R. F. POWER.

AERIAL OBSERVATION INSTRUMENT.

APPLICATION FILED APR. 19, 1918.

1,324,519.

Patented Dec. 9, 1919.

4 SHEETS—SHEET 1.

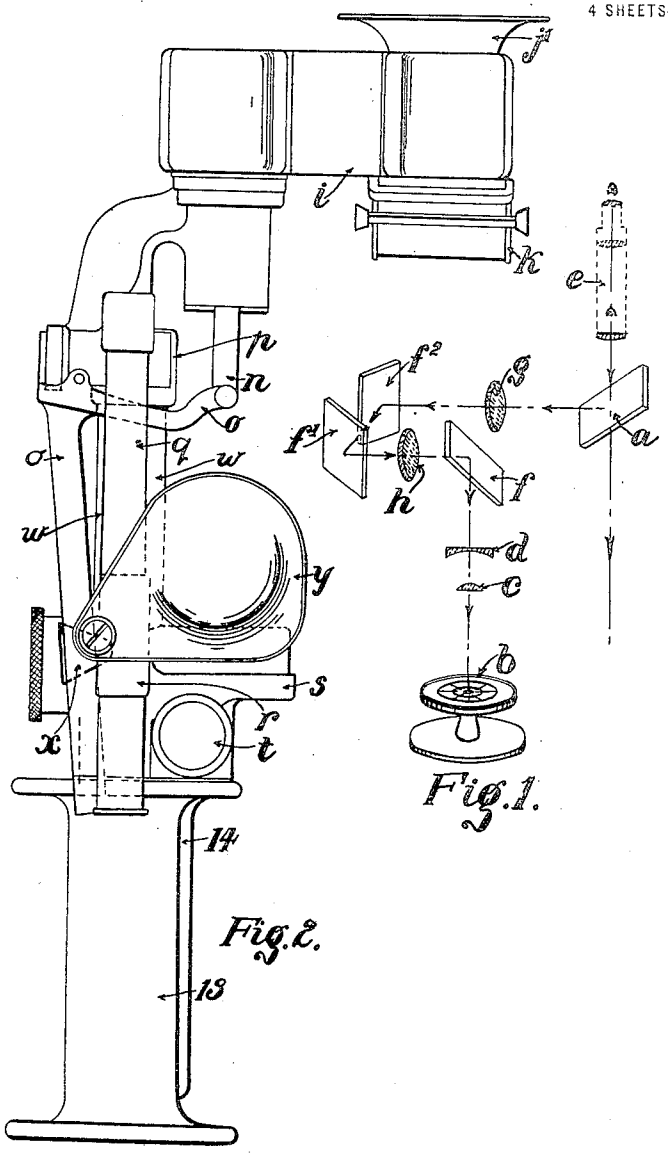


Fig. 1.

Fig. 2.

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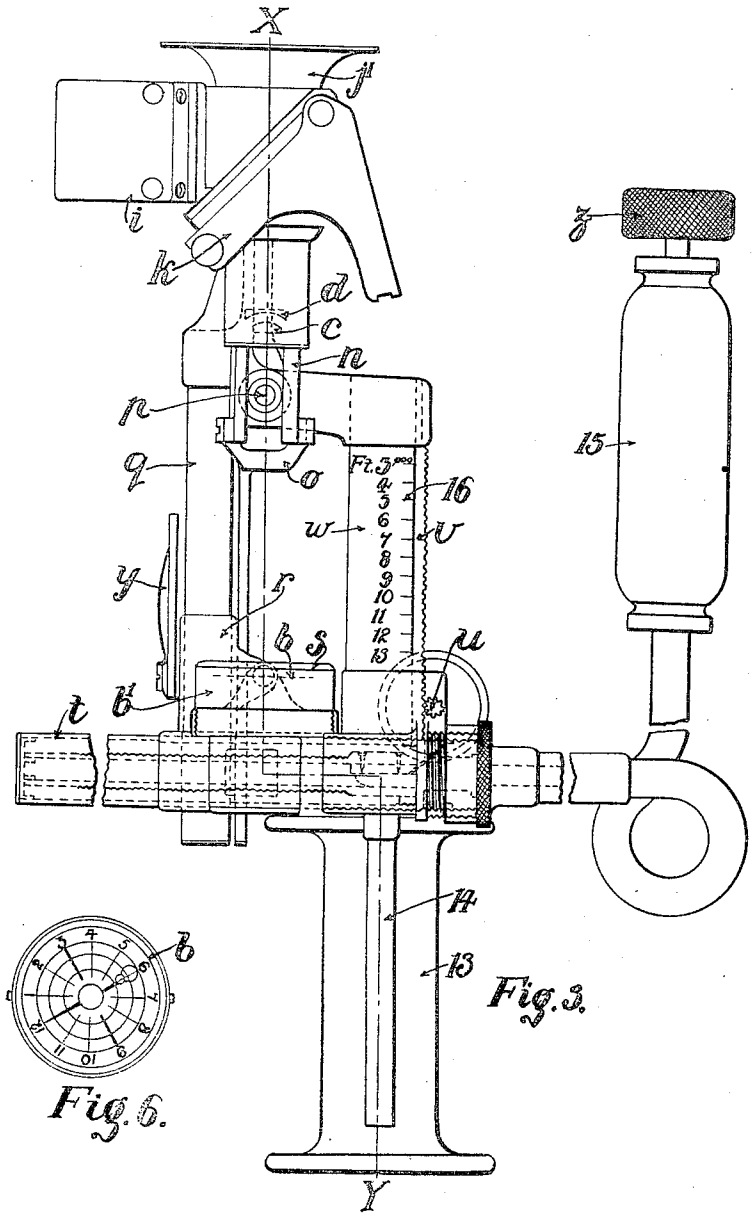


Fig. 3.

Fig. 6.

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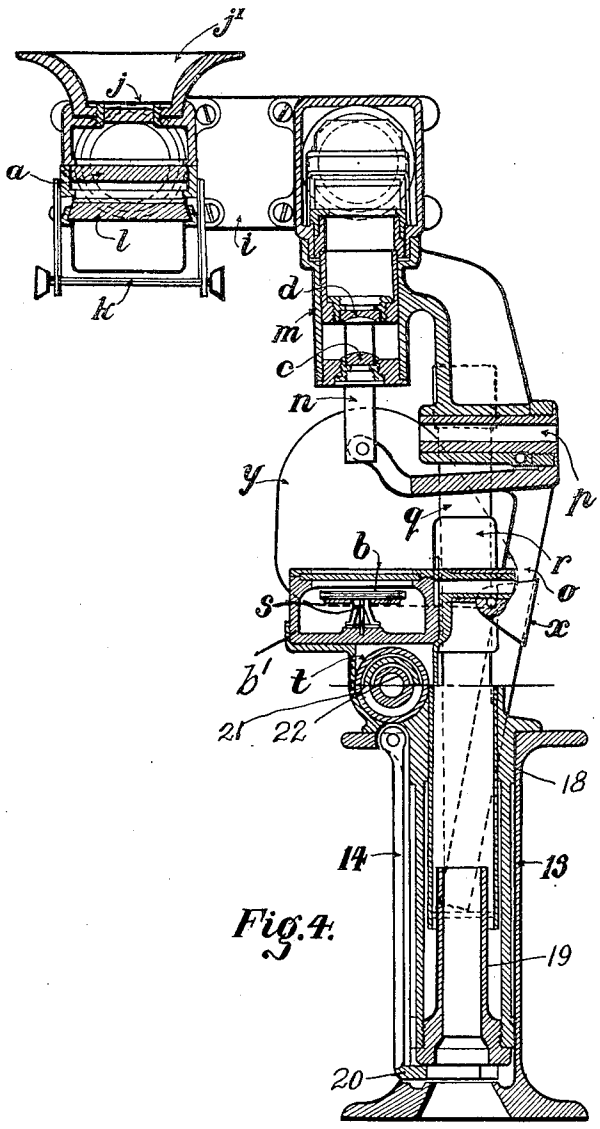


Fig. 4.

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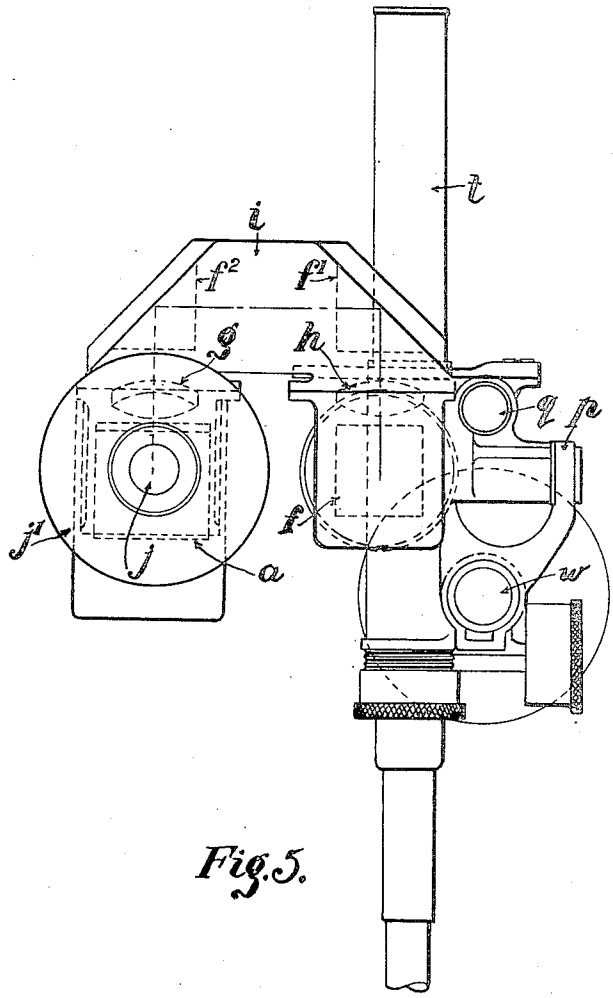


Fig. 5.

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UNITED STATES PATENT OFFICE.

RICHARD FITZ POWER, OF DOVERIDGE, ENGLAND.

AERIAL OBSERVATION INSTRUMENT.

1,324,519. Specification of Letters Patent. Patented Dec. 9, 1919.

Application filed April 19, 1918. Serial No. 229,574.

To all whom it may concern:

Be it known that I, RICHARD FITZ POWER, a subject of the King of Great Britain, residing at Doveridge, in the county of Derby, England, have invented certain new and useful Improvements in Aerial Observation Instruments, of which the following is a specification.

This invention relates to optical sighting instruments.

One object of the invention is to simplify and improve the construction and operation of sighting apparatus, and to render the same more efficient.

Other objects of the invention will appear more fully hereinafter.

My invention also consists, in part, of modifications or improvements upon the observation instrument shown in my application Serial No. 184725, filed August 6th, 1917. In my said application is shown a construction of apparatus wherein both an observation surface having a graticule pattern formed with position identification lines and means for indicating angular position are set forth, but in that case separate surfaces are employed for the distance identification and for the angular position identification, and comparison between the two surfaces is a matter of estimation.

In my present application is shown a method of projecting a graticule pattern formed with position identification lines, both distance and angular, on to an observation surface by reflection, and my invention consists in the construction, combination, and arrangement of the parts of the instrument, all as will be more fully hereinafter set forth, as shown in the accompanying drawings and finally pointed out in the appended claims.

Referring to the accompanying drawings, Figure 1 is a diagram illustrating the method of carrying the invention into effect; Fig. 2 is a front view of an aerial observation instrument constructed in accordance with this invention; Fig. 3 is a side view of same; Fig. 4 is a vertical section on the line X, Y of Fig. 3; Fig. 5 is a plan of Fig. 3; and Fig. 6 illustrates the graticule marking of the compass face.

The same part is designated by the same reference-sign wherever it occurs throughout the several views.

Referring to Fig. 1, which indicates diagrammatically the method employed, in an instrument for use in aerial observation, say, of gun fire at a target which is being directed by the observer in the aircraft, it is necessary to use a sighting device which not only indicates a central axis, but also certain angular deflections away from that axis. The graticule marking used in such sighting devices usually includes a system of position identification lines which are in the form of circles drawn to scale around the center which is supposed to indicate the target, and a series of radial lines or numbers emanating from the said center by which angular position can be indicated; if this graticule pattern can be seen on an observation surface, sharply in focus, simultaneously with the distant target, while its apparent size relative to the images of other objects seen in the field of view can be varied at will, very accurate observation can take place. This projection may be accomplished by the method shown in Fig. 1, in which *a* is a half-silvered mirror placed at 45° to the line of vision (shown vertical) and preferably embracing a telescope *e* through which the target therefore is viewed by transmitted light; *b* is a compass card pivoted within a mounting *s* by means of a pivot point and cup in the well known manner so as to be automatically maintained horizontal, the inclosing case or box b^1 being advantageously provided with a suitable liquid in known manner to damp the oscillations of the said card; this card is marked not only with the distance system of circles, known as the clock code, but also with radial lines passing through the compass center and corresponding to the hour numbers of a clock face which are marked at the ends of the said radii. This position identification graticule is collimated by a system of lenses and reflecting prisms, or their equivalent, so as to be seen by reflection in the half silvered mirror *a* as if projected on the field of view. It might perhaps be explained that the use of the word "collimated" in this specification is intended to mean that the pattern is rendered in sharp focus simultaneously with distant objects, that is to say, the pattern looks as if it were moved to a very great distance, in fact, in this instrument as if the graticule pattern appeared on the ground. The optical system consists essentially of a combination of positive and negative lenses, one or both of which may be mechanically controlled so as to be movable

in relation to the movable graticule pattern, which may thus be projected to infinity.

c is the positive lens, *d* is the negative lens, the focal lengths of which are very short, and both are mounted between the compass card *b* and the system of lenses and reflecting prisms *f*, *h*, f^1, f^2, and *g*, by the combination of which members the pattern on *b* is reflected on to *a*. The optical axis of the lenses *c*, *d* is parallel with the line of vision through the mirror *a*. The reflector *f* turns the optical axis through one right angle, two other reflectors, f^1, f^2 turn it through two right angles, and bring it into the plane of the line of vision, the mirror *a* finally reflecting the image of *b* to the eye.

Such a system of four reflections is known to afford an inverting system with the optical axis passing out of the system parallel to its direction of entry. Taken in conjunction with two equal similar objectives *g* and *h* placed in telescopic adjustment the one *g* near the half silvered mirror and the other *h* at a suitable distance from the positive and negative lens system and between the prisms *f*, f^1 there is obtained a suitable magnification and an erect image. The whole effect of the complete system is to cause the compass cord to be seen as it would appear with the eye held very close up to the positive and negative lens system, while actually ample eye freedom is provided to admit of the interposition of the half silvered mirror.

It is found preferable to fix the positive lens and place it adjacent to the compass card while the negative lens is the movable element. With this arrangement it will be found that when viewed through the complete optical system the compass card pattern subtends the same angle as it would do if viewed directly from a point situated between the positive lens and the compass card at the focus of the positive lens for rays passing from the negative lens to the positive lens parallel to their common optical axis. This point may be termed the "equivalent view point." Since this view point is outside the lens system there is no difficulty in bringing the compass card close enough up to it to subtend an angle wide enough to correspond to observations at low altitudes.

Referring now to Figs. 2, 3, 4, 5 and 6, *t* represents a bar supported horizontally (assuming the aircraft is on an even keel, if secured to such), which bar is connected to an upright pillar *w* carried by the handle 13; by means of this handle 13, which may be in the form of a socket, the instrument may be carried by the side of an aeroplane fuselage, or other convenient position, which would allow of the observer having more freedom to attend to it. The pillar *w* is provided with a scale 16 by which the apparatus may be set for the height at which the aviator is going to observe. and the horizontal bar *t* is fixed in position before starting by means of the pinion *u* meshing with the rack *v*; it may of course be altered when in the air, or if the aviator decides to observe at a different altitude, it being noted that the particular location of the bar *t* on the pillar *w* is required for a particular height, say, of 5,000 feet, which will be different if the aircraft rises, say, to 10,000 feet.

The whole of the optical system is carried in a mounting *i*, and its elements will be identified by the same reference letters as those used in Fig. 1. Observations are made through the window *j* in the eye guard j^1, beneath which is placed the half silvered mirror *a*. A shade *k* is preferably fitted over the mirror, being provided with a detachable tinted glass *l*. The negative lens *d* is carried in a sliding bush *m* movable by side bars *n* attached to a bell crank lever *o*. The mounting *i* is pivoted on a horizontal bar *p*, the axis of which passes through the equivalent view point above mentioned. Also it is secured to the bar *q* movable through a guide *r* pivoted on a mounting *s* for the compass box b^1 containing the graticule clock code pattern *b*, (see Fig. 6). The said mounting *s* can slide along the horizontal bar *t* by reason of the action of the rotatable screw 22 within the nut 21 which nut works within a crosshead attached to the mounting *s*. Further, the bar *t* and the mounting *s* can be moved by the action of the pinion *u* and the rack *v* up the pillar *w* of the instrument, which pillar carries the bearing *p*. The guide *r* has pivoted to it a guide *x* through which passes one member of the bell crank lever *o*, which is pivoted on the mounting *i* adjacent to the bearing *p*. A movable shade *y* hinged on the guide *r* serves to prevent dazzling reflection from the glass cover to the compass mounting. The compass card is submerged within the case b^1 in any suitable fluid to damp its oscillations. To counteract the refractive effect of the liquid the pivot of the guide *r* is placed at a suitable distance above the upper surface of the compass card. Otherwise the pivot would be situated in the same plane as the card. Movement of the graticule mounting along the bar *t* is effected by a screw rotatable by a flexible shaft from a knurled knob *z*. For convenience the shaft passes through a handle 15 which may be attached to the handle of the steering lever of the aircraft, so that the pilot can by the same hand which manipulates the steering lever actuate the knob *z*.

As will be seen on reference to Figs. 2, 3, and 4, 13 is a sleeve which may be held by the hand, and within this sleeve is a member 18 attached to the upright support to which the view member is pivoted, this member 18 being freely rotatable within the sleeve 13 so that the view member may be

directed toward any object on the ground, it being understood that the sleeve 13 must be held vertical; in place of holding the sleeve 13 by hand it is provided on its interior with a socket 19 which may be slipped over a post carried by a bracket on the aircraft, this said post passing also through the ring 20 on the end of the spring-controlled pivoted lever 14; by means of this lever 14 the ring 20 is drawn eccentrically against the post of the bracket so that it will retain the instrument in a given position when in action, and by pressing against the lever 14 the ring 20 is moved so as to be concentric with the post of the bracket and thereby the view member may be freely moved in a circular direction, being set in the required position when the lever 14 is released.

From the foregoing taken in conjunction with the drawings it is evident that vertical movement of the graticule mounting to compensate for variations of height of observation is accompanied by corresponding variations of the position of the negative lens *d* through the action of the lever *o*, the latter being so designed that it varies the focal length of the optical combination in a manner which is exactly correlated to the vertical adjustments of the graticule mounting. These adjustments are effected by the rack and pinion, and the vertical pillar is appropriately graduated to indicate different altitudes, as indicated by the scale thereon in Fig. 3. The angle between the line of vision and the vertical is altered by horizontal movement of the graticule mounting, causing the parts *i*, *q* and *o* to be swung about the pivot *p*. At the same time the lever *o* automatically adjusts the position of the lens *d*.

As will be seen the mechanical arrangements in the instrument provide for automatically keeping the image of the compass card centrally in the field of view and in focus, showing the concentric circles of the correct size and shape to correspond to circles drawn on the ground around the target of fixed linear dimensions, while at the same time affording an image of the clock face oriented in relation to true north according to the accepted convention.

If the aircraft moves horizontally farther away from the object the lens system is made to swivel around the pivot *p* by moving the compass *b* along the bar *t* (by means of knob *z*) until the object is again in view through the center of mirror *a*, this automatically therefore keeping the compass at correct proportional distance from *a*, and slightly altering the focus by reason of the lever *o* being drawn farther out of the clip *x*; similarly, movement of the compass mounting b^1 up (or down) the pillar *w* for altitude correction alters the proportional distance of the compass from *a* and again corrects the focus by means of the length of the lever *o* outside the clip *x*.

By means of the telescopic objectives *g*, *h*, of which *h* may advantageously be placed between *f* and f^1, and *g* between f^2 and the mirror *a*, a unit magnification erecting sight is obtained, and the arrangement overcomes the mechanical difficulty occasioned by the fact that it is impossible otherwise to look through the half silvered mirror *a* while wearing goggles, as would usually be the case with an aviator, and at the same time to get the eye very close up to the comparatively diminutive positive and negative lenses *c* and *d*. It should be understood that a telescope *e* (shown dotted in Fig. 1) may be incorporated in the optical system with the half silvered mirror *a* placed in front of the object glass of same. In this manner the whole combination will provide an optical sight in which any degree of magnification can be afforded to the telescope, with the possibility of varying the apparent size of the graticule pattern seen superimposed on the field of view of the telescope.

In operation the observer looks at his target on the ground through the window *j*; he thus sees the target on the earth through the half silvered observation surface *a*, and, by means of the lens system just described, the graticule pattern *b* of the compass card is thrown on the said surface and is projected by means of the lens system so that it looks as if the pattern were on the ground around the target; consequently, if the observer sees a shell-burst wide of the target he can ascertain at once by reference to the graticule pattern exactly in what direction and at what distance the burst is wide of the target at which it is aimed.

By reason of the clock code graticule working as a compass, the observer is shown its relation always to the north to south line of the locality, the 12—6 o'clock line of the clock face usually being the one representing north-south; the clock code rings are formed with predetermined distances between them to a known scale, and becoming proportionally more distant from the eye in consequence, both when the height adjustment is increased and when the obliquity of the angle of observation is increased, the observer can thus signal to a gunner, or other receiving point on the ground, the position of a shell-burst by one direct observation.

The horizontal plane of the compass card intersects the optical axis through the view tube at a point such that the distance between the intersection and the window *j* is proportionate to the distance from the intersection to the object; this will be the same as the parallel length between the surface of the compass card and the window, and it

will vary with each angle of observation with respect to the objects viewed because in order to see the object through the center of the reflection of the compass card on the mirror *a* the compass must be moved along the bar *t* until, whatever may be the obliquity of the sight line from eye to object, the center of the reflection is on the said sight line; movement of the compass of course alters its distance from the optical system, but as this alteration is proportional to the greater (or less) distance of the optical system from the object due to obliquity this alteration is requisite.

The explanation of this point is more fully set out in my concurrent application for United States patent, Serial No. 184,725.

It should be noted that when the eye piece is at an angle to the vertical, the compass face *b* is at an oblique angle with reference to the lens system, the effect of which will be that an elliptical distortion of the round compass face with its concentric circle markings will be reflected on to the half silvered mirror *a;* this, however, is correct, and really a great advantage of the invention, in that the observer also sees the object on the ground at an oblique angle, and the imaginary circles of the clock code on the ground around the target would be projected as elliptical, and thus the correct position is indicated with reference to the clock face circles reflected on the mirror *a*, which would not otherwise be the case.

If it is desired to observe an object vertically beneath the view tube, the reflection of the compass case will then take place in its full, or round form, which again is correct, because that is how the observer is looking at the ground, and thus the instrument is correctly adjusted in each case to correctly signal the position, say, of a target, whether seen from a vertical or oblique height above it.

By the use of this invention as set forth above, more accurate observations can be made than have hitherto been made by observers relying on their own individual capacity unaided by instruments, and, owing to the fact that the reflection of the surface of the compass face with clock code circles is superimposed on the surface through which the object is seen, a positive indication of the position of a second object seen through the view tube may be observed in relation to the first object, or target.

While I have described in the foregoing specification the construction of parts and operations preferred, I am aware that numerous changes of construction and operation may be made without departing from the spirit and scope of the invention, and I, therefore, do not wish to be understood as limiting myself by the positive terms employed in connection with the description, excepting such as the state of the art may require.

What I claim as new and useful and of my own invention, and desire to secure by Letters Patent, is:—

1. The method of aerial observation, which consists in observing an object through the center of an observation surface, and from a prescribed height above a second surface marked with a graticule pattern and automatically maintained horizontal, and in reflecting the said graticule pattern on to the said observation surface, the said horizontal surface having its graticule pattern composed of position identification lines, whereby the position of a secondary point or points in the field of view can be ascertained relatively to the first object.

2. The method of aerial observation, which consists in observing an object through an observation surface, in projecting thereon by reflection the collimated image of a magnetic compass marked with a graticule pattern composed of distance identification circles and angular identification characters correlated to the north–south line of the compass, the said compass being disposed at a proportionate distance from the observation surface depending upon the altitude at which the observation is made, and the angularity of the line of sight.

3. The method of aerial observation, which consists in observing an object through the center of an observation surface disposed in front of an eye piece, in projecting upon the said surface by optical reflection the collimated image of a horizontal surface marked with a graticule pattern in the form of distance identification circles, and in varying the optical reflecting system simultaneously with any angular variation of the line of sight, whereby elliptical distortion of the said image corresponds with that apparently occurring in the field of view when angular change of the line of sight takes place.

4. In an aerial observation instrument, the combination of an observation surface through which the objects to be observed can be directly seen, with a graticuled surface, means for maintaining the graticuled surface horizontal, and means for varying the distance of the graticuled surface from the said observation surface in accordance with the distance of the latter from the objects observed, the said graticule being in the form of position identification lines of predetermined scale, and means for reflecting the graticule on to the said observation surface, whereby an observer is enabled to see one or more objects in the field of view directly in their relation to the said position identification lines, according to a scale proportionate to the height of observation.

5. In an aerial observation instrument, the combination of a half silvered observa-

tion surface, with a graticuled compass surface horizontally supported at a distance from the said observation surface proportional to the altitude of the observer, and the angularity of vision, the said graticule having distance identification circles of predetermined scale and angular position identification radii or figures corresponding to the numbers of a clock face, and means for reflecting the said graticule on to the said observation surface, whereby the position of any point in the field of view may be ascertained relatively to a central object, and to the north-south line of the earth.

6. In an aerial observation instrument, the combination of an observation surface, with a graticuled surface supported so as always to remain horizontal at a prescribed distance from the said observation surface, the said graticule being in the form of position identification lines of predetermined scale, and an optical system comprising a positive lens, a negative lens, and reflecting members, the said positive lens, negative lens, and graticule being connected together so that any one or more of them is movable in a fixed relationship, whereby the graticule pattern may always be seen sharply in focus on the observation surface simultaneously with distant objects while varying at will its apparent size relative to the images of such objects seen in the field of view.

7. In an aerial observation instrument, a magnetic compass surface supported so as always to remain horizontal and marked with clock code circles of known scale and the hour numbers of a clock face with the 12–6 o'clock line coinciding with the north-south line of the compass, a view member having an eye piece thereon, a reflecting surface in the view member adapted to receive a reflection of the markings on the compass surface while allowing the observer to see an object or objects through it, and means for so varying the distance of the said compass surface from the said reflecting surface as to be proportionate to the distance of the said reflecting surface from the object viewed.

8. In an aerial observation instrument, a view member having an eye piece thereon, a magnetic compass surface marked with clock code circles of known scale and the hour numbers of a clock face, and supported so as always to remain horizontal with the plane of its said surface intersecting the optical axis of the view member at a distance from the eye piece proportionate to the distance of the eye piece from the object viewed, means for varying the angular position of the view member and therewith the position of the compass surface without altering the condition just mentioned, a half silvered mirror, or its equivalent, in the view member adapted to receive a reflection of the markings on the compass surface while allowing an observer to see an object, or objects, through it, and means for so varying the proportionate distance of the said compass surface from the eye piece as to correspond to different places—usually altitudes—of view.

9. In an aerial observation instrument, a view member having an eye piece thereon, a magnetic compass surface marked with clock code circles of known scale and the hour numbers of a clock face, and supported so as always to remain horizontal with the plane of its said surface intersecting the optical axis of the view member always at a distance from the eye piece proportionate to the distance of the eye piece from the object viewed, a surface in the view tube adapted to receive a reflection of the markings on the compass surface while allowing the observer to see an object, or objects, through it, a rotatable upright support to which the view member is pivoted, a guide bar on the upright support at right angles thereto having means for adjusting its position on the said support and carrying a connection common to the view member and the magnetic compass surface, whereby the angular position of the view member and therewith the position of the compass surface may be varied without altering the condition above mentioned as to the intersection of the plane of the compass surface and the line of sight through the view member.

10. In an aerial observation instrument, a view member having an eye piece thereon, a magnetic compass surface marked with clock code circles of known scale and the hour numbers of a clock face, and supported so as always to remain horizontal with the plane of its said surface intersecting the optical axis of the view member always at a distance from the eye piece proportionate to the distance of the eye piece from the object viewed, an observation surface in the view member adapted to receive a reflection of the markings on the compass surface while allowing the observer to see an object, or objects, through it, a rotatable upright support to which the view tube is pivoted, a guide bar on the upright support at right angles thereto, a pinion on the guide bar meshing with a rack on the upright support whereby the guide bar may be reciprocated on the said support, a cross head on the guide bar carrying the magnetic compass surface and a pivotal connection with the view member, and means for reciprocating the said cross head along the guide bar, substantially as and for the purpose set forth.

11. In an aerial observation instrument, a view member of short dimension having an eye piece thereon, a rotatable upright support to which the view member is pivoted with its axial sight line clear of the in-

strument, a toothed rack on the upright support, a guide bar at right angles thereto having a hand wheel and pinion of which the latter engages the said rack, a cross head on the guide bar carrying a magnetic compass surface marked with clock code circles of known scale and the hour numbers of a clock face, and supported so as always to remain horizontal with the plane of its said surface intersecting the axial sight line of the view member always at a distance from the eye piece proportionate to the distance of the eye piece from the object viewed, an observation surface in the view member capable of receiving a reflection while allowing the observer to see through it, an optical system, a casing for said system connecting the view member and its pivotal support, said optical system comprising a positive lens, a negative lens, a series of reflectors, and intermediate objective lenses, giving an erecting sight with suitable magnification which reflects the graticule markings of the surface of the magnetic compass on to said observation surface, a pivotal sliding rod connection between the view member and the compass cross head, means for varying the relationship of the members of the optical system according to the varying angular position of the magnetic compass, and means for traversing the compass cross head along the guide bar, substantially as and for the purpose set forth.

12. In an aerial observation instrument, a view member having an eye piece thereon, a rotatable upright support to which the view member is pivoted, a toothed rack on the upright support, a guide bar at right angles thereto having a hand wheel and pinion of which the latter engages the said rack on the upright support, a cross head on the guide bar carrying a magnetic compass surface and connected by a pivot with a sleeve sliding on an extension of the view tube, a nut in the said cross head, a threaded spindle rotatably supported on the guide bar engaging the said nut, a handle and flexible shaft rotating said spindle, an observation surface in the view member receiving a reflection from the compass surface which is marked also with a graticule pattern having clock code circles of known scale and the hour numbers of a clock face, the said reflection receiving surface being also transparent, and the said compass surface and view member being connected to the sliding cross head so that the plane of the surface of the magnetic compass intersects the optical axis of the view tube always at a distance from said observation surface proportionate to its distance from the object viewed.

13. In an aerial observation instrument, a view member having an eye piece, an observation surface therein having reflection and transparent qualities, a compass card with a clock code graticule and numbers also marked thereon, a guide rod or bar, a pillar supporting same, a socket supporting the pillar so that the guide rod may always rotate in a horizontal plane while the pillar remains vertical, a cross head linearly movable on the said guide bar and carrying said compass, a rod on the view member having a swiveling connection with said cross head, means for raising and lowering the horizontal guide bar in a vertical direction, an optical system adapted to reflect a collimated image of the compass card on to the said observation surface, a hinged mounting for same, and interconnecting bell crank mechanism having a sliding connection with said cross head, whereby adjustment of the compass mounting is accompanied by automatic adjustment of the optical system.

14. In optical sighting instruments, the combination comprising an optical system having a positive lens, a negative lens, and a graticule, any one or more of which is or are movable in a fixed relationship, the parts being arranged in conjunction with a half silvered mirror or its equivalent, through which the field of view is observed while the collimated graticule markings are seen by reflection, a mounting for said optical system hinged on the main portion of the instrument coincidently with the equivalent view point of the optical system, said graticule being pivoted and in the form of a compass card and a mounting for the same adjustable linearly in two directions mutually at right angles, a relatively movable bar and pivoted guide respectively secured to the two mountings, a bell crank lever pivoted on the mounting of the optical system, and a pivoted guide on the graticule mounting co-acting with the said bar, the lever being arranged to control one of the elements of the optical system, substantially as described.

In testimony whereof I affix my signature.

RICHARD FITZ POWER.