertical stud or axis 31 projects from the upper side of the arm 28 at a point slightly nearer the center of the instrument, and this axis enters with free play an opening *x* in the ranger-ring 26 and has an accurate link connection with it by which the ranger-telescope 10, mounted on same, is oscillated by means of the oscillation of the arm. This link connection consists of two bars 32 and 33, bent to a horseshoe form, engaging with the vertical axis 31 on the arm 28 by their rounded parts, where they are reduced in thickness, so as to lie one upon the other, as shown in Figs. 1 and 3, and are held in position by a broad-headed screw screwing into the axis. The straight limbs of these bent bars 32 and 33, which lie in opposite directions, are secured to cross-bars 34, which have curved parts to abut on studs or pins 35, formed on the ranger-ring in the line of the arc of oscillation by means of capstan-screws 36, and this arrangement permits of fine adjustment of the ranger-ring in relation to the arm.

The free end of the arm 28 moves over a segmental graduated scale or dial 37, secured to frame 1 of instrument, on which is marked a series of indications of distances or a graduated arc showing divisions which are multiples of minutes and seconds of arc. The ranger 10 is adjusted on the object, being observed by means of the worm 38 on the rod 39, turned by the milled head 40 engaging with a curved rack 41, secured on the arm 28, the motion being communicated to the ring 26 by means of the link connections described.

After adjustment of the follower and ranger telescopes 9 and 10 so that their lines of sight cross at a point whose distance is known, and which may be conveniently two hundred and ninety-seven and one-half feet in front of the instrument, while the center line 42 of the eye of the arm 28, above which a magnifier (not shown in the drawings) would be mounted, is over the number 26 of the scale, all that has to be done to find the range of any object beyond that distance is to adjust the ranger-telescope by moving the arm 28 over the dial 37 until the cross-line of the ranger 10 and follower 9 simultaneously coincide with the object, when the distance can be read off on the dial. The reading may also be taken by a vernier at the end of the arm reading into a graduated arc on the dial 27, whose divisions represent multiples of the angle described by the line of collimation of the ranger-telescope, a reference to specially-prepared tables giving the distances or ranges corresponding to the observed angles.

When the true center lines of sight of the follower and ranger telescopes are parallel, the cross center line 42 over the dial should coincide with or cover a line indicating infinite distance, or the zero of the arm should correspond with the line marked zero on divided arc when a vernier on the arm is used. This line forms one end of the figured part of the dial or divided arc, as the case may be. The other end of the dial or scale is determined as the position that the zero or cross-line of the arm indicates on the dial when the cross-lines of the follower and ranger telescopes simultaneously center or bisect a distinct mark which has been accurately placed at the nearest distance which the instrument has been designed to measure. This distance has been referred to as preferably two hundred and ninety-seven and one-half feet in front of the instrument. Any suitable distance, however, may be fixed on and the figuring on the dial adapted to it.

A reciprocal scale may be used instead of the dial. The marks on the scale corresponding to distances or ranges may quite conveniently be made empirically.

A convenient method of figuring the dial and marking the divisions of the arc for an instrument with a twenty-seven-inch optical base is as follows: Set the cross-line or zero of the radial arm at about the center of the blank dial or arc. Then by means of the milled head 44, Fig. 3, adjust the cross-lines of the ranger-telescope onto a wire which has been placed very accurately at a distance of five hundred and ninety-five feet from the center of the instrument. Then by means of the "tommy-pin" in the capstan-headed screw 23, Figs. 2 and 4, of the follower-telescope adjust its cross-lines onto the same wire. When the cross-lines of the ranger and follower telescopes simultaneously bisect the wire referred to, the position of the arm should be marked on the dial or arc and this point treated as the center of its length. This adjustment of the follower-telescope is permanent, and the tommy-pin in the capstan-headed screw 23, Figs. 2 and 4, must not be again used in taking ranges. For a divided arc this point should be called 13, and if plain figures are to be used it should read five hundred and ninety-five feet. Place another wire at half the foregoing distance—namely, 297.5 feet—and adjust the ranger onto it by means of the rod 39 and worm 38 with the right hand and the follower by means of the screw 44, Fig. 3, with left hand. When these adjustments are simultaneous, the point indicated by the arm on the dial will be the minimum range and for an arc should be called 26 or for plain figures 297.5 feet. As the angle varies as the reciprocal of the range it follows that the distance of motion on the arc of the radial arm in adjusting the ranger-telescope from an object at 297.5 feet to an object at twice that distance, or five hundred and ninety-five feet, will be equal to half the motion from 297.5 feet to infinite distance. Therefore if we assume that the arm describes, say, roughly, six inches on the arc in giving ranges from 297.5 feet to five hundred and ninety-five feet, then six inches more of the arc will be left to indicate ranges from five hundred and ninety-five feet up to infinite distance. If 26 on the arc corresponds to range 297.5 feet and 13 on the arc corre-

sponds to range five hundred and ninety-five feet, then zero on the arc will correspond to range infinite distance and the line of collimation of the ranger-telescope will describe an angle of twenty-six minutes in ranging from the minimum distance of 297.5 feet up to infinite distance.

The angle given by the instrument is the angle subtended by the optical base of the instrument at the object.

I claim as my invention—

1. A range-finder having a base, a telescope mounted on one side thereof, a ring pivoted to the base, a telescope on the ring, an arm pivoted to the base and to the ring and extending inward across the ring, substantially as described.

2. A range-finder having a base, a telescope, a saddle mounted on one side thereof, a ring pivoted beneath said telescope and passing through the saddle, a telescope on the opposite side of the pivot on the ring and an arm pivoted to the frame, and to the ring, and extending across the ring, substantially as described.

3. A range-finder having a base, a telescope mounted on one side thereof, a ring pivoted to the base, a telescope on the ring, an arm pivoted to the base and to the ring, and extending across the ring, a rack on the arm, and a worm and worm-shaft on the frame to turn the rack, substantially as described.

4. A range-finder having a base, a telescope mounted on one side thereof, a ring pivoted to the base, a telescope on the ring, an arm pivoted to the base and to the ring, and extending across the ring, a rack on the arm, a worm and worm-shaft on the frame, to turn the rack and a graduated scale at the end of the arm, substantially as described.

5. In range-finding instruments, a frame, a telescope secured thereto, a ring pivoted to the frame, and a telescope rigidly mounted on the ring, an indicating arm and scale on the frame extending across the ring, link connections between the ring and arm and means for operating the ring through the medium of the arm, in combination with an adjustable cradle to support the frame, a pillar and a tripod, said tripod having turning and clamping appliances and a graduated stay-rod 5, as and for the purpose described.

6. A range-finder having a base, a telescope mounted on one side thereof, a ring pivoted to the base, a telescope on the ring, an arm pivoted to the base, carrying a stud, links pivoted to the stud and to the ring, and an opening in the ring through which the stud passes free from contact with the sides thereof, substantially as described.

7. A range-finder having a base, a telescope mounted on one side thereof, a ring pivoted to the base, a telescope on the ring, an arm pivoted to the base, carrying a stud, links pivoted to the stud and to the ring, and an opening in the ring through which the stud passes free from contact with the sides thereof, said arm extending inward across the ring, in combination with gearing for moving said arm and a scale on the frame over which said arm moves, substantially as described.

8. In combination with a range-finder having a frame, a supporting-pillar, two telescopes and a graduated scale, a stay-rod secured to the frame at one end, and adjustably secured to the pillar at the other end, and a graduated scale on the stay-rod, as and for the purpose described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JAMES WADDELL.

Witnesses:
R. C. THOMSON,
D. BENNIE BROWNLIE.