

June 16, 1942.

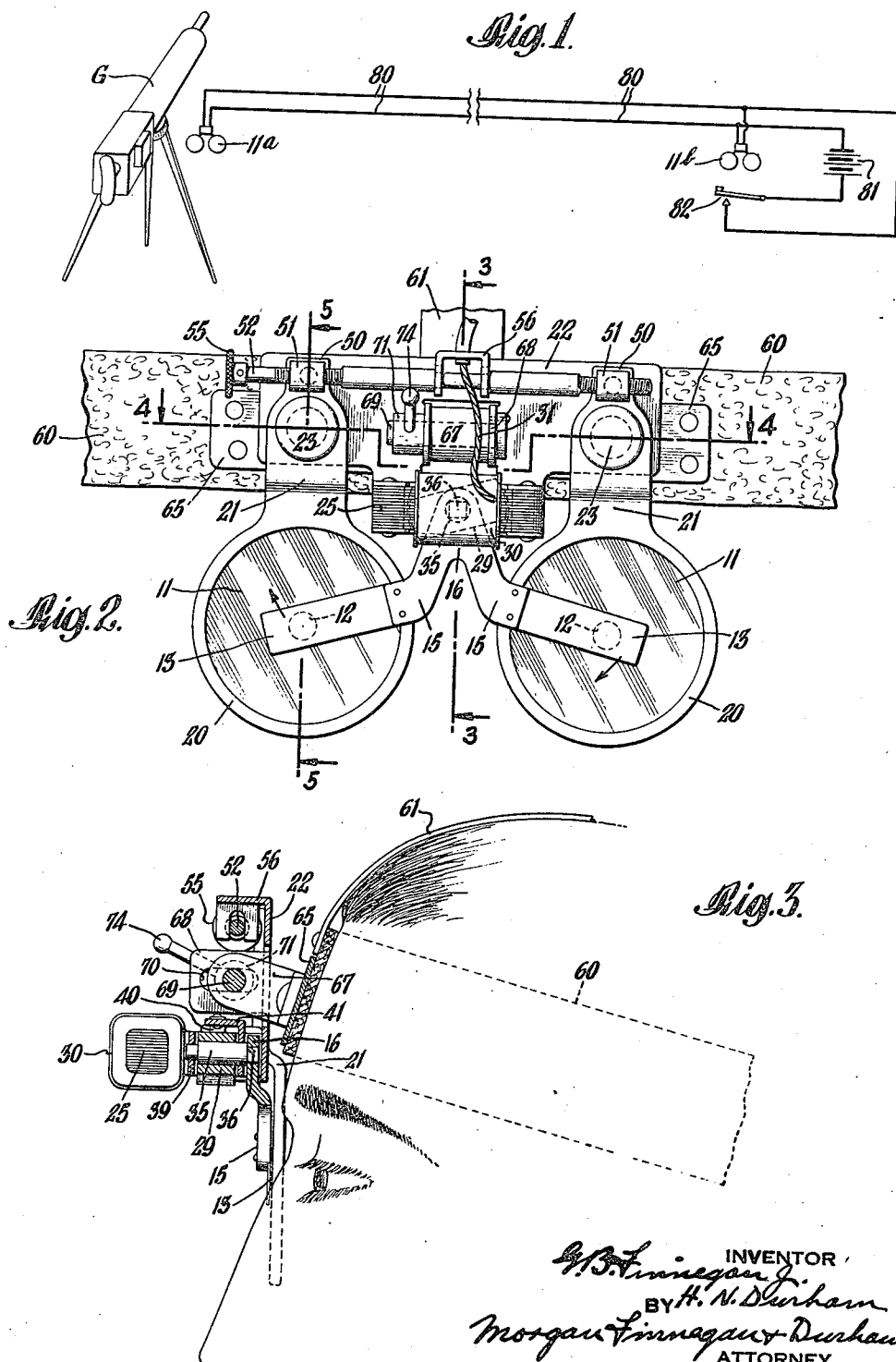
H. N. DURHAM ET AL

2,286,474

FIRE CONTROL

Filed Dec. 15, 1937

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

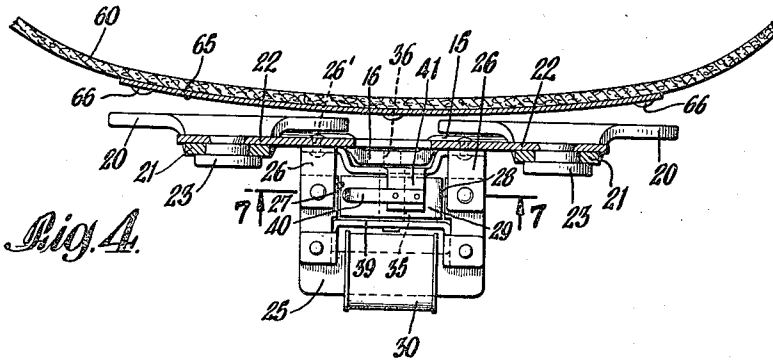


Fig. 4.

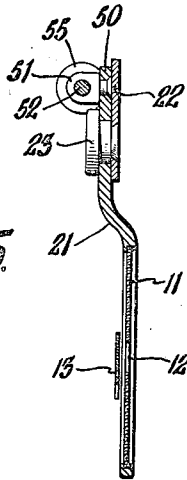


Fig. 5.

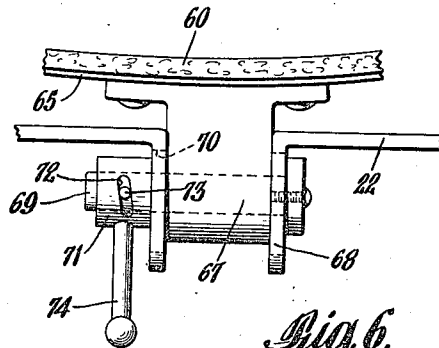


Fig. 6.

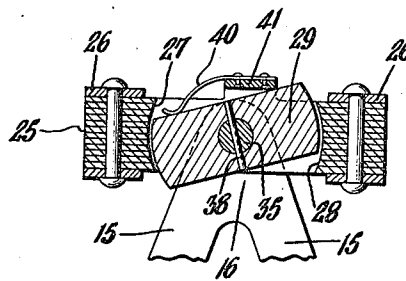


Fig. 7.

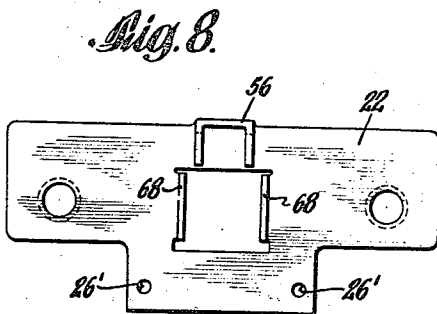


Fig. 8.

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2,286,474

FIRE CONTROL

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9 Claims. (Cl. 33—66)

The present invention relates to fire control and more particularly to a novel and useful fire control device for artillery firing at aerial and other moving targets.

Objects and advantages of the invention will be set forth in part hereinafter and in part will be obvious herefrom, or may be learned by practice with the invention, the same being realized and attained by means of the instrumentalities and combinations pointed out in the appended claims.

The invention consists in the novel parts, constructions, arrangements, combinations and improvements herein shown and described.

The accompanying drawings, referred to herein and constituting a part hereof, illustrate one embodiment of the invention, and together with the description, serve to explain the principles of the invention.

Of the drawings:

Fig. 1 is a schematic view showing diagrammatically the arrangement of the various parts of the anti-aircraft fire control apparatus in accordance with the present preferred embodiment of the invention;

Fig. 2 is a front elevation of an illustrative embodiment of one of the fire observing instruments used in the embodiment of Fig. 1;

Fig. 3 is a section on line 3—3 of Fig. 2 with the fire observing instrument shown applied to the head of an observer;

Fig. 4 is a horizontal section on line 4—4 of Fig. 2;

Fig. 5 is a vertical section on line 5—5 of Fig. 2;

Fig. 6 is a fragmentary detailed elevation of the forehead adjusting means;

Fig. 7 is a vertical section on line 7—7 of Fig. 4; and

Fig. 8 is a detail in elevation of the main plate of the supporting frame.

The present invention is, in certain respects, an improvement upon the anti-aircraft fire-control method and apparatus shown and described in the patent of Grayson Schmidt 2,157,575, May 9, 1939. In other respects the invention comprises certain subject matter disclosed, but not claimed in said application of Grayson Schmidt. The present invention has for its object the provision of a novel and improved anti-aircraft fire control apparatus and method, applicable to firing of projectiles which are visible during at least a part of their trajectory by which the accuracy of fire at a moving aerial target, such as an airplane, can be improved. A further ob-

ject is the provision of a novel and improved anti-aircraft fire control device which can be used with ease and will give to both the gunner and a flank observer an accurate indication of when the visible projectile is at the range of the target so that the true deviations of the projectile from the target are made apparent and the appropriate corrections may be made in the firing of the gun for future shots. Still another object of the invention is the provision of an improved fire observing instrument which will enable the gunner and flank observer to ascertain the position of the projectile simultaneously and with the greatest degree of accuracy.

In accordance with the present embodiment of the invention, the flank observer and gunner both observe the trajectory of a tracer bullet, or other visible projectile, as it is moving towards its target and when the flank observer appears to see the bullet at the range of the plane or other target a visual indication is given to the gunner under the control of the flank observer, so that the gunner may ascertain the true deviation of the projectile and correct his aim to cause the next bullet and succeeding bullets to come closer and closer to the target. This visual indication is given by means of a change in color of the image observed by the gunner and preferably also by the flank observer. Thus, the flank observer and gunner are able to see and follow the tracer bullet and target during the entire travel of the bullet, and this vision is not interrupted at any time either before, during or after the giving of the signal. Specifically, the gunner and flank observer view the travel of the tracer bullet through a color filter which is momentarily removed from the path of vision during the giving of the signal, so that the bullet appears of a different color at that moment, and thus the gunner can distinctly visualize and ascertain the true deviation of the bullet at the proper moment. The differently colored images stimulate the same nerves so there is no important reaction time or lag in observations and the gunner and observer do not run the risk of losing sight of the projectile or target as would be the case where the signal is given by non-visual means or where their vision is interrupted.

For simple installations, as where there is a flank observer for each gunner, the flank observer and gunner each follow the path of the same bullet as its trajectory appears to intersect the line of travel of the target, and when both the gunner and flank observer appear to see the target being hit at the time of the signal, the

gunner knows that his aim and range are both correct and that he has made a hit. If the gunner sees the bullet at any other point at the instant of signal, the angular distance between the bullet and target represents the true deviation and the gunner will correct his pointing accordingly. The flank observer may operate the two observing instruments simultaneously by means of a telegraph key and with only a little practice he is able to anticipate the apparent intersection of the trajectory and target so as to eliminate his own reaction time involved in closing the circuit after the intersection has apparently occurred.

The observing instruments for the gunner and flank observer may be of various widely different constructions, but as illustratively embodied comprise a pair of eyepieces or goggles to be worn by the gunner and a similar pair to be worn by the observer. The goggles are provided with "lenses" which are of a relatively light color, each having a small aperture uncolored, said aperture lying in the line of vision of the corresponding eye pupil. Another piece of the same colored material overlies the uncolored aperture, and is adapted to be moved into and out of overlying position by means of an electromagnet or solenoid. Thus, when the flank observer closes the circuit, the overlying pieces are momentarily removed from their normal position and allow both men to have a momentary uncolored view of the target and bullet, and this actuation is rhythmically repeated as the trajectories of the bullets appear to intersect the target.

While it is helpful for the flank observer to be provided with goggles, they are not essential for his observations, so that in simplest form the apparatus will comprise a pair of goggles as described, worn by the gunner or an observer at the gun position, while the flank observer may use only the naked eye or a cross-hair telescope and a manually operable switch, such as a telegraph key, for closing the circuit.

Where mechanical means are provided for closing the actuating circuit, means are provided for causing this closing to take place once each time a tracer bullet is fired, rather than once each time any kind of a bullet is fired, and these means may comprise a switch adapted to be closed only once each predetermined number of actuations, one actuation occurring each time a bullet is fired, and the predetermined number corresponding to the relative number of tracers and bullets. In the present application, however, illustrative disclosure will be made only of a manually operable system, although it will be clear that mechanical circuit-closing means of the type referred to might be combined therewith.

It will be understood that the foregoing general description and the following detailed description as well are exemplary and explanatory of the invention but are not restrictive thereof.

Referring now in detail to the illustrative embodiment of the present invention as shown by the accompanying drawings, there is provided a color filter shifting device through which the gunner or observer at the gun station observes the path of the tracer bullet as well as the target, and this color filter shifting device is adapted to be operated by means under control of the flank observer at a considerable distance from the gun. A similar color filter shifting device may optionally be provided for the flank observer and this operates simultaneously with the gunner's device so that the observer and gunner may take

their observations at precisely the same instant.

As embodied, the preferred form of color filter shifting device comprises a pair of goggles to be worn by the gunner, each of the goggle lenses being provided with or composed of a transparent color-filtering element 11, which filter element is formed with a central clear spot or aperture 12 through which the tracer and target may be observed in their natural colors, while the surrounding area is viewed through the color filter. Preferably the color filter is of a light red or orange color so as to increase the contrast against the sky and to eliminate the haze as much as possible. However, the color of the filter may be varied to give the best all-around visibility and to provide the maximum color contrast in the view of the tracer. The color filter 11 may be conveniently used as the cementing layer between two sheets of glass thus forming a shatter-proof or safety glass lens. A similarly colored filter shutter 13 is provided which is moved back and forth over the central aperture 12 in the lens, this movement being controlled by the flank observer, and as the clear central aperture is covered or uncovered by the shutter 13, the gunner receives his signal to take the observation of the position of the tracer and target. Inasmuch as the signal is merely a change in color and the stimulus is transmitted to his brain over that set of nerves which are already sensitized by the continuous vision, there is no appreciable reaction time involved and the readings are much more accurate than when an auditory or tactual signal is employed as might otherwise be feasible. Furthermore the use of the color filter obstructs no part of the field of vision and thus allows the gunner and flank observer to watch the target and the entire flight of the projectile (or as much thereof as desired) and when the signal is given the tracer and target are in full view and remain in full view.

The signal shutters are electromagnetically actuated and the electromagnetic actuating means for the several pairs of goggles are preferably connected in series so as to eliminate the necessity for using matched lengths of wire and other circuit constants between the power supply, signal transmitting and receiving stations. While preferably both lenses 11 may be provided with the central uncolored apertures 12 and corresponding filter shutters 13, if desired this arrangement may be confined to only one lens of the goggles, the other lens being entirely composed of the color filter layer 11.

The embodied means for electromagnetically actuating the filter shutters 13 so as to cause them to rapidly uncover and recover the apertures 12 comprises a centrally-disposed, pivotally mounted yoke 16, the arms 15 of which extend toward the two lenses 11 and in a plane just over the outer faces thereof. The two colored shutters 13 are rigidly fixed to either end of the arms 15 of the yoke so as to normally cover the openings 12. The shutters 13 are preferably relatively long and narrow rectangular strips of colored Celluloid or the like of a width somewhat greater than the diameter of the corresponding apertures 12. The upper central portion 16 of the V-shaped yoke is pivotally mounted for limited rotation so as to swing the shutters 13 to uncover the apertures 12 and then to return them to the covered position. The eye pieces 11 are suitably supported in circular frames 20 of metal or other suitable material. The frames are integrally formed with supporting arms 21 which

extend upwardly and are pivotally connected by suitable bearing pins 23 near the ends of a rigid supporting frame 22. The frame member 22 also serves to support the centrally disposed electromagnetic mechanism which imparts turning movement to the shutter yoke 16. As embodied, an electromagnet having a laminated iron core 25 is rigidly mounted centrally of the frame member 22 by a suitable bracket 26 held by pins which pass through holes 25' in the frame. Thus that part of the frame and the electromagnet structure overlies the bridge of the nose of the wearer, as will be clear from Fig. 3. The electromagnet is preferably rectangular, the opposed poles 27 and 28 being arcuate to permit close turning movement therebetween of the armature 29, the ends of which are conformably curved. The outer or base portion of the magnet is surrounded by a suitable electric coil 30, to which is connected a lead wire 31.

The embodied means for imparting movement from the rotatable armature 29 to the arms 15 of the shutter yoke comprises a shaft 35, to the inner square end 36 of which is fixed the central part 16 of the shutter yoke, so that the yoke will rotate with the shaft. The armature 29 surrounds the shaft 35 and is fixed to rotate therewith as by pin 38. The outer end of shaft 35 is rotatably journaled in a suitable bearing bracket 39, which bracket is fixed to the core of the electromagnet.

Means are provided for normally holding the armature 29 out of alinement with the poles of the magnet, in which position the shutters 13 are adapted to cover the apertures 12. As embodied, the armature 29 is mounted to lie with its axis at an angle to the horizontal plane, as shown in Figs. 2 and 7, being held in that position by the end of a spring finger 40 which extends from a projecting finger 41 formed as a part of a bracket connected to and extending from the frame member 22. Upon energization of the magnet coil 30, the magnetic field will cause the armature 29 to rotate against the spring until it lies with its axis horizontal and it will there remain until the circuit is broken and the spring 40 returns it to its original position. Thus, closing of the coil circuit will instantaneously cause the eyepiece apertures 12 to be cleared by the shutters 13 and the re-closing of the shutters will be performed just as rapidly by breaking the circuit.

The invention further comprises various means for adapting the pairs of goggles to the different sizes and configurations of the individuals who will wear them. Primarily, the goggles are adapted for rapidly and securely varying the distance between the apertures 12 in a pair of goggles so as to accommodate them for various inter-pupillary distances commonly encountered in human beings. As embodied, the arms 21 of the lens supports are provided with portions 50 which extend above the pivotal supporting shaft 23, and means are provided for imparting transverse movement to said arms 50 to thereby cause a rocking movement of the frame 20 and thus a variation in the position of the central apertures 12. For this purpose an internally threaded block or nut 51 is pivotally mounted to extend from the outer face of the arm 50, while a threaded shaft 52 passes through and engages the threads in said nut. The shaft 52 extends to engage similar nuts 51 on either arm 50 of the goggles, it being clear, however, that the threading of the shaft and the adjacent nut for the

left-hand lens frame is opposite in direction to that for the right-hand, so that rotation of the shaft in a given direction will cause the two lenses to move in opposite directions. A suitable knurled knob 55 is provided at one end of the shaft and the shaft is further supported centrally in a U-shaped bearing bracket 56 formed on and upstanding from the face of the main frame member 22. The lead wire cable 31 for the magnet coil may also be supported by a suitable aperture in said bracket 56. It will be clear that rotation of the shaft 52 in the desired direction will cause the lenses 11 and apertures 12 to move together or spread apart the desired amount to accommodate for variations in inter-pupillary distance of the wearer, and the overlapping width and length of the shutter members 13 will be sufficient to accommodate all such positional changes of the lenses and apertures.

The hereinbefore described goggle mechanism is preferably supported on the head of the wearer by a suitable constricting brow band such as a leather or elastic strap 60, having means (not shown) for fastening same at the rear of the wearer's head. Preferably, also, a resilient metallic strap 61 is adapted to engage and pass over the center line of the wearer's skull, as in a telephone head set. The main frame 22 of the goggles is suitably attached to the brow band 60 by means of a metal brow strap 65 which is rigidly connected to the forehead portion of the brow band as by rivets 66. A U-shaped bracket 67 extends outwardly from the band 65 and engages the inner faces of a conforming bracket 68 struck up from the central portion of the main frame piece 22.

The invention also provides for variations in the mounting and setting of the goggle mechanism to accommodate different shapes and slopes in the configuration of the forehead of the wearer, so that, within reasonable limits, the goggle lenses 11 will always lie substantially normal to the line of sight of the wearer. As embodied, the bracket members 67 are pivotally attached to the supporting brackets 68 by a transverse shaft 69 which permits rocking movement of the goggles and goggle frame with respect to the forehead bracket 67. The bracket members 68 are also horizontally slotted at 70 to permit a certain amount of fore-and-aft movement of the goggles and frame with respect to the forehead. A tightening sleeve 71 is mounted about the projecting end of shaft 69 and is provided with an inclined slot 72 which cooperates with a pin 73 on the shaft 69 to permit tightening of the shaft in any position of adjustment. A suitable tightening handle 74 may be provided to effect the desired action.

It will be understood that the foregoing detailed description and disclosure of the goggle mechanism is merely illustrative of a preferred construction and means of adjustment thereof for carrying out the broad principles of the invention, and that numerous changes in constructional details may and will be made in practice without departing from the essential features of the invention.

In operation, a pair of goggles, as indicated by 11A in Fig. 1, will be worn by the gunner or an observer stationed at a machine gun G, while another pair of goggles 11B will be worn by a flank observer stationed at a suitable distance to the flank of the gun. As shown, the goggles are connected in series by suitable lead wires 80 and a suitable source of power such as battery

61 may be positioned at any convenient point in the line. Normally, the circuit will be open whereby the gunner and observer view the target and tracer bullets through the colored filters 11 and 13. A suitable manually operated switch 82, such as a telegraph key which is adapted for rapid opening and closing, is placed at the hand of the flank observer. Upon the firing of a given tracer bullet both the gunner and flank observer follow it with their eyes through the color filters as it nears the aerial target. When the flank observer sees that the bullet is about to intersect the line between himself and the target, he closes the switch momentarily, thus causing the gunner's shutters 13 to open for a brief instant so that the gunner, looking through the clear space 12, will see the target and tracer bullet in their natural colors at the instant of intersection. The flank observer will be able to gage his own reaction time so as to move to close the switch sufficiently early so that the gunner will receive the shutter signal at the instant of intersection, neither before nor after. It has been found that with a little practice the flank observer will be able to perform this operation very accurately at rates of fire of one tracer shot per second or even more rapidly.

In general the principles and objects of the invention may also be realized by causing the gun observer to normally view the projectile and target through an uncolored glass or with the naked eye and causing the color filter to move into his line of vision only at the instant of signalling. In that case the aperture 12 (which preferably would be greater in area) would normally be left open by keeping the circuit closed, the filter shutter 13 being allowed to close only at the instant of signalling. Also the aperture 12 may be of a different color from the filters 11 and 13, so that the change in the apparent color of the projectile may be from one shade to another instead of from colored to natural or vice versa.

The general construction of the observing goggles may also be utilized to carry out the principles of the fire observation and control with an opaque shutter as disclosed and claimed in the previously mentioned application of Grayson Schmidt Ser. No. 79,822. That is, the desired signal may be imparted to the gun observer by causing an opaque shutter to flash across his line of vision at the desired instant, his vision being otherwise normal and uncolored. For such use the lenses 11 of the goggles may be of clear glass throughout, while an opaque shutter similar to the shutter 13 would normally be mounted outside the line of direct vision of the wearer. If preferred the clear glass lens may be omitted so that the observer normally looks through an empty frame. At the instant of signaling said opaque shutter would be caused to cross the observer's line of vision and immediately recede therefrom. By providing a speed shutter movement across the line of vision faster than $\frac{1}{16}$ second the persistence of vision will not be interrupted, but the observer will receive a distinct impression or signal to his optical nerves. This signaling effect will be similar to that shown and described in connection with the magnetic shutter mechanism in said Schmidt application.

While the invention has been illustrated with one gun observer under control of a flank observer, it is possible to so coordinate the firings of several guns that they may be under the control of a single flank observer without imposing

an undue burden on the flank operator. This coordination will consist primarily in the suitable spacing of tracer bullets for the several guns so that they fire in sequence and at intervals no smaller than say one-third a second.

A modification of the lens construction (not shown) may be provided wherein one or both lenses of the goggles may be provided with vertical and/or horizontal cross hairs and also with mil scale divisions to facilitate observation of fire.

The invention in its broader aspects is not limited to the specific mechanisms shown and described but departures may be made therefrom within the scope of the accompanying claims without departing from the principles of the invention and without sacrificing its chief advantages.

What we claim is:

1. Mechanism for controlling fire of a gun using projectiles which are visible for at least a portion of their trajectory, including in combination, a color filter transparency, means for maintaining said color filter in the line of vision of an observer at the gun for viewing the target and trajectory of said projectile, electrically-operated means for suddenly removing said filter from the line of vision of the observer to inform him when the projectile has reached a selected point on its trajectory, a switch at a flank position and circuit connections therefrom to the electrically-operated means for controlling the movement of the filter from a flank position.

2. Mechanism for observing a gun projectile having a visible trajectory including in combination a colored transparency positionable in the line of vision of an observer at the gun and means for controllably removing said colored transparency from said line of vision and for restoring same to said line of vision comprising an electrically-operated actuator for moving said transparency, circuit connections and a switch for controlling said movements from a remote station and a similar colored transparency at said remote station and, an electrically operated actuator therefor, said actuators being connected in series.

3. In an apparatus for observing and controlling gun fire the combination of a pair of goggles comprising lenses and means for supporting said lenses on an observer's head in his line of vision, said lenses being covered for the most part with a color filter but having a clear spot directly in the line of vision, and a colored member movable relatively to the clear spot to cover and uncover same.

4. In an apparatus for observing and controlling gun fire the combination of a pair of goggles comprising lenses, means for supporting said lenses from on an observer's head in his line of vision, said lenses being covered for the most part with a color filter but having a clear spot directly in the line of vision, a colored member movable relatively to the clear spot to cover and uncover same and electromagnetic means on the supporting means for moving said colored member.

5. Mechanism for fire observation and control including in combination a pair of viewing lenses adapted to be positioned before the eyes of an observer, means for fastening said lenses in said position on the head of the observer, a color filter transparency normally lying in the line of vision of the observer, and electromagnetic means for moving said colored transparency out of said line of vision.

6. Mechanism for fire observation and con-

trol including in combination a pair of viewing lenses adapted to be positioned before the eyes of an observer, means for fastening said lenses in said position on the head of the observer, a color filter transparency normally lying in the line of vision of the observer through at least one of said lenses, electromagnetic means for moving said colored transparency out of said line of vision, a second pair of lenses similarly constructed for a second observer, and circuit means connecting the electromagnetic means of each pair so that the transparencies may be moved simultaneously.

7. Mechanism for fire observation and control including in combination a pair of viewing lenses adapted to be positioned before the eyes of an observer, means for fastening said lenses in said position on the head of the observer, a color filter transparency on at least one of said lenses and normally lying in the line of vision of the observer, electromagnetic means for moving said colored transparency out of said line of vision, and means for varying the interpupillary distance of the two lenses.

8. Mechanism for controlling fire of a gun using tracer projectiles including in combination a color filter transparency movably mounted across the line of vision of an observer at the gun

for viewing the target and trajectory of a projectile, means for moving said filter into and out of said line of vision to vary the view of the observer, an unobstructed view being obtained when the filter is out of the line of sight, and means at a locus remote from the observer for controlling the actuation of said filter-moving means to inform the observer when the projectile has reached a selected point on its trajectory by varying the color of his field of view.

9. Mechanism for controlling fire of a gun using tracer projectiles including in combination a color filter transparency movably mounted across the line of vision of an observer at the gun for viewing the target and trajectory of a projectile, electrically operated means for moving said filter into and out of said line of vision to vary the view of the observer, and means at a locus remote from the observer for controlling the actuation of said filter moving means to inform the observer when the projectile has reached a selected point on its trajectory by varying the color of his field of view, said means comprising devices for transmitting electrical energy from said locus to said filter-moving means.

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