(No Model.) 5 Sheets—Sheet 1.

A. BARR & W. STROUD.

RANGE FINDER

No. 583,243. Patented May 25, 1897.

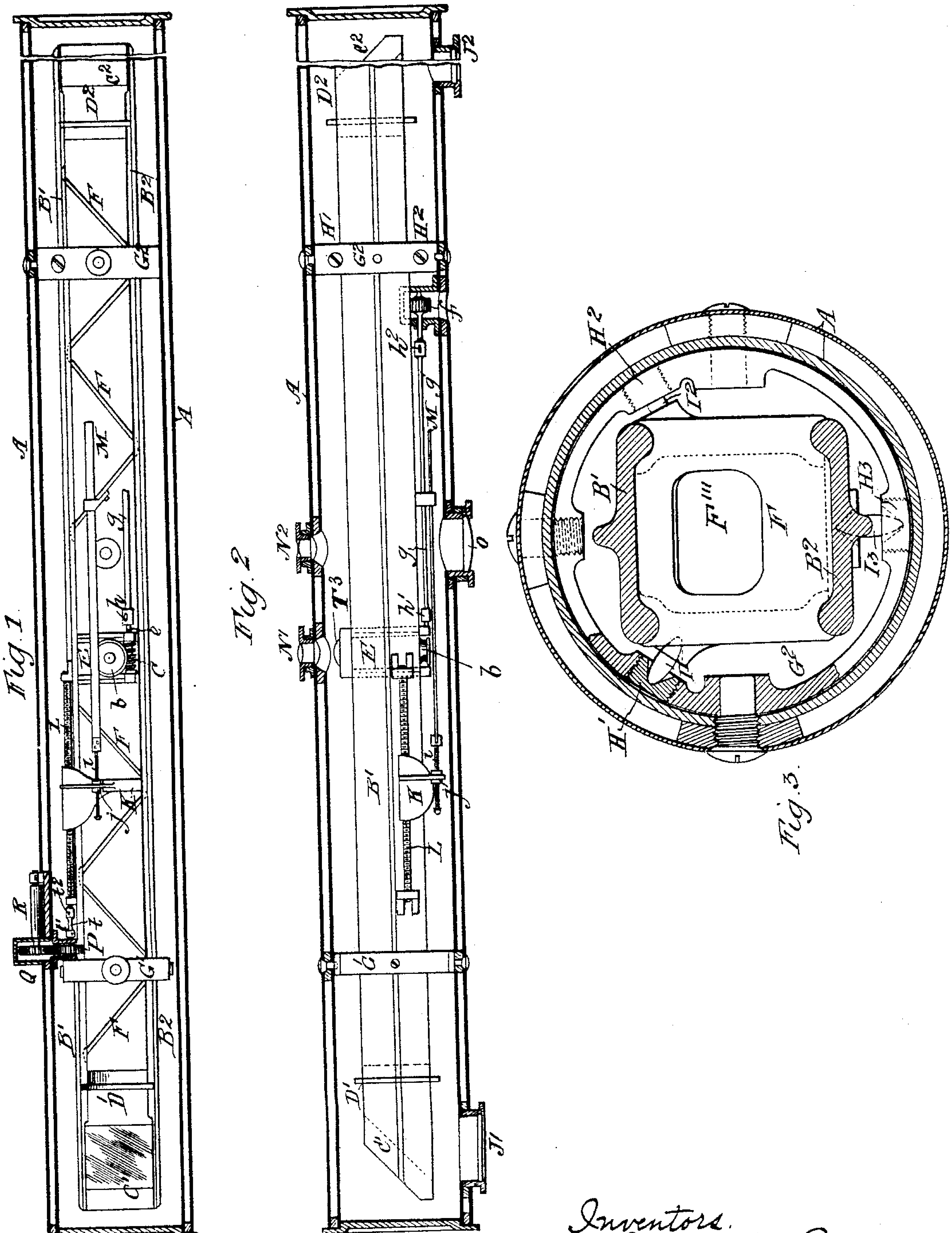

Fig. 1

Fig. 2

Fig. 3.

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(No Model.) 5 Sheets—Sheet 2.

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RANGE FINDER.

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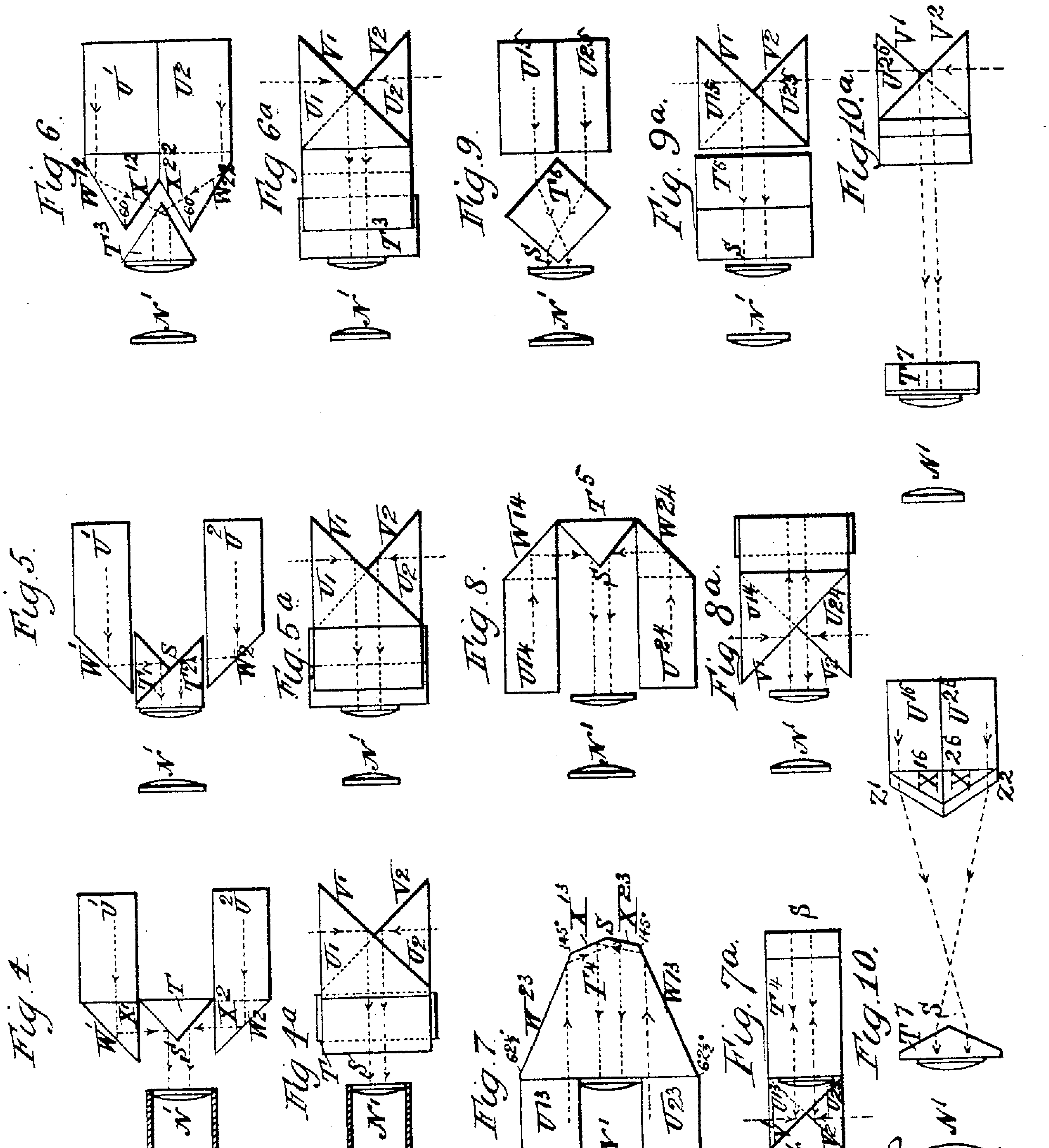

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(No Model.) 5 Sheets—Sheet 3.

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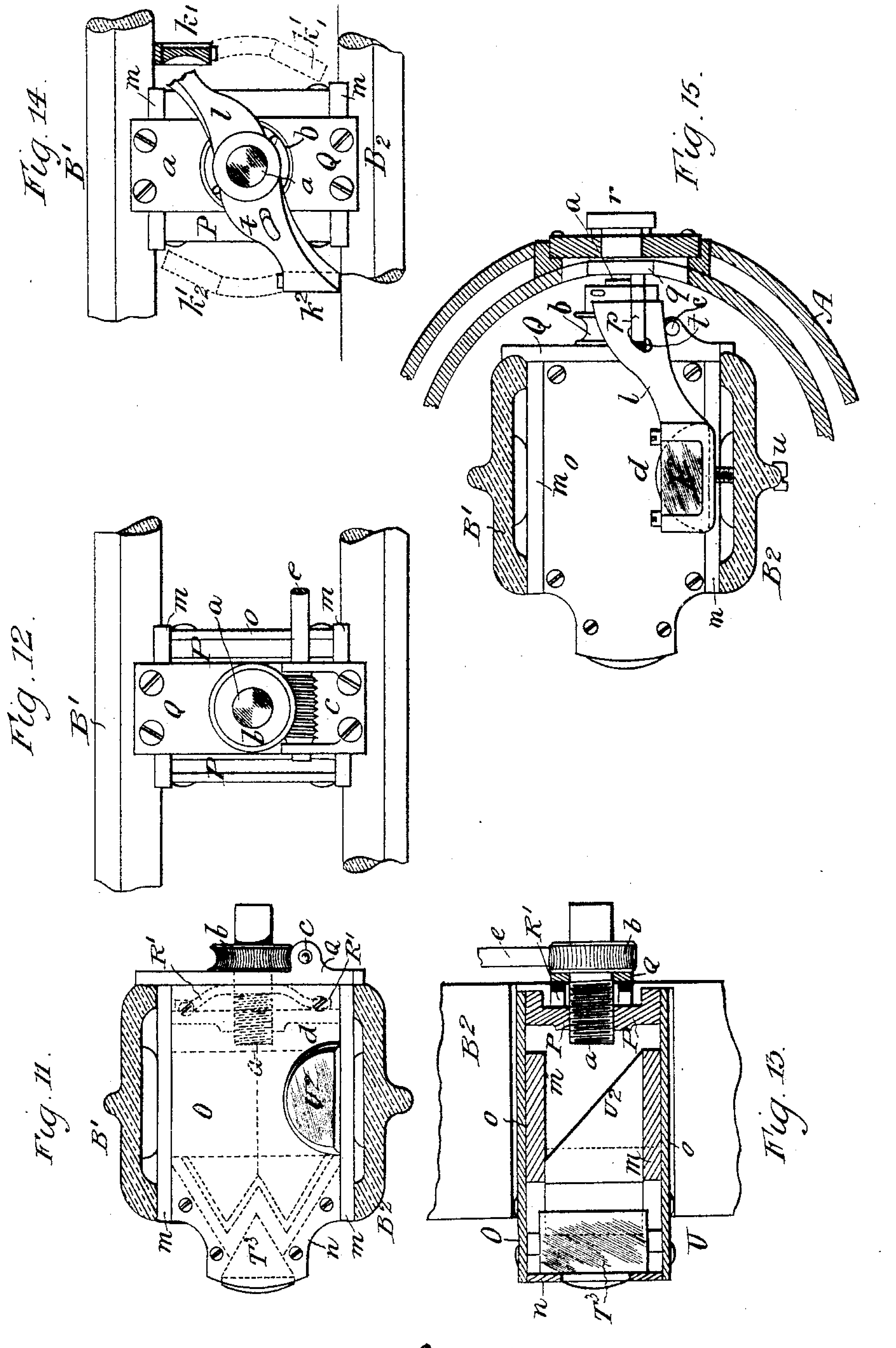
RANGE FINDER.

No. 583,243. Patented May 25, 1897.



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(No Model.) 5 Sheets—Sheet 4.

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RANGE FINDER.

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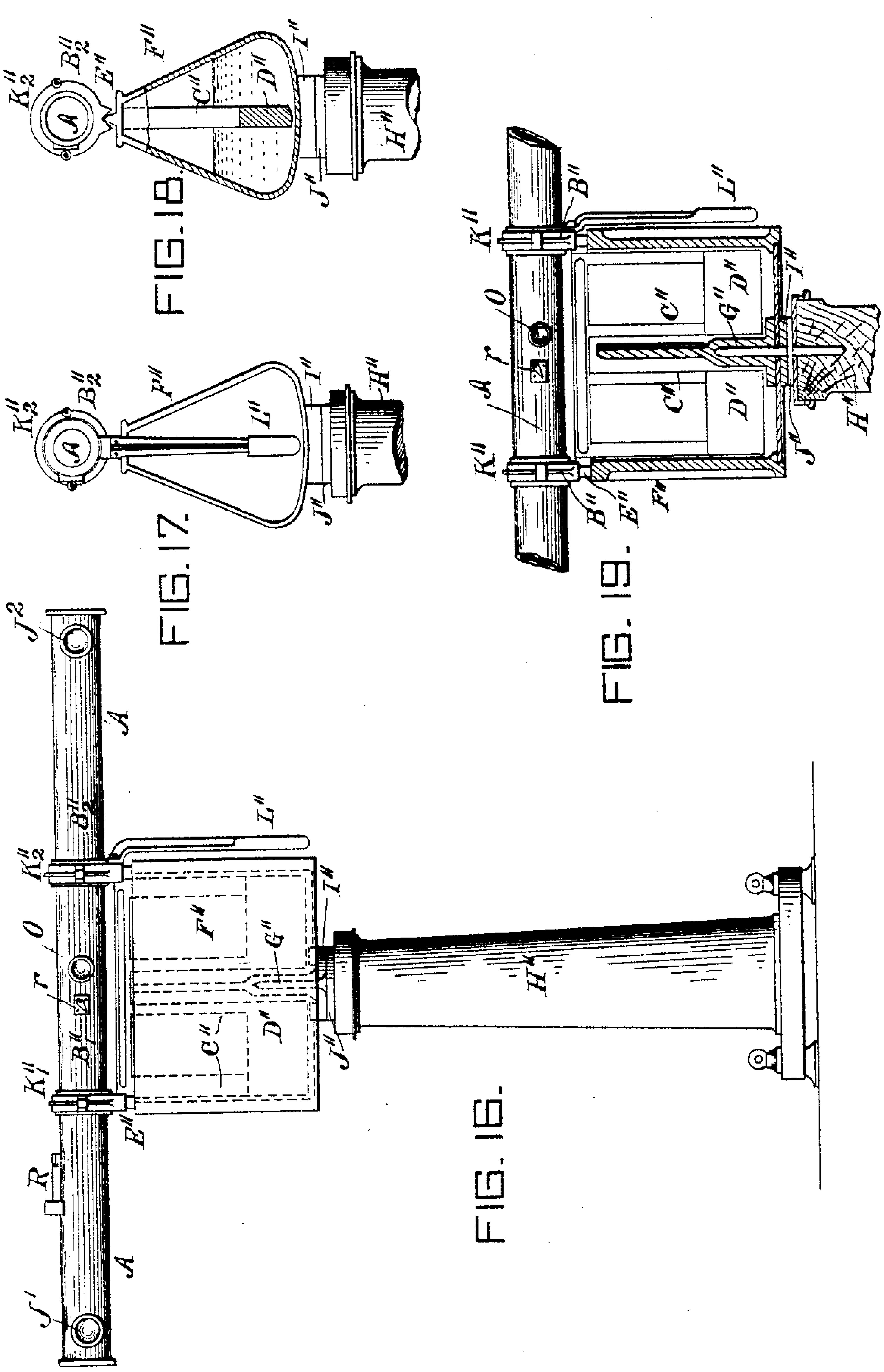

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(No Model.) 5 Sheets—Sheet 5.

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RANGE FINDER.

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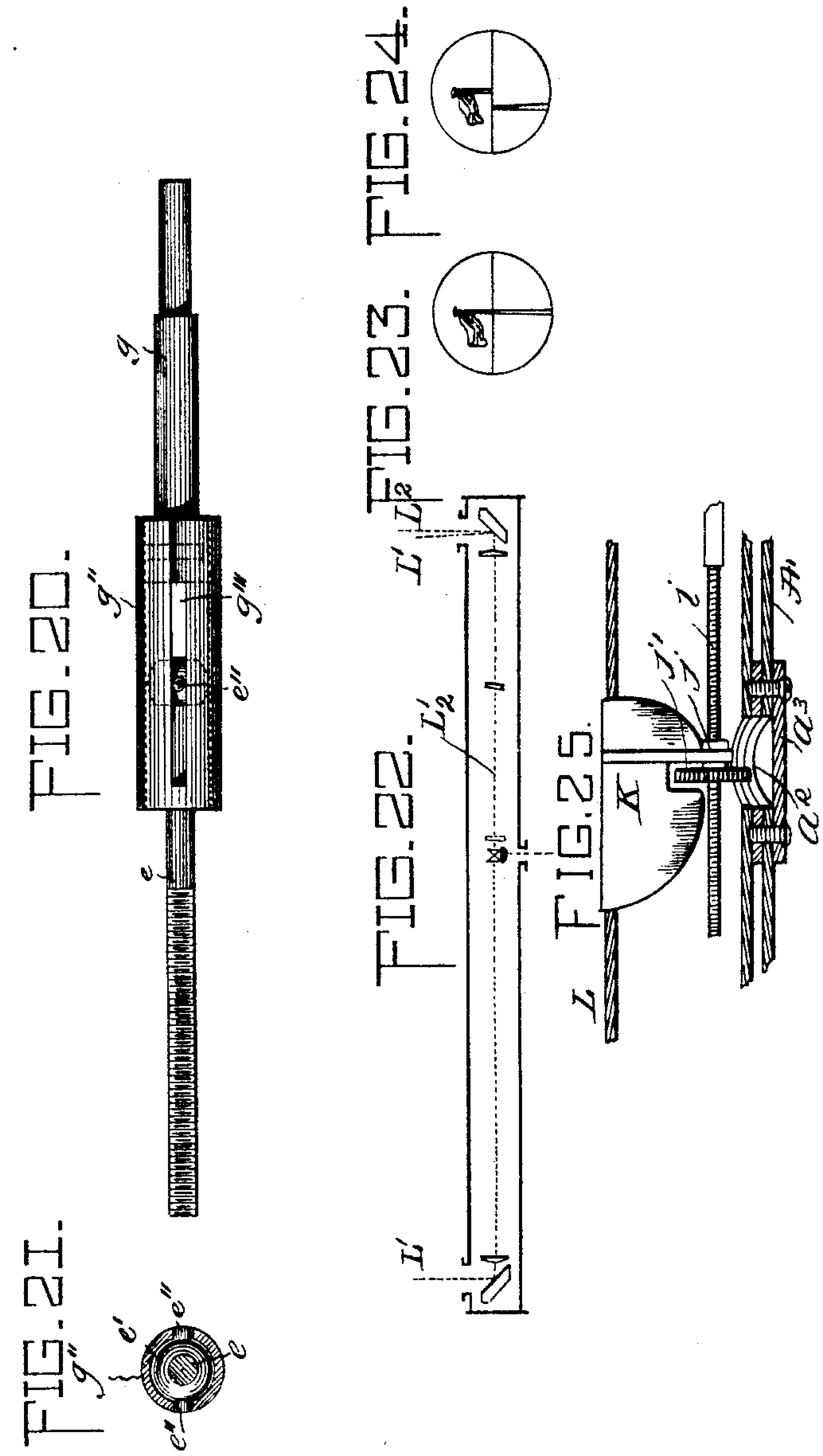

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UNITED STATES PATENT OFFICE.

ARCHIBALD BARR, OF GLASGOW, SCOTLAND, AND WILLIAM STROUD, OF LEEDS, ENGLAND.

RANGE-FINDER.

SPECIFICATION forming part of Letters Patent No. 583,243, dated May 25, 1897.

Application filed January 19, 1895. Serial No. 535,567. (No model.) Patented in England July 12, 1893, No. 13,507; in France June 23, 1894, No. 239,528; in Italy July 27, 1894, No. 36,926, and in Belgium August 8, 1894, No. 111,339.

To all whom it may concern:

Be it known that we, ARCHIBALD BARR, a resident of Glasgow, Scotland, and WILLIAM STROUD, a resident of Leeds, England, subjects of the Queen of Great Britain and Ireland, have invented Improvements in Range-Finders, of which the following is a specification.

This invention is embodied in patents in the following countries: Great Britain, No. 13,507, dated July 12, 1893; France, No. 239,528, dated June 23, 1894; Italy, No. 36,926, dated July 27, 1894, and Belgium, No. 111,339, dated August 8, 1894.

This invention relates to improvements in single-observer range-finders; and the object is to construct such instruments so that they shall give more accurate means for determining the ranges or distances of objects.

Our invention is an improvement in that construction of range-finder described, shown, and claimed in Letters Patent No. 567,675, issued to us on the 15th day of September, 1896.

In the drawings, Figure 1 is a side elevation of our improved range-finder, the casing being shown in section. Fig. 2 is a top view looking at right angles to that shown in Fig. 1, the casing being shown in section. Fig. 3 is a transverse section through a bearing-ring. Figs. 4, 5, 6, 7, 8, 9, and 10 are side views, and Figs. 4^a, 5^a, 6^a, 7^a, 8^a, 9^a, 10^a are top views, respectively, showing different forms of eyepiece-prisms. Fig. 11 is a transverse section showing a side view of the halving device as seen from the right-hand end of the instrument. Fig. 12 is an elevation thereof, looking toward the observer. Fig. 13 is a horizontal section of the same. Fig. 14 is a detail side elevation showing the rocking lens-lever. Fig. 15 is a detail side elevation thereof. Fig. 16 is a side elevation of our range-finder provided with a stand. Fig. 17 is an end elevation thereof. Fig. 18 is a vertical transverse section of the same. Fig. 19 is a vertical longitudinal section thereof. Fig. 20 is an enlarged elevation of the coupling. Fig. 21 is a transverse section thereof. Fig. 22 is a diagrammatic view of the instrument. Fig. 23 shows partial images in coincidence. Fig. 24 shows partial images out of coincidence. Fig. 25 is a detail section showing means for adjusting the scale on the prism-frame.

Figs. 1 and 2 show a range-finder embodying some of the improvements to which this specification more especially refers.

A is the outer case of the instrument, composed of two tubes in the manner described below.

B' B^2 are respectively the upper and lower metal bars of the framework carrying the principal optical parts of the instrument, especially the reflectors C' C^2, which are represented as made of speculum-metal, the object-glasses, contained in holders D' D^2, and the eyepiece-prisms, hereinafter described, contained in a box E. This framework consists of two metal bars B' B^2, as stated, (preferably of copper, on account of its high conductivity for heat,) of the section shown in Fig. 3, or other suitable section, connected together by a system of waved bracing F. This bracing F may consist of wires or rods, but we prefer to construct it of a strip or plate F, of copper or other metal, (preferably with thickened edges,) which is bent upward and downward in a waved line, as shown in Fig. 1, and soldered or riveted or otherwise attached to the bars B' B^2. This strip F is pierced with apertures F''' of the necessary dimensions to allow the passage of the beams of light (reflected, respectively, from the reflectors C' C^2) to the eyepiece-prisms. This bracing therefore constitutes a system of diaphragms, besides giving strength to the frame.

We may sometimes use a cast-metal frame of a construction somewhat similar to that above described. The essential feature of this framework is that the upper and lower bars being flat or nearly flat expose much less surface than a tube would do to receive heat from the front or back of the instrument, and in the second place afford the best means for the conduction of the heat received from the back to the front of the framework, or vice versa, thus tending to maintain the front and back portions of the frame or support carrying the optical parts of the instrument or some of them as nearly as possible at the same temperature. It is not essential that the upper and lower bars should be so nearly at one and the same temperature. The framework described has, then, the advantages over the tube hitherto customarily used for supporting the optical parts, or some of them, of single-observer range-finders or telemeters that it affords convenient access to the various parts during construction and subsequently, and that it greatly lessens the liability of the instrument to give erroneous indications, due to bending caused by unequal heating at the front and back of the instrument.

The framework is supported from the outer case A of the instrument by means of two bearing rings or pieces G′ G², one of which, G′, is, as shown in the drawings, constructed in a similar manner to the gimbal-ring of a mariner's compass. The other bearing-ring, G², we prefer to construct as illustrated in Fig. 3. The ring G², which is fixed to the outer case by screws or other means, carries three screwed plugs H′ H² H³, containing conical or spherical recesses at their inner ends, and the instrument is supported by means of three pillars or struts I′ I² I³, extending between these conical or spherical recesses and similar recesses in parts attached to the framework B′ B². The object of this special means of support is that while the bearing G′ prevents the instrument from moving longitudinally or transversely in the case or from rotating about the axis of the case the bearing shown at G² does not control the instrument longitudinally nor rotationally with reference to the case A, and thus any bending or twisting of the case A communicates no bending or twisting to the tube or framework carrying the optical parts.

J′ J², Fig. 2, are windows, preferably constructed of optically-parallel plane glass, which serve to exclude rain and dust from the interior of the instrument. K is the frame, carrying the deflecting-prism; L, the screw, operating that frame M is the scale; N′, the right eyepiece; N², the left eyepiece.

O is a small object-glass which, together with a conical lens in the eyepiece N², constitutes a small Galilean telescope, which we sometimes use as a "finder" to enable the observer more quickly to direct the instrument upon any given object, in the same manner as the finder facilitates the use of an astronomical telescope. In this case the concave lens in the eyepiece N², above referred to, may only occupy one half of the aperture of the eyepiece, the other half having opposite to it a portion of a convex lens, by means of which a portion of the scale and an index attached to the framework B′ B² may be seen. The scale is, preferably, in this case kept above or below the level of the center of the instrument, so as not to interfere with the view of the object to be observed through the finder. The screw by which the deflecting-prism is moved is worked by a pinion P, into which a wheel Q gears, the wheel Q being mounted upon the spindle of a toothed roller R, which is operated by the fingers of the observer. The axle of the pinion P is preferably supported in bearings attached to the case, and the axle is preferably connected to the screw L (supported in bearings attached to the framework B′ B²) by means of a connecting-piece provided with universal joints and freedom for endwise motion, but capable of communicating rotary motion in a similar manner to that hereinafter described with reference to the "halving adjustment," so that no important forces tending to bend the framework may be communicated to the framework from the hand of the observer.

In Figs. 4, 4ª, 5, 5ª, 6, 6ª, 7, 7ª, 8, 8ª, 9, 9ª, 10, and 10ª we show several methods of carrying out our improved system of constructing the optical arrangements situated in the center of the instrument for reflecting the beams of light to the eye of the observer. Plane mirrors may in some cases be substituted for reflecting-prisms where such mirrors would produce a like effect. These optical arrangements (which in the instrument are contained or held in a case or holder E, shown in Figs. 1 and 2 and in more detail in Figs. 11, 12, and 13) we usually designate "eyepiece-prisms." Figs. 4 and 4ª show one arrangement of such eyepiece-prisms.

T is a prism of speculum-metal or other opaque reflecting material with an edge S as sharp as possible, which edge is situated in the focus of a lens or eyepiece N′. This prism or its equivalent in other arrangements we designate the "separating-prism."

U′ U² are two pieces of glass, each of which may be formed of two prisms cemented together or of one piece having the form of such a combination. For convenience we shall call these reflectors "prisms," even when compound. These prisms U′ U² receive upon their faces V′ V² beams of light from the two ends of the instrument, respectively, and reflect these beams through a right angle, or approximately so, onto the sloping faces W′ W², whence they are reflected through the faces x' x^2 onto the separating-prism T, which again reflects them through the lens or eyepiece N′. The several angles of these prisms may be somewhat modified, but we prefer to make the angle at S of the separating-prism ninety degrees and the angles between the faces W′ X′ W² X² forty-five degrees.

Figs. 5 and 5ª show an alternative arrangement in which the speculum-metal separating-prism is replaced by a totally-reflecting prism, (or combination of two prisms T′ T².) The prism T′ is cemented to the prism T² by means of Canada balsam or other transparent material of as nearly as possible the same refractive index as glass.

Figs. 6 and 6ª show another alternative arrangement in which the separating-prism is equilateral, or nearly so. In this case the faces W¹² W²² are parallel, respectively, to the remote faces of the separating-prism T^3, while the faces X^{12} X^{22} are parallel, or nearly so, to the near faces of the separating-prism T^3.

Figs. 7 and 7^a show another alternative arrangement. U^{13} U^{23} represent right-angled prisms arranged to receive the beams of light from the objective and to reflect them away from the eyepiece into the prism T^4. The faces W^{13} X^{13} of the prism T^4 are at right angles to each other, and the faces W^{23} X^{23} are at right angles to each other, while the angle between the faces X^{13} X^{23} is preferably a few degrees greater than one hundred and twenty degrees—say one hundred and twenty-five degrees—in order to allow rays of light passing from the reflecting-face W^{23} to points on the reflecting-face X^{23} (close to the edge S) to pass clear of the face X^{13}. The paths of two rays are shown in the drawings. In this case the faces X^{13} and X^{23} must be silvered.

In another arrangement shown in Figs. 8 and 8^a the separating-prism T^5 is of speculum-metal or other opaque reflecting material. The prisms U^{14} U^{24} receive the beams of light on their faces V' V^2 and reflect them away from the eyepiece to the faces W^{14} W^{24}, which reflect them to the separating-prism T^5, whence they are reflected to the eyepiece.

The arrangements shown in Figs. 7, 7^a, 8, and 8^a have the advantage that the object observed is caused to appear erect without the aid of an erecting system of lenses in the eyepiece.

In all the above cases it will be noted that there are three reflectors for each beam in the "eyepiece-prism" combination, two reflecting-surfaces being necessary in each of the beams to direct the light onto the separating edge. In the next case, however, Figs. 9 and 9^a, two of the reflections are replaced by two refractions.

T^6 represents a prism of glass whose section is a square or a rhomboid, (or approximately so,) through which the beams of light (after reflection from the prisms U^{15} U^{25}) are transmitted and refracted, as shown. In this case the edge of the prism nearest the eyepiece forms the separating edge, and upon it the eyepiece is focused.

Figs. 10 and 10^a show another arrangement of prisms in which the light is refracted in passing through the inclined faces X^{16} X^{26} of the prisms U^{16} U^{26}. In this case the prisms U^{16} U^{26} may be made of crown-glass, and prisms Z' Z^2, of flint-glass, may be cemented to those faces in order to constitute an achromatic arrangement. The images are, as in the other cases, formed above and below the separating edge S of the separating-prism T^7, the faces of which have such an angle that the beams of light striking them in an inclined direction are caused to become parallel to one another before passing through the eyepiece.

In the eyepiece-prism arrangements shown in Figs. 5, 5^a, 6, 6^a, 7, 7^a, 10, and 10^a the field-lens of the eyepiece (or a single-lens eyepiece, if such be used) may be cemented onto the outer surface of the separating-prisms, as shown; or the outer face may in some cases be ground convex, so as to be equivalent thereto.

It is to be understood that the essential feature of our improved system of eyepiece-prisms is the use of a prism (which for distinction we call the "separating-prism") having one edge (which for distinction we call the "separating edge") parallel to the length of the instrument and in the focus of the eyepiece, (or nearly so,) which prism is so formed and disposed that the two images formed by light entering at the two ends of the instrument, respectively, are formed at or near the edge referred to, and while the rays forming the images approach the separating edge in different directions they are respectively either refracted at or reflected by the two faces which meet in the separating edge, so as to pass through the eyepiece as if they came from one image. The portion of one image which falls below the separating edge and the portion of the other image which falls above that edge are not seen by the observer.

Figs. 11, 12, and 13 show our improved method of effecting the halving adjustment—that is, to accomplish the condition that the two partial images shall form a complete one, Fig. 11 being a side view of the arrangement as seen from the right-hand end of the instrument, Fig. 12 an elevation looking toward the observer, and Fig. 13 a horizontal section. The arrangement of eyepiece-prisms shown in these figures is that shown in Figs. 6 and 6^a, but the method is applicable also to other systems of eyepiece-prisms constructed upon our improved method—as, for example, those shown in Figs. 4, 4^a, 5, 5^a, 8, 8^a, 10, and 10^a. The prisms U U^2 are held in a box *m*, fixed to the framework B' B^2, while the separating-prism T^3 is held in a metal piece *n*, to which are attached two plates O, which pass along the sides of the box *m*. These plates are connected at the end remote from *n* by means of a piece P. Another piece Q is fixed across the back of the box *m*, and springs R' tend to force P and Q apart, while they are pulled together by means of a screw *a*, actuated by a worm-wheel *b*, driven by a worm *c*, so that when the worm is rotated the piece P is moved backward or forward, carrying with it the cheeks or plates O and the block *n*, and thus the separating-prism T^3 is moved outward or inward relatively to the prisms U' U^2. The effect of such motion (as will be obvious from the paths of the reflected rays, as shown in Fig. 6) is to cause the two partial images of the objects observed, seen respectively above and below the separating edge S, to appear to move vertically toward or from each other, by which means the adjustment which we term "halving" is accomplished.

Apertures, as shown at *d*, are made in the sides of the box *m* and in the cheeks O, so as to admit the beam of light from the two ends of the instrument to the prisms U′ U^2, respectively.

The shaft *e*, Figs. 12 and 13, is connected to a milled head *f*, Fig. 2, by means of a shaft *g*, Figs. 1 and 2, preferably provided with couplings *h′* h^2, so constructed that while they communicate rotary motion from the shaft carrying the milled head *f* they impart no important forces to the frame work B^2, tending to bend the latter. Such couplings may conveniently be constructed as follows, (see Figs. 20 and 21:) Short pieces of cylindrical tubes *g″*, having two longitudinal slots *g‴* diametrically opposite each other, are fixed on the ends of the shaft *g*. The shaft *e* and the spindle carrying the milled head *f* have each a spherical or somewhat spherical end *e′*, which lie within the tubes referred to, and pins *e″*, passing through these spherical ends, engage in the slots *g‴* of the tubes *g″*, attached to *g*, and communicate rotational motion to the latter, while exerting no important longitudinal or bending stresses.

In Figs. 1 and 2 the scale M is shown attached to a screw *i*, which passes through a nut *j*, carried upon the prism-frame K, but free to revolve relatively thereto. Referring to Fig. 25, access to the nut may be gained through an aperture a^2 in the case A, provided with a removable cover a^3, or the nut *j* may be formed as a toothed wheel *j′*, gearing with a pinion-rod supported from the framework B, driven by a milled head attached to the tube A and communicating its motion to the same pinion-rod through the medium of a shaft provided with couplings, in a manner similar to that above described with reference to the halving adjustment.

Figs. 14 and 15 show one means of carrying out our improved method for the observation of lights and other objects difficult to observe upon on account of their smallness of apparent dimensions or irregularity of outline.

k′ k^2 are lenses or pieces of glass having one or both surfaces ground to either a concave or convex cylindrical form, such as the lenses used by opticians in spectacles to neutralize astigmatism, but we use lenses of greater curvature than ordinary spectacle-lenses when we introduce them in the position indicated in the drawings. These lenses are fixed to a rocking lever *l*, which is pivoted upon the outer end of the screw *a*. (Shown in Fig. 14.) The lever is kept in its position by means of a collar or other suitable device. This lever is omitted in Figs. 1, 2, 11, 12, and 13 to avoid confusion. When the lever is in the position represented in Figs. 14 and 15, the beams of light coming to the prisms U′ U^2 from the two ends of the instrument, respectively, pass through the "astigmatizing-lenses." The effect of interposing these lenses is to cause the images of a spot of light to appear as a line at right angles or approximately, so to the separating edge S, before mentioned. When not required, the lenses may be removed from the beams of light by rotating the lever *l* so as to bring the lenses *k′* k^2 into the positions indicated by the dotted lines at k_1' k_2'. The lever *l* is operated from the outside of the tube A by means of crank *q*, the pin *p* of which passes through a slot *t* in the lever *l* in such a manner as not to apply forces tending to bend the framework B′ B^2 of the instrument.

The crank *q* is worked by means of a lever *r*, lying outside of the tube A, as shown in Figs. 15, 16, and 19, the crank *q* and the lever *r* being fixed to a spindle passing through a suitable bearing carried by the tube A.

The screw *u*, Fig. 15, is for the purpose of stopping the lever *l*, and consequently the lenses *k′* k^2, in the desired position. We do not confine ourselves to this mechanism for putting the cylindrical lenses into the paths of the beams, nor do we confine ourselves to introducing the lenses into the position indicated in the drawings.

Lenses having one or both surfaces cylindrical may be introduced into the beams of light at any point of the course of those beams. Thus they may even be introduced outside of the windows, so that the beams pass through them before entering the instrument, the lenses being chosen of such a curvature as to produce the desired length of streak.

One lens may be introduced into the two beams of light after these have passed the separating edge and either before or after the beams have passed through the eyepiece or one lens of the eyepiece, but this has the disadvantage that the separating edge will no longer be clearly visible while the object is astigmatized.

In Figs. 1, 2, and 3 the outer case A is shown constructed of two tubes, one outside of the other. One or both of these tubes is preferably constructed of a metal having high conductivity for heat, such as copper, in order to further equalize the temperature around the frame-piece or tube to which the optical parts are attached.

Figs. 16, 17, 18, and 19 show our improved arrangement of stand for the instrument, suitable for use on board ship. H″ represents a pillar or pedestal constructed of metal or wood, carrying a vertical spike or pivot G″. This pillar H″ is fixed to the deck or other portion of the ship by suitable screws or other connections. A tank F″ is supported upon the spike G″, so as to be free to revolve in azimuth about the latter. This tank may conveniently be constructed of three cast-metal plates, of the shape shown in outline in Fig. 17, which form its two ends and a central diaphragm. A sheet of metal is bent round these plates and fastened to them, thus forming the front, bottom, and back of the tank. The central diaphragm may contain a socket to fit over the spike G″, and the tank may have a flange or facing I″, resting upon a corresponding facing J'', attached to the pedestal H''. Knife-edges E'', fixed to the ends of the tank, support a framework C'', to which a balance-weight D'' is attached. This framework C'' also supports two forks or bearings B_1'' B_2''. In these bearings B_1'' B_2'' the instrument A rests, so as to be free to be turned about its longitudinal axis, while it may be prevented from moving endwise by means of slightly-projecting flanges or collars, attached to the instrument and lying on each side of one of the bearings.

The instrument A may be secured in the bearings B_1'' B_2'' by means of hinged cover-pieces K_1'' K_2'', fixed to the bearings by means of pins. Attached to the swinging frame a handle L'', Figs. 16, 17, and 18, may be provided, most conveniently placed at the left-hand side of the observer, when using the instrument.

The tank may when desirable be partly filled with water or other liquid, as shown in Fig. 18.

During use the instrument may be turned in azimuth about the spike G'' and may be rotated in the bearings B_1'' B_2'' to the required angular altitude, but the latter motion may also be accomplished by swinging it upon the knife-edges E'' by aid of the handle L''. Again, if the instrument is set by rotation in its bearings so as to be directed toward the horizon or other altitude the balance-weight D'' tends more or less to maintain the direction of observation independently of the rolling or pitching of the ship, while the tendency of the instrument to oscillate may be checked or damped by means of liquid in the tank, and the observer may further control such motions by use of the handle. The tank further serves, though no water be used in it, to shield the balance-weight from the wind, which otherwise would tend to move the instrument in altitude.

Bearings of the ordinary form or ball or roller bearings may be substituted for the knife-edges E''; or, again, bearings equivalent to B_1'' B_2'' may be attached to the tank or an equivalent supporting-framework free to revolve in azimuth relatively to the pillar H'', and the instrument A may be supported in such bearings and have attached to it a balance-weight equivalent to the balance-weight D''. In this case the handle L'' would be attached to the instrument A.

Fig. 22 is a diagrammatic representation of the instrument, details being omitted in order to render the mode of operation more easily followed. Two beams of light from the object viewed are received by reflectors C' C^2 and transmitted through objectives D' D^2 toward the center of the tube, where an arrangement of prisms E is placed. These prisms reflect the beams outward through the right eyepiece N'. By these means two partial images of a distant object are seen, one over the other, as shown in Fig. 24. The image seen in the upper half of the field of view of the eyepiece N' is thus formed by the equivalent of a telescope directed toward the object from the right-hand end of the instrument, the image seen in the lower half being formed by the equivalent of a second telescope looking at the object from the left-hand end. Suppose a very distant object is viewed by rays shown at L' L^2, Fig. 22, and that the partial images are seen in correct coincidence, as illustrated in Fig. 23. If now the object approaches the instrument, the beam of light received at C' will have a different direction, such as is shown by the dotted line L_2', and the partial images will no longer appear in proper coincidence, but will occupy such relative positions as are shown in Fig. 24. The partial images might evidently be brought together by rotating the reflector C', but the necessary rotation would be almost infinitesimal, and would consequently require to be made and indicated with excessive delicacy.

We claim—

1. A range-finder or telemeter comprising a framework, for supporting the optical parts of the instrument consisting of two longitudinal pieces, and a bracing by which the pieces are connected together; substantially as described.

2. A range-finder or telemeter comprising a framework, for supporting the optical parts of the instrument consisting of two longitudinal bars and a strip provided with apertures and bent upward and downward and connected with the bars to provide a bracing; substantially as described.

3. A range-finder or telemeter comprising an eyepiece, a prism having one edge situated in the focus of the eyepiece or nearly so and parallel to the length of the instrument, and lenses; the prism being so arranged in combination with the lenses that the partial images of an object viewed through the instrument are formed respectively above and below the edge, while the beams forming these images meet in the edge referred to; substantially as described.

4. A range-finder or telemeter comprising a lense or lenses interposed into one or both of the means of light by which an object is seen for the purpose of drawing out or "stigmatizing" one or both of the images; substantially as described.

5. A range-finder or telemeter comprising a framework for supporting the optical parts, and a case composed of inner and outer tubes, having apertures and connected together at their apertures, providing a space between the tubes, for the purpose of retarding and rendering uniform the communication of heat to and from the inner tube and framework; substantially as described.

6. A range-finder or telemeter comprising a case composed of inner and outer tubes, a framework, for supporting the optical parts,

a bearing-ring for supporting one end of the framework, and a bearing for the other end of the framework consisting of a bearing-ring having three screw-threaded and recessed plugs, and three pillars occupying correspondingly-recessed portions in the framework; substantially as described.

In testimony whereof we have signed our names to this specification in the presence of two witnesses.

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