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L. M. APPLEGATE

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STEREOSCOPIC RANGE AND HEIGHT FINDER WITH ADJUSTABLE RETICLES

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Fig. 1.

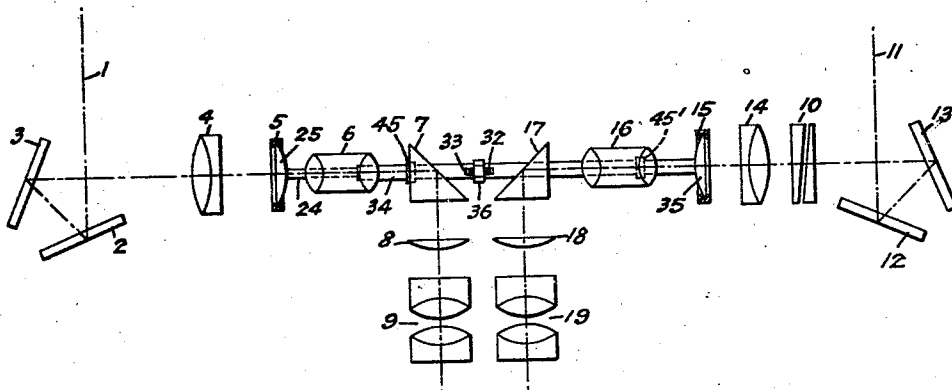
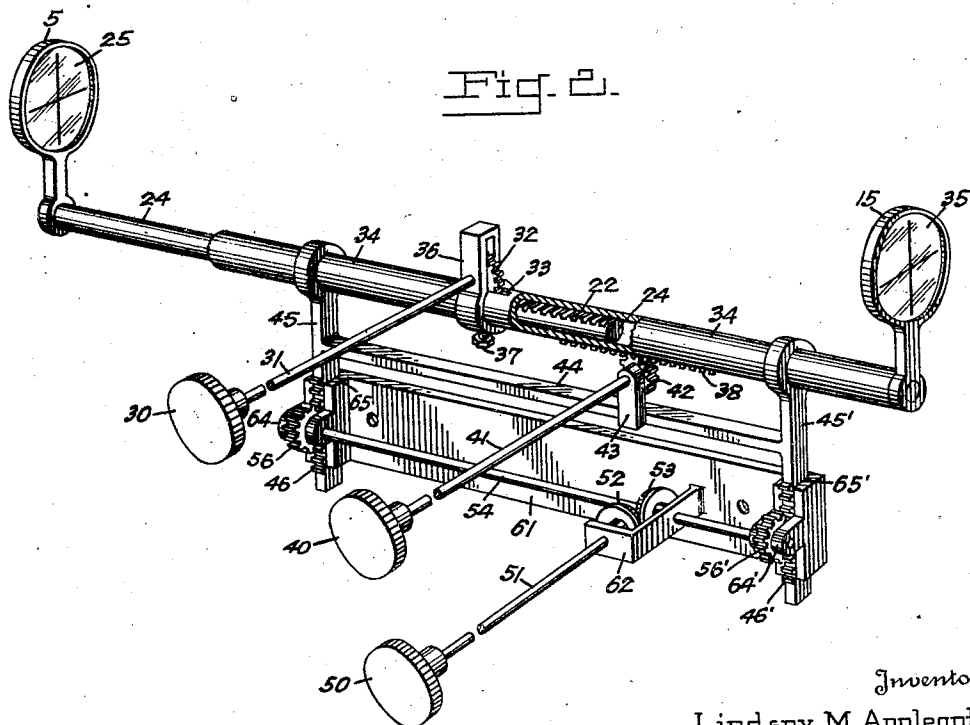


Fig. 2.



Inventor
Lindsay M. Applegate

By C. E. Herrstrom & H. C. Philodean

Attorneys

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STEREOSCOPIC RANGE AND HEIGHT
FINDER WITH ADJUSTABLE RETICLES

Lindsay M. Applegate, Portland, Oreg.

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amended April 30, 1928; 370 O. G. 757)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment to me of any royalty thereon.

This invention relates to fire control of guns, and is particularly concerned with fire control means incorporated in, and made part of, stereoscopic range and height finders.

As now employed in fire control systems the stereoscopic range finder or height finder determines the range or slant height of a target, which may be an aircraft, for example. This data is relayed or transmitted, together with other information such as present azimuth and present angular height, target velocity, etc., to a computing machine known as a director. The target data, including the range as determined by the stereoscopic range finder, is entered into the director, together with such known data as muzzle velocity of the gun. From these given data the director automatically determines the set forward position or future position of the target (i. e., the position at which the target traveling at the determined velocity will be hit by the projectile fired from the gun of known ballistic characteristics); from this automatic determination of the set-forward position, the director yields the information required to properly train the gun to cause its projectile to hit the target at the said future position, this information being principally lateral lead, superelevation, and fuse time setting.

The object of this invention is to provide a fire control apparatus which is combined with the stereoscopic range finder, and which is implemented with means for establishing the set-forward or future position of the target within the stereoscopic or three-dimensional view of the improved fire-control range finder. That is the observer not only manipulates the stereoscopic device to make "stereoscopic contact" between the target-image and the reticle of the device, in the usual manner, but also, by means fully described herein, shifts the reticle ahead of the target-image to bring the reticle to the future or predicted position of the target. For this purpose the reticle is not fixed. On the contrary, the reticle of the improved fire-control device is capable of being moved so that its image within the three-dimensional view may be made to move in three spatial directions. The device is provided with certain manual knobs, fully described subsequently, for so shifting the reticle-image spatially to the set-forward or predicted position of the target-image. The manipulation of the manual knobs in shifting the reticle-image to the future target position, also function to operate computing mechanism similar to the computing instrumentalities of the director (briefly described above) to yield the same information as that gotten from the director, namely, lead, superelevation etc.

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For the attainment of the foregoing and such other objects as may appear or be pointed out herein I have shown one embodiment of my invention in the accompanying drawing, wherein:

Fig. 1 is a schematic plan view of the optic train of the improved fire control device of this invention.

Fig. 2 is an isometric view of the aforementioned manual knobs for controlling the spatial shifting of the reticle-image to the predicted target position.

Before describing the improved fire control means of this invention, the conventional stereoscopic range finder will be first briefly outlined. Referring to Fig. 1, rays I and II emanating from the target enter the instrument, with rays I (which schematically represent the binocular view of the target as seen from the left side) entering the instrument at the left, at end reflecting surface 2; rays II, which schematically represent the binocular view of the target as seen from the right side, enter the instrument at the right, at end reflecting surface 12. The left rays I and right rays II, upon reflection from their respective end reflectors 2 and 12, are again reflected, at 3 and 13, and directed axially inwardly to central prisms, respectively, left prism 7 and right prism 17. Between the end reflectors, 3 and 13, and the central prisms, 7 and 17, the left and right rays successively pass through objective lenses, respectively, 4 and 14, collective lenses, 5 and 15, and erecting lenses, 6 and 16. Following a 90° shift at the central prisms, 7 and 17, the left and right rays are directed through collective lenses, respectively, 8 and 18, and eye lenses, 9 and 19.

The left eye of the observer is placed before left eye lens 9, with his right eye before right eye lens 19, so that the left eye can see only the rays I representing the binocular view of the target as seen from the left, and so that the right eye can see only the rays II representing the binocular view of the target as seen from the right. Both left and right rays are fused in the brain of the observer so that what is actually seen is a three-dimensional or "solid" view of the object or target. The conventional range finder is implemented with means for shifting the distance plane of the target as viewed in the instrument, so that the distance plane will appear to be nearer to, or further away from, the observer. This shifting of the distance plane is achieved by changing the lateral distance between corresponding points in the two pictures viewed; for this purpose there is provided in either the left ray or the right ray path—in the right ray path, as shown in Fig. 1—a pair of complementary measuring wedges 10. These are a pair of oppositely or complementarily beveled pieces of optic glass, which are rotatively adjustable to cause the image—the right image, as shown in Fig. 1—to be shifted laterally. Thus by laterally

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shifting the right image the lateral distance between corresponding points on it and the left image can be varied to cause a shifting of the distance plane (as explained above).

One type of known range finder is provided with hair-line guide marks or reticles which are usually associated with the collective lenses 5 and 15, Fig. 1. That is, identical reticle marks are provided on both the left collective lens 5 and the right collective lens 15, so that the observer sees a single fused reticle in the three-dimensional view, which serves as a reference point in determining the range of the target. What an observer sees when looking through a stereoscopic range finder is a fused or three-dimensional image of the target and of the reticle. By rotating the measuring wedges 10 the target image and the reticle image are made to be in the same distance plane, at which coincidence "stereoscopic contact" is said to be established. By associating the measuring wedges with a calibrated scale, an observer, by establishing stereoscopic contact with a target, can by consulting the calibrated scale determine the range to the target.

In the aforesaid known stereoscopic range finder the reticles, left, 5, and right, 15, are fixed. In the fire control device of this invention, on the other hand, the left and right reticles may be adjusted in various ways which will now be described. Whereas in the operation of the stereoscopic range finder, stereoscopic contact is established by bringing the target image and the reticle image into coincidence, in the fire control device of this invention, the reticles, 5 and 15, are adjusted, as well as the measuring wedges 10, which control the distance plane of the target image, so as to advance the reticle image ahead of the present target position to the future or predicted, set-forward position of the target. Prediction is accomplished by what in effect is visually estimating in the stereoscopic or three-dimensional view, the future position of the target, by advancing the reticle (i. e., the fused image therefrom as seen in the three-dimensional view) to that position. It should be noted that the reticle is shifted or advanced in three directions, namely, horizontally or vertically laterally in a given distance plane, or in a direction normal to the said lateral movements, or normal to the distance planes, the latter movement being in effect from one distance plane to another. For convenience the said first two directions will be referred to as "horizontal-lateral" and "vertical-lateral," and the said third direction will be referred to as "distance-plane."

The following mechanism, shown in Fig. 2, may be employed for adjusting the left reticle 25 and the right reticle 35, so that the fused image of the reticle may be shifted in the said three directions. Left reticle 25 is secured at the left end of a rod 24 which is telescopically received in a tubular rod or slide 34 at the right end of which is secured the right reticle 35. As explained above in connection with the conventional stereoscopic range finder, the fused image of the reticle may be moved in the said "distance-plane" direction by varying the distance separating the left and right reticles, i. e., by bringing them closer to each other or by separating or drawing them apart. For this purpose, a bracket 36 is secured to the tubular rod or slide 34, as by a set screw or the like 37. Bracket 36 provides bearings for a manipulative rod 31 at one end of which is a knob 30 and at the other

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end of which is a gear 32 which clears through a slot 33 provided in the tubular rod 34, to mesh with rack teeth provided along the right end portion of inner rod 24.

The tubular rod 34 is supported for an extent of longitudinal movement in a left bearing member 45 and a right bearing member 45' which are integrally united by a horizontal brace bar 44. On brace bar 44 is provided an upstanding bearing 43 for a manipulative rod 41. At one end of manipulative rod 41 is a knob 40 and at the other end is secured a gear 42 which meshes with a rack 38 secured to the underside of the tubular rod 34. Rotations of knob 40 is effective to move the tubular rod 34 to the left and right, thus moving together or as a unit, the right reticle 35, which is secured at the right end of tubular rod 34, and the left reticle 25 which is secured at the left end of inner rod 24 which is carried by the outer tubular rod 34. Thus rotation of knob 40 is effective to impart "horizontal-lateral" movements to the reticles 25-35, and to their fused image as seen in the stereoscopic view.

Left bearing member 45 is mounted for an extent of vertical sliding movement in a left trackway 65 provided at the left of a frame plate 61. At the right of frame plate 61 is a right trackway 65' in which slides the right bearing member 45' of the unit 45-44-45', for an extent of vertical movement. The left bearing member 45 is provided with a rack 46 while a rack 46' is provided on the right bearing member 45'. Meshing with the two vertically-disposed racks 46 and 46' are gears, respectively, 56 and 56' which are secured on a horizontal shaft 54 which is mounted on end bearings 64, left end 64', right, provided on the frame plate 61, more particularly, projecting laterally from the said end slide tracks, respectively, 65 and 65'. Also secured on horizontal rod 54 is a bevel gear 53 which meshes with a bevel gear 52 which is secured at one end of a manipulative rod 51. The frame plate 61 is provided with an angle bracket 62 which serves as bearings for the manipulative rod 51 and the horizontal shaft 54. At the other end of manipulative rod 51 is a knob 50. Rotation of knob 50 is effective to rotate horizontal shaft 54 and its gears 56 and 56' and thereby to elevate the frame 45-44-45' and thus the telescopic rods 24 and 34, which are mounted in the bearing members 45 and 45', as described above. Thus the knob 50 is effective to move the reticles 25, 35, in the said "vertical-lateral" direction.

To recapitulate, manipulative knob 30 is adjusted to shift the reticle in the said distance-plane direction; manipulative knob 40 is adjusted to shift the reticle in the said horizontal-lateral direction; manipulative knob 50 is adjusted to shift the reticle in the said vertical-lateral direction. By operating the knobs 30, 40 and 50 the reticle image is placed in perspective in the three-dimensional view, at the set forward point at which fire is to be directed. It is understood that each of the manipulative rods 31, distance-plane direction 41, horizontal-lateral direction, and 51, vertical-lateral direction, has associated appropriate instrumentalities similar to the type used in directors, described above, which give the required data for fire control operation, such as lateral deflection, vertical deflection and superelevation, and fuse setting.

I claim:

1. In a device for determining, from the present position of a moving target, the data required

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for training a gun of known characteristics to cause projectiles therefrom to hit the said target at a predicted future position, the combination of a stereoscopic range finder having left and right eyepieces and left and right optic trains including a left and a right collective lens adapted to form a three-dimensional image of a target and to shift the distance-plane thereof, a left and a right reticle associated with the said collective lenses and adapted to be formed as a three-dimensional image of the reticle, means for altering the distance between the left and the right image of the target to cause stereoscopic contact between the distance-plane of the target and the distance-plane of the reticle by relative movement thereof in the distance-plane direction, means for altering the distance between the said pair of reticles to advance the distance-plane of the reticle image ahead of its said present position, in the said distance-plane direction, to the said predicted future position, and means for moving the said pair of reticles in unison, maintaining their said distance apart, to shift the lateral position of the said reticle image of the said predicted future position of the target both vertically and horizontally in the said adjusted distance plane of the reticle image.

2. In a device for determining, from the present position of a moving target, the data required for training a gun of known characteristics to cause projectiles therefrom to hit the said target at a predicted future position, the combination of a stereoscopic range finder having left and right eyepieces and left and right optic trains adapted to form a three-dimensional image of a target and to shift the distance-plane thereof, a left and a right reticle associated with the said optic trains and adapted to be formed as a three-dimensional image of the reticle, means for altering the distance between the left and the right image of the target to cause stereoscopic contact between the distance-plane of the target and the distance-plane of the reticle by relative movement thereof in the distance-plane direction, means for altering the distance between the said pair of reticles to advance the distance-plane of the reticle image ahead of its said present position, in the said distance-plane direction, to the said predicted future position, and means for moving the said pair of reticles in unison, maintaining their said distance apart, to shift the lateral position of the said reticle image of the said predicted future position of the target both vertically and horizontally in the said adjusted distance plane of the reticle image.

3. In a device for determining, from the present position of a moving target, the data required for training a gun of known characteristics to cause projectiles therefrom to hit the said target at a predicted future position, the combination of a stereoscopic range finder having left and right eyepieces and left and right optic trains adapted to form a three-dimensional image of a target and to shift the distance-plane thereof, a pair comprising left and a right reticles associated with the said optic train and adapted to be formed as a three-dimensional image of the reticle, means for altering the distance between the said pair of reticles to advance their distance-plane to an estimated predicted future position, and means for moving the said pair of reticles in unison, maintaining their said distance apart, to shift the lateral position of the said reticle image of the said predicted future position of the

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target both vertically and horizontally in the distance plane of the reticle image.

4. A stereoscopic range finder of the type having right and left groups of optical elements arranged along an axis and adapted to provide a stereoscopic image of a distant object when viewed through right and left eyepieces cooperating with said groups respectively, comprising a frame, a bearing member guided for translation by said frame in a first direction normal to said axis, a first slide carried by said bearing member for translation in a second direction parallel to said axis, a second slide carried by said first slide for translation in said second direction, means connecting said slides for equal and opposite movement relatively to said bearing member, and a reticle carried by each said slide, each reticle being interposed in a respective group of elements and on said axis.

5. A stereoscopic range finder having right and left groups of optical elements arranged along an optical axis and right and left eyepieces into which said groups are adapted to project an image of a target when viewed through said eyepieces, a pair of reticles each interposed in a respective group of said elements along said axis, first means connecting said reticles for equal and opposite translation along said axis, second means mounting said first means for translation whereby said reticles may be moved as a unit along said axis, and third means mounting said first and second means for translation to effect movement of said reticles as a unit transversely of said axis.

6. A stereoscopic range finder having groups of optical elements adapted to project images of a target along a common axis into right and left eyepieces for fusion in a first distance plane by an observer looking into said eyepieces, comprising a pair of reticles each interposed in a respective group of optical elements along said axis for fusion by said observer in a second distance plane, first means mounting said reticles for conjoint movement in and along said axis to vary the apparent separation of said planes, and second means mounting said first means to move said reticles transversely of said axis whereby operation of said two means effects apparent movement of said reticle in three dimensions relatively to the image of said target, as viewed through said eyepieces.

LINDSAY M. APPLGATE.

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