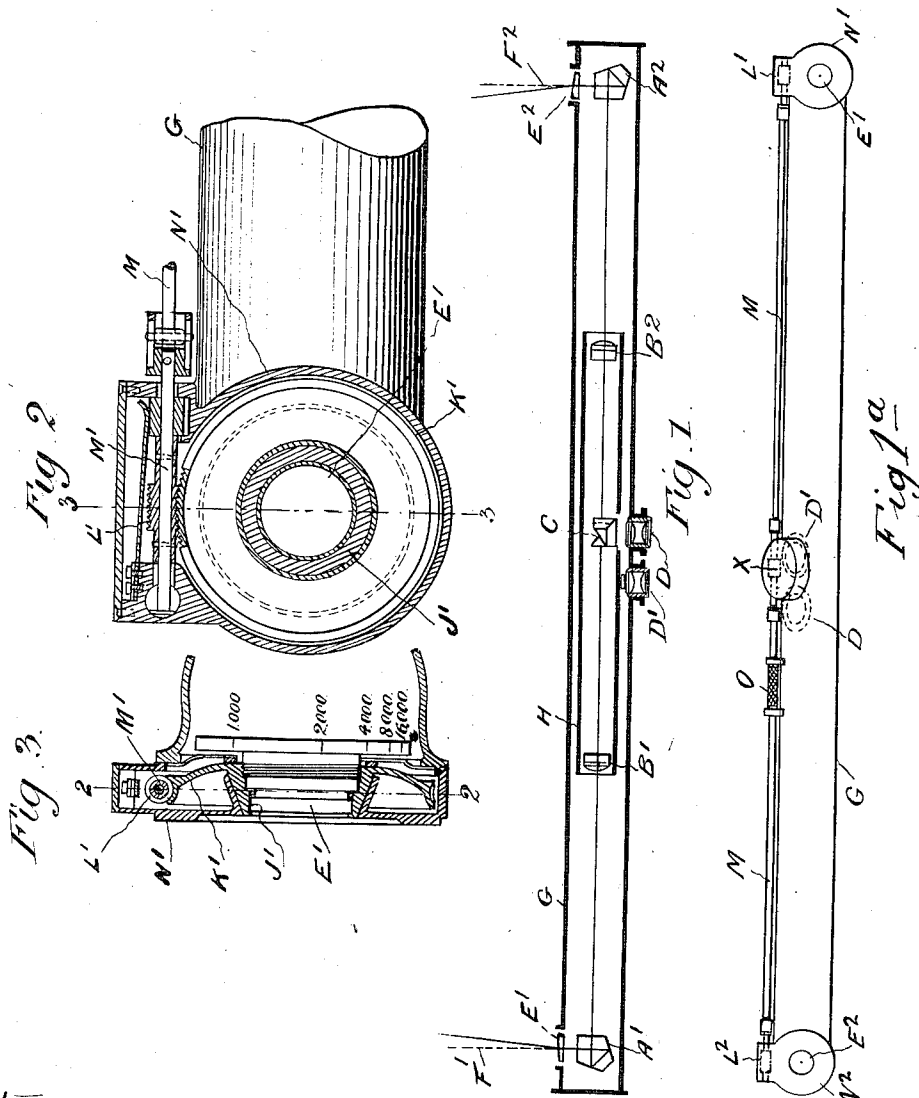


A. BARR & W. STROUD.
SINGLE OBSERVER RANGE FINDER.
APPLICATION FILED APR. 24, 1907.

1,019,412.

Patented Mar. 5, 1912.

3 SHEETS—SHEET 1.



Witnesses
J. M. Wyndham
E. R. Heine.

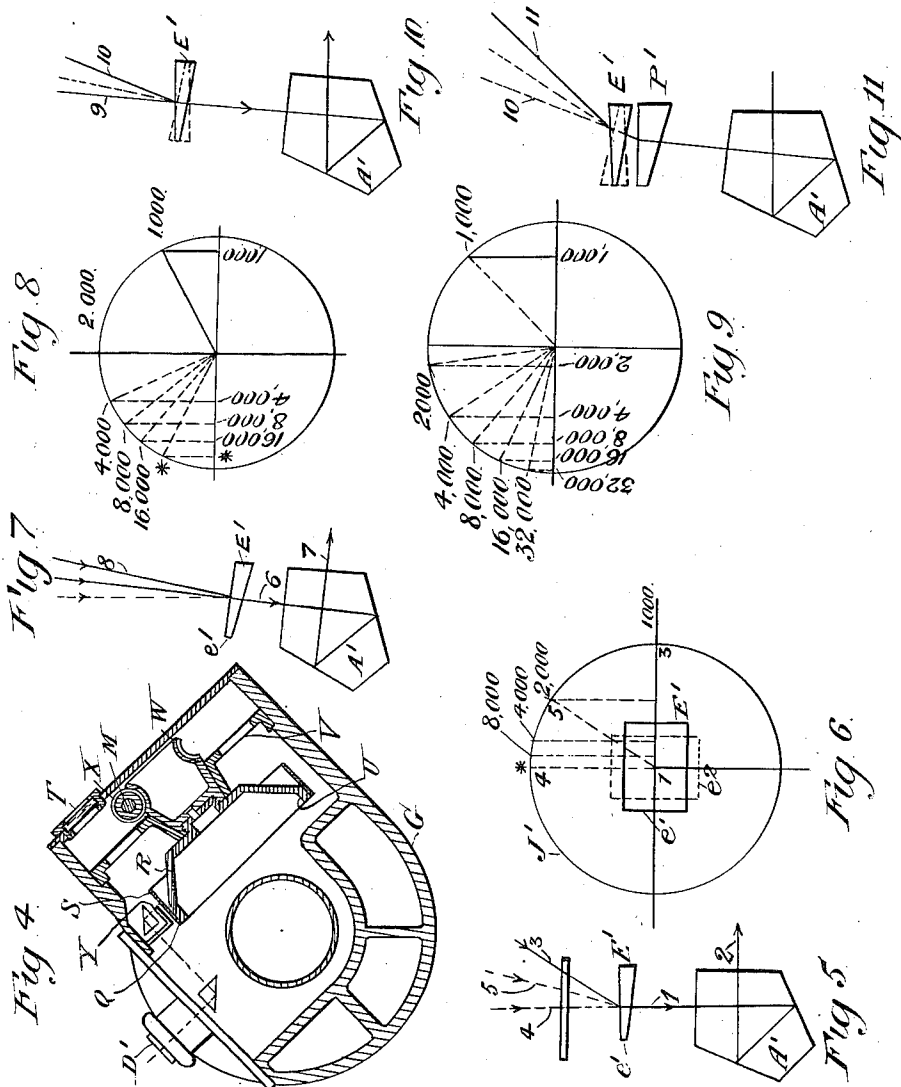
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3 SHEETS—SHEET 2.



Witnesses:
J. M. H. H. H.
E. R. Heine.

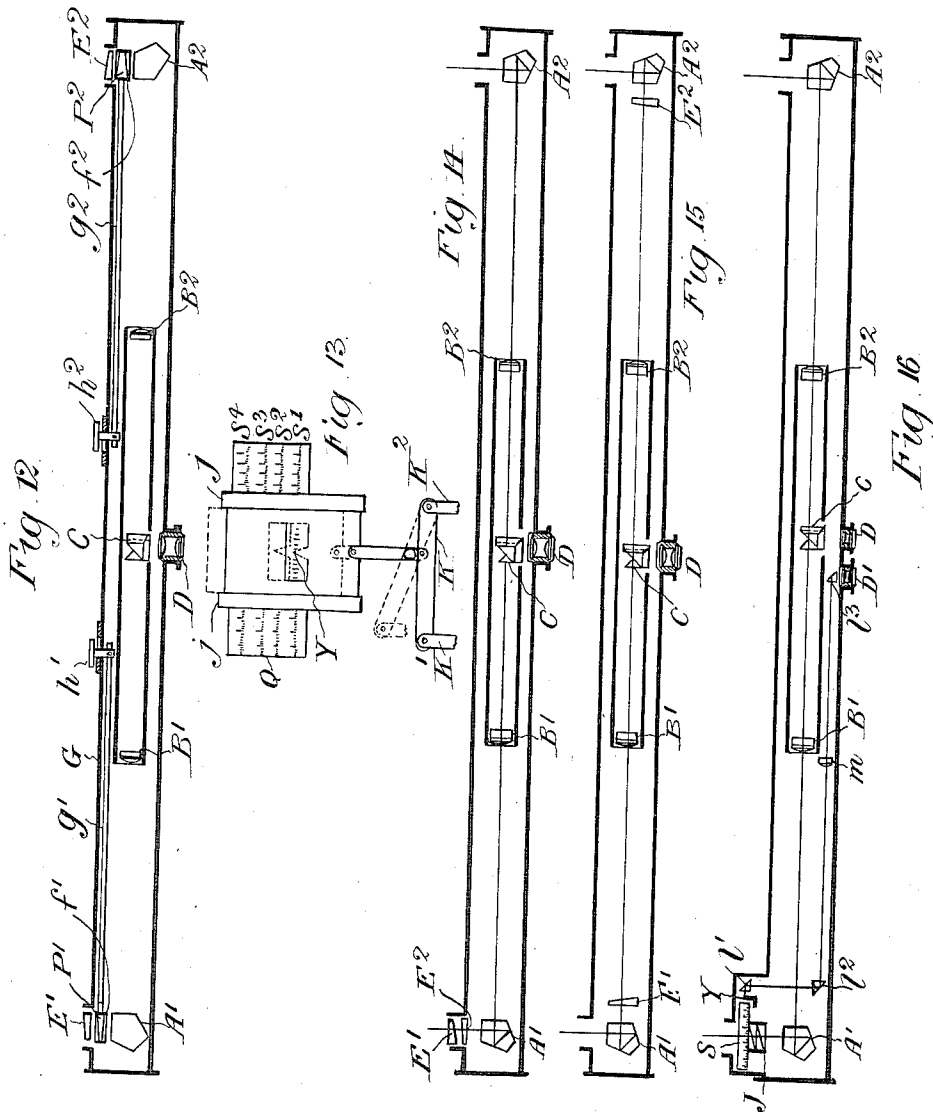
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3 SHEETS—SHEET 3.



Witnesses,
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C. R. Keim.

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Attorneys

UNITED STATES PATENT OFFICE.

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

SINGLE-OBSERVER RANGE-FINDER.

1,019,412.

Specification of Letters Patent.

Patented Mar. 5, 1912.

Application filed April 24, 1907. Serial No. 370,003.

To all whom it may concern:

Be it known that we, ARCHIBALD BARR, of Glasgow, in the county of the City of Glasgow, Scotland, and WILLIAM STROUD, of Leeds, in the county of York, England, have invented certain new and useful Improvements in Single-Observer Range-Finders, of which the following is a specification.

10 This invention relates to improvements in single observer rangefinders of the fixed base type comprising a reflector at each end of the base length of the instrument by which the beams entering at the two ends
15 are reflected inward at approximately right angles toward the center of the base with two objectives through which the beams of light respectively pass on their way to eye piece reflectors provided at the center of the base where the beams are directed outward at approximately right angles to the base, so that observations may be made on the well known coincidence principle of action. In instruments of this type it will be recognized that two complete telescopes are involved which extend in coaxial alinement from the center to form the instrument, and it is necessary to explain, that in the class of instrument to which this invention refers, the objectives in the telescopes, located between the end reflectors and the eye pieces, are situated at an appreciable distance from their respective end reflectors. In instruments of this type the refraction requisite for operation has hitherto been effected in the region between the objective and the eyepiece of one of the telescopes, a condition which restricts the range of observation of the instrument inasmuch as beams of
40 light coming from objects at different distances will in some cases only partially enter the objectives, and it is the object of this invention to effect the refraction of the beams within a sphere adjacent to one of the end reflectors or in the sphere adjacent to the two end reflectors of the telescopes, in order to produce improved instruments of the type in question capable of operation over a wide range, and, further, to provide
50 means for producing definite deviations of one or both of the beams, in conjunction with the provision of appropriate scales adapted for use with such devices, in order to enable a large motion of the indicating device to be made for a given change of

range while enabling the instrument to work over a wide series of ranges.

In order to produce the deviation of one or both beams for operation according to this invention two adjustable rotatable refracting prisms of small and approximately equal angular deviations are provided, and the essential feature is that neither of the rotating prisms must be at an extended distance from one of the end reflectors. This essential condition may be accomplished by placing both prisms near one end reflector or by placing one near each end reflector, and again they may be placed near the end reflectors either toward the outside or toward the inside of the instrument. Further it is an essential condition that the rotating prisms in whatever positions they may be placed will, as viewed from the distant object, appear to rotate during the operation of taking a range, by equal amounts in opposite directions. In order to produce a definite deviation of the beams, if required, a subsidiary refracting prism (or prisms) may be provided adapted to be inserted at will into one (or both) of the beams in conjunction with the provision of a scale or series of scales appropriate to the definite deviation produced, for use in conjunction with the means for indicating the degree of actuation of the adjustable refracting prisms used in the operation of the instrument.

According to our invention achromatic adjustable refracting prisms are preferably used. These prisms are mounted so as to be capable of rotation about axes perpendicular, or approximately so, to their own planes, and means are provided for producing equal rotations of these prisms in the process of determining a range. A scale is provided to indicate the rotation of the prisms which may be graduated so as to indicate directly the range of the target; and in order to obviate the necessity of using delicate micrometric mechanism for measuring the rotation of the adjustable prisms it may in some cases be advisable to use prisms of very small refracting angle. In this case the minimum range observable will be large (especially with a very long base) and we may provide a subsidiary refracting prism P^1 or P^2 capable of being inserted in the path of one of the beams (preferably near the end of the instrument) so as to increase the to-

tal refraction of the beam by a constant amount. For use in conjunction with a subsidiary prism of this character a subsidiary scale may be provided and provision made 5 so that when the subsidiary refracting prism P^1 or P^2 is introduced or removed the appropriate scale alone is exhibited. This principle of action may be extended to the case of 2 (or more) extra prisms. With two 10 prisms P^1 , and P^2 , (preferably with one P^2 having double the angle of refraction of P^1) we can utilize 4 scales: (1) without P^1 and P^2 , (2) with P^1 alone (3) with P^2 alone, (4) with both P^1 and P^2 .

15 In order that the nature of our invention and the manner in which the same may be performed may be more clearly and fully understood we shall now describe some examples of construction embodying this invention with reference to the accompanying 20 drawings and to the letters and marks thereon.

In the various figures the same letters are used to indicate the same or like parts when 25 these occur.

Figure 1 is a diagrammatic representation, in plan, of one form of rangefinder constructed in accordance with our present invention. Fig. 1^a is a front view of the 30 instrument. Figs. 2 and 3 show one arrangement in detail for effecting the required rotation of the operating prisms in which Fig. 2 is a section on line 2—2 of Fig. 3, and Fig. 3, a section on line 3—3 of Fig. 2. Fig. 4 shows one arrangement of the 35 scale upon which the ranges are read. Figs. 5, 6, 7, 8 and 9 are illustrative diagrams referred to below in reference to the nature of the scale. Figs. 10, 11, 12, and 13 illustrate 40 the use of a supplementary prism (or prisms) to give more open scales, as described below. Figs. 14, 15 and 16 are illustrative diagrams showing modifications in the arrangement of parts of the instrument.

45 Fig. 1 is a diagrammatic representation of one form of instrument constructed in accordance with our present invention. In this figure A^1 , A^2 are two reflecting prisms, which may be of any suitable type, the 50 pentagonal type being indicated. B^1 and B^2 are two objectives. C is a system of reflectors or prisms which we designate eyepiece prisms, designed to turn the beams outward through an eyepiece D , to enable 55 the images to be viewed by an operator in the manner common to this type of instrument. E^1 and E^2 are two refracting prisms, (preferably achromatic prisms) arranged to give equal and small angles of deflection to 60 rays traversing them, and situated in this case in the paths of the beams as these come toward the reflectors A^1 and A^2 . The prisms E^1 and E^2 are capable of rotation about axes F^1 and F^2 perpendicular, or approximately so, to the planes of the prisms. Gear-

ing is provided for giving these prisms E^1 and E^2 equal and opposite rotations, so that the vertical components of the deflections balance each other while the horizontal components are in opposite directions. Thus 70 it may be arranged that when the prisms have their thin edges directed outward as shown at E^1 and E^2 , Fig. 1, the partial images of an object at (say) 1,000 yards are seen in coincidence. A rotation of the 75 prisms in opposite directions so as to bring the thin edges toward the upper (or under) side will cause the beams of light from a distant object to come into coincidence in the eyepiece field. The images seen in the 80 eyepiece field will at the same time appear to move upward (or downward) but this does not matter since the object can be kept continuously in view by a suitable rotation of the whole instrument about its longitudinal center line. A scale operated in connection with the gearing which effects the rotations of the prisms E^1 and E^2 may be so 85 graduated as to indicate, for any position of the refracting prisms E^1 and E^2 , the distance of an object the partial images of which are in coincidence for that position of the refracting prism. The reflectors A^1 and A^2 , the eyepiece D , the mountings for the prisms E^1 and E^2 and the gear for operating these may be conveniently supported 90 in or from a tube G , while the objectives B^1 and B^2 and the eyepiece prisms C may be carried on a short inner tube H , so supported within the tube G as not to be distorted by forces applied to the latter during use. 95

A convenient type of gearing for effecting the required rotation of the prisms E^1 and E^2 is illustrated in Figs. 1^a, 2 and 3. 100 Fig. 1^a is an elevation of the whole instrument as seen from the front. Fig. 2 is a front elevation, and Fig. 3 a side view (each partly in section) showing the compound prism E^1 and the gear operating it. 110

In Figs. 2 and 3, E^1 is shown mounted in a holder J^1 formed externally (wholly or partially) as a worm wheel K^1 , which is caused to rotate by the revolution of the worm L^1 , mounted on a shaft M^1 . The 115 prism holder J^1 is supported on a carrier N^1 attached to the outer tube G of the instrument. The shaft M^1 is connected to a working head O (seen in Fig. 1^a) which may be conveniently placed for operation by the right hand of the observer. A similar gearing is provided for the prism E^2 except that while one of the worms is right handed the other is left handed. Letters referring to the corresponding parts at the 120 right hand end of the instrument have the affix 2 thus— J^2 , M^2 , etc. 125

The scale on which the ranges are indicated may conveniently be engraved on the prism holder J^1 , or on the corresponding 130

holder at the right hand end of the instrument or on both, and an index provided on the carrier N^1 , (or vice versa.)

One arrangement of scale is illustrated in more detail in Fig. 4 which shows a section of the instrument at about $2\frac{1}{2}$ inches to the left of the eyepiece D. In the arrangement there shown the instrument is supposed to be so constructed that the operator looks downward at an angle of 45° when viewing an object on the same level as the range-finder.

In Fig. 4, Q is a drum of celluloid or other translucent material, having the scale S cut on its outer face, and illuminated by transmitted light from a conical reflector R which receives light through a suitable window T the scale S then revolves during the operation of the instrument, past an index pointer Y. The drum Q is mounted on a holder U supported from the tube G, Fig. 4, by a carrier V, and the holder U has attached to it, or formed upon it, a worm wheel W into which a worm X gears, the worm X being mounted upon, or driven from the shaft M which operates the worms L^1 and L^2 above referred to. The drum Q may be caused to revolve less than one revolution for the whole range of operation of the instrument, in which case the scale may be graduated circularly upon it. In the arrangement shown the scale is viewed through an eyepiece D^1 suitably placed for use by the left eye of the observer, while his right eye is opposite the eyepiece D through which the image of the object is viewed.

The action of the refracting prisms and the nature of the scale will be understood by reference to the diagrams Figs. 5, 6, 7 and 8. Fig. 5 is a plan of the optical parts at the left hand end of the instrument. Suppose the prism A^1 to be so constructed that a ray entering it is deviated through a right angle as shown in Fig. 5, and that the ray 1 comes toward the prism A^1 at right angles to the length of the instrument, so that after reflection in A^1 it passes along the center line of the instrument to the eyepiece prisms, as shown by the course 2. If the refracting prism is in the position shown in Fig. 5 with the thin edge e^1 directed outward, the entering ray which would take the course 1, 2 would approach the instrument horizontally from a near object as shown by the course 3. The distance of the object from which the ray 3, and the corresponding ray entering the instrument at the right hand end come, will be the minimum range that the instrument is designed to observe. Suppose, for example, that this range is 1,000 yards. If now the prism is rotated through an angle of 90° so that the thin edge comes to the underside the entering ray that would follow the course 1, 2, will not be deviated in the horizontal plane, and its plan will be in-

dicated by the dotted lines 4 in the figure. As a similar action takes place simultaneously at the other end of the instrument, the rays entering through E^1 and E^2 will be parallel, and come from an infinitely distant object. (The rays in this case would come from an object at a higher angular altitude than that from which the ray 3 came, but this does not affect the use of the instrument, as the whole instrument can be suitably directed in altitude to observe on an object at any angular altitude.)

Fig. 6 represents an elevation of the prism E^1 and of the rays shown in plan in Fig. 5. (For clearness the prism E^1 is shown in this illustration as being rectangular in outline though in practice it may conveniently be made circular in outline as shown in Fig. 2). Suppose a screen erected in front of E^1 as shown at c in Fig. 5, the rays 3, 4, etc. would pierce this screen at points 3, 4, etc. in Fig. 6, such points lying on a circle described about the point in which the ray 1 (produced outward) would pierce the screen. Such points on the screen might thus form a scale on which the distance of the objects viewed could be indicated. Thus in the example chosen (Fig. 6) 4 would correspond to an "infinite" distance, (represented in the figure by the symbol *), while 3 would correspond to a distance of 1,000 yards. When the object is at 2,000 yards, the ray coming to E^1 would bisect the angle between 3 and 4 in Fig. 5 (very approximately) as shown by the course 5. The corresponding point on the screen would be at 5 as shown in Fig. 6. It will thus be seen that, if a scale graduated in reciprocal manner be set out along the line 1—3 in Fig. 6, and the points projected upward to the circle there shown, the scale on the screen would be as indicated on Fig. 6. The angle 3, 1, 5, Fig. 6, is thus the angle through which the prism E^1 (and simultaneously the prism E^2) would have to be rotated in order to pass from a range of 1,000 yards to one of 2,000 yards and the angle 5, 1, 4, the angle through which rotation would have to be made in passing from a range of 2,000 to one of "infinity."

It will be observed that the angle on the scale from 1,000 yards to 2,000 yards is great and the angles between say 4,000 and 8,000 yards very small in the case assumed. Especially near 1,000 yards the angle per yard difference of range would be comparatively very great. In order to make a more convenient scale it will usually be preferable to adopt a modified system as illustrated in Figs. 7 and 8. In this case the prisms A^1 and A^2 are constructed to set out angles somewhat less than 90° as shown in Fig. 7 in which the angle between the rays 6 and 7 is less than a right angle by the angle subtended by half the base length at a range say

double of the minimum range which the instrument is designed to indicate. Suppose as before that the instrument is to work between the ranges "infinity" and 1,000 yards. Thus the prisms A^1 and A^2 each set out an angle less than a right angle by the angle represented in circular measure by the fraction $\frac{B}{4000}$ (or more precisely an angle represented trigonometrically by $\tan \frac{B}{4000}$ where B represents the base length in yards, but the difference between these values is in practical cases usually inappreciable. Now let the prisms E^1 and E^2 have angles of deviation somewhat greater than the difference between the angle between 6 and 7 (Fig. 7) and a right angle. Then when the prism E^1 is turned with its thin edge downward (or upward) the rays traversing it will not be deviated in plan and consequently this position of the prism E^1 (with the prism E^2 correspondingly placed) would correspond to a range of 2,000 yards. If now the prism be turned with its edge e^1 vertical and outward as shown in Fig. 7, the range indicated would be less than 1,000 yards, so that the indication 1,000 yards is reached when the prism is rotated through an angle less than 90° , say, an angle of 60° from the position in which the edge is horizontal, and the indication "infinity" is reached when the prism is rotated through an equal angle in the opposite direction. Fig. 8 illustrates the type of scale thus obtained, the points on the circle being the vertical projections thereon of a reciprocal scale set out along the horizontal line as indicated by the numbers there shown. It is in no way essential that the center point of the rotation used should correspond to a range of double of the minimum range. This has only been chosen as an example. The scale may be opened out still farther at high ranges by suitable alteration in the angles set out by the prisms A^1 and A^2 and the angles of deviation of the prisms E^1 and E^2 as is shown for example in Fig. 9. Again it is not essential that the scale should read up to "infinity", though it is convenient to arrange it so, in order that tests and adjustments may be made by observations on the moon or on a star.

In some cases (in order to have a larger motion of the rotating prisms and a longer scale than can be conveniently gotten in the arrangement above described for giving maximum and minimum ranges, or for other reasons) we adopt the following arrangement: Suppose that it is desired to be able to indicate ranges from 1,000 yards to infinity, and yet to have a comparatively large rotation of the refracting prisms, and a long scale, for ranges from 2,000 yards to infinity. We may construct the instrument with the angles set out by A^1 and A^2 and the angles of deviation of the prisms E^1 and

E^2 so calculated as to indicate, in the manner described, from infinity to 2,000 yards, and provide a scale to indicate accordingly. Then when it is desired to indicate ranges below 2,000 yards we may arrange to introduce into one of the beams, a subsidiary refracting prism that would so deviate the rays, that, when it is inserted, the partial images of an object at 2,000 yards will be brought into coincidence when the prisms E^1 and E^2 are in the position that, in the former case, represented "infinity" (or other high range). If now the prisms E^1 and E^2 be rotated, a series of ranges from 2,000 yards downward will be indicated, and an additional scale may be provided to indicate these ranges. To prevent errors being made by reading the wrong scale provision may be made for bringing the second scale into view only when the additional prism is in action and the first scale into view only when the prism is out of action. In Fig. 10, let the ray 9 represent a ray coming from an infinitely distant object and ray 10 one coming from an object at 2,000 yards. If now an additional prism P^1 of a suitable angle (say about double the angle of deviation of E^1) be inserted between E^1 and A^1 as shown in Fig. 11, the prism E^1 will have to be rotated into the dotted position, (or some position near it) in order to indicate a range of 2,000 yards, and on rotation into the position shown by full lines, the incoming ray will have such a direction as is shown by 11, coming from a point at about 1,000 yards range.

If it were desired to indicate ranges to 500 yards (still retaining the same scale for ranges between infinity and 2,000 yards) a second prism P^2 (or say double the angle of P^1) might be inserted between E^1 and A^1 ,—or preferably in a corresponding position between E^2 and A^2 —and another scale provided and exhibited when the two prisms are in place. Then, with neither P^1 nor P^2 in action, ranges from say infinity to 2,000 yards would be indicated, with P^1 inserted, ranges from 2,000 to 1,000 with P^2 alone ranges from 1,000 to 667 yards, and with P^1 and P^2 ranges from 667 to 500. It is not essential to the use of such additional prisms that these angles of deviation should bear any special relations to the angles of deviation of prisms E^1 and E^2 , and they may be conveniently so arranged as to give series of ranges which overlap somewhat. Nor is it essential that the prisms should be inserted between the reflecting prism A and the refracting prism E . They might be placed in front of prism E , or between reflector A and the objective E Fig. 1. Again the instrument may obviously be designed, adopting the same principle, to read the lower ranges when the prisms are not inserted, and the

higher ranges when the prisms are inserted, in which case the prisms will have their edges directed oppositely to the directions required in the cases above described, or again the instrument may be designed to read medium ranges without the prisms and higher and lower ranges with the prisms inserted.

One arrangement for readily inserting and removing the prisms, and suitably exhibiting the appropriate scale, is illustrated in Figs. 12 and 13. In Fig. 12 prisms P^1 and P^2 are shown mounted in holders f^1 and f^2 which are suitably guided to prevent rotations of the prisms. Attached to the holders f^1 and f^2 are rods g^1 and g^2 operated by slides h^1 and h^2 arranged for operation from the outside of the tube G. Fig. 13 shows a scale drum Q of the type illustrated in Fig. 4 in more detail, provided with an index Y capable of motion in the direction of the axis of the scale drum Q in the guides j attached to the tube G. The index piece Y is attached to a double ended lever the ends K^1 and K^2 of which are so connected to the rods g^1 and g^2 Fig. 12 that when the prism P^1 Fig. 12 is inserted into the beam of light passing between E^1 and A^1 the end K^1 of the lever is raised by an amount that causes the index Y to rise from the scale S^1 to the Scale S^2 . Similarly when P^2 is inserted the end K^2 is raised by such an amount that the index rises from S^1 to S^2 , and when both P^1 and P^2 are inserted the index Y rises from the scale S^1 to the scale S^4 .

It is to be understood that we do not confine ourselves to the use of optical squares of the pentagonal prism type at the ends of the instrument. Optical squares of other suitable forms may be adopted or optical squares constructed of two mirrors may be substituted, or single reflectors may be used, if due provision is made to prevent errors arising from the bending of the frame on which they are mounted.

The arrangements of the parts may be further modified in various ways:—Thus, instead of having one of the rotating refracting prisms at each end of the instrument, both may be placed at one end, as shown diagrammatically in Fig. 14. In this arrangement provision is made for imparting opposite rotary motions to the prisms E^1 and E^2 . Again the prisms E^1 and E^2 need not be placed in front of the end reflectors as shown in Fig. 1. They may be placed near the end reflectors but one between each end reflector and the corresponding objective as indicated in Fig. 15. In this case the prisms should be rotated in the same direction. Again both prisms may be placed near one end reflector and between it and the corresponding objective and have opposite rotations.

When both refracting prisms are placed in one of the beams, the additional prism (or prisms) P^1 and P^2 Figs. 11 and 12 may be arranged to be inserted into either beam or into the two beams as may be preferred.

When the scale is fixed to one of the rotating prism carriers we may still arrange that it can be viewed by the left eye, while the right eye is used to observe the coincidence, by inserting suitable lenses and reflectors to convey an image of the scale to a second eyepiece, placed at about $2\frac{1}{2}$ " to the left of the eyepiece D, Fig. 1. One such arrangement is shown diagrammatically in Fig. 16 in which S is the scale attached to and rotating with the prism carrier, J; l^1 , l^2 , l^3 , are reflecting prisms; m is an objective; and D^1 the left eyepiece. The arrangement of prisms and lens (or lenses) may be modified to suit the requirements in various forms of instruments constructed in accordance with our present invention.

It is to be understood that our present patent refers only to range-finders having a reflector at each end of the base and two objectives through which the beams entering at the two ends respectively pass and does not refer to instruments using one objective only.

Claims:

1. A single observer rangefinder comprising two telescopes, parts of which extend in co-axial alinement from the center of the instrument, two end reflectors, the objectives of the telescopes being situated at an appreciable distance from their respective end reflectors, two refracting prisms of equal angle of deviation each disposed near an end reflector, means for rotating the prisms, and a graduated scale moved in accordance with the prisms, for the purposes set forth.

2. A single observer rangefinder comprising two telescopes, parts of which extend in co-axial alinement from the center of the instrument, two end reflectors, the objectives of the telescopes being situated at an appreciable distance from their respective end reflectors, two refracting prisms of equal angle of deviation each disposed outside and near an end reflector, means for rotating the prisms, and a graduated scale moved in accordance with the prisms, for the purposes set forth.

3. A single observer rangefinder comprising two telescopes, parts of which extend in co-axial alinement from the center of the instrument, two end reflectors, the objectives of the telescopes being situated at an appreciable distance from their respective end reflectors, two refracting prisms of equal angle of deviation disposed respectively near the said end reflectors, means for rotating the prisms, and a graduated scale moved in accordance with the prisms, for the purposes set forth.

4. A single observer rangefinder comprising two telescopes, parts of which extend in co-axial alinement from the center of the instrument, two end reflectors, the objectives of the telescopes being situated at an appreciable distance from their respective end reflectors, two refracting prisms of equal angle of deviation disposed respectively outside and near the said end reflectors, means for imparting equal and opposite rotational motions to the prisms, and a graduated scale moved in accordance with the prisms, for the purposes set forth.
5. A single observer rangefinder comprising two telescopes, parts of which extend in co-axial alinement from the center of the instrument, two end reflectors, the objectives of the telescopes being situated at an appreciable distance from their respective end reflectors, two refracting prisms of equal angle of deviation each disposed near an end reflector, means for rotating the prisms, a range indicating scale moved in accordance with the prisms, an index, a subsidiary prism that can be introduced at will into one of the beams and a subsidiary scale to be used when the subsidiary prism is inserted for the purpose set forth.
6. A single observer rangefinder comprising two telescopes, parts of which extend in co-axial alinement from the center of the instrument, two end reflectors, the objectives of the telescopes being situated at an appreciable distance from their respective end reflectors, two refracting prisms of equal angle of deviation each disposed outside and near an end reflector, means for rotating the prisms, a range indicating scale moved in accordance with the prisms, an index, a subsidiary prism that can be introduced at will into one of the beams and a subsidiary scale to be used when the subsidiary prism is inserted for the purpose set forth.
7. A single observer rangefinder comprising two telescopes, parts of which extend in co-axial alinement from the center of the instrument, two end reflectors, the objectives of the telescopes being situated at an appreciable distance from their respective end reflectors, two refracting prisms of equal angle of deviation disposed respectively near the said end reflectors, means for rotating the prisms, a range indicating scale moved in accordance with the prisms, an index, a subsidiary prism that can be introduced at will into one of the beams and a subsidiary scale to be used when the subsidiary prism is inserted for the purpose set forth.
8. A single observer rangefinder comprising two telescopes, parts of which extend in co-axial alinement from the center of the instrument, two end reflectors, the objectives of the telescopes being situated at an appreciable distance from their respective end reflectors, two refracting prisms of equal angle of deviation disposed respectively outside and near the said end reflectors, means for imparting equal and opposite rotational motions to the prisms, a range indicating scale moved in accordance with the prisms, an index, a subsidiary prism that can be introduced at will into one of the beams and a subsidiary scale to be used when the subsidiary prism is inserted for the purpose set forth.
9. A single observer rangefinder comprising two telescopes, parts of which extend in co-axial alinement from the center of the instrument, two end reflectors, the objectives of the telescopes being situated at an appreciable distance from their respective end reflectors, two refracting prisms of equal angle of deviation each disposed near an end reflector, means for rotating the prisms, a range indicating scale moved in accordance with the prisms, an index, subsidiary prisms that can be inserted into the optical system and subsidiary scales to be used when the subsidiary prisms are inserted, for the purpose set forth.
10. A single observer rangefinder comprising two telescopes, parts of which extend in co-axial alinement from the center of the instrument, two end reflectors, the objectives of the telescopes being situated at an appreciable distance from their respective end reflectors, two refracting prisms of equal angle of deviation each disposed outside and near an end reflector, means for rotating the prisms, a range indicating scale moved in accordance with the prisms, an index, subsidiary prisms that can be inserted into the optical system and subsidiary scales to be used when the subsidiary prisms are inserted, for the purpose set forth.
11. A single observer rangefinder comprising two telescopes, parts of which extend in co-axial alinement from the center of the instrument, two end reflectors, the objectives of the telescopes being situated at an appreciable distance from their respective end reflectors, two refracting prisms of equal angle of deviation disposed respectively near the said end reflectors, means for rotating the prisms, a range indicating scale moved in accordance with the prisms, an index, subsidiary prisms that can be inserted into the optical system and subsidiary scales to be used when the subsidiary prisms are inserted, for the purpose set forth.
12. A single observer rangefinder comprising two telescopes, parts of which extend in co-axial alinement from the center of the instrument, two end reflectors, the objectives of the telescopes being situated at an appreciable distance from their respective end reflectors, two refracting prisms of equal angle of deviation disposed respectively outside and near the said end reflectors, means for imparting equal and opposite rotational motions to the prisms, a range indicating scale moved in accordance with the prisms, an index, a subsidiary prism that can be introduced at will into one of the beams and a subsidiary scale to be used when the subsidiary prism is inserted for the purpose set forth.

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when the subsidiary prisms are inserted, 10
for the purpose set forth.

In witness whereof we have hereunto set
our hands in the presence of two witnesses.

ARCHIBALD BARR.
WILLIAM STROUD.

Witnesses:

JOHN LIDDLE,
JOHN T. LIDDLE.