A clay shooting simulation system is provided which comprises, in combination, at least a first projector providing a visible mark, at least a second projector providing an invisible mark, a screen, a mirror adapted to reflect the visible mark and the invisible mark to the screen, apparatus for moving the mirror three-dimensionally thereby moving the two marks on the screen such that the invisible mark leads the visible mark to simulate a lead-sighting point in actual clay shooting, a light-receiving type gun responsive to an invisible light beam reflected from the invisible mark on the screen and an electric system responsive to an operation of the gun to inform a hitting to an operator.

14 Claims, 38 Drawing Figures
CLAY SHOOTING SIMULATION SYSTEM

BACKGROUND OF THE INVENTION

The present invention relates to a clay shooting simulation system suitable to use in the training of the clay shooting or for the amusement purpose.

Several kinds of indoor type such systems have been known and one of them which has been developed most recently utilizes a light-emitting type gun and a clay pigeon provided with a light responsive element. In this system, the clay pigeon is actually discharged and the shooter sights the clay pigeon. Since the light responsive element is provided in the clay, the hitting occurs when the light beam from the gun enters the light responsive element. Therefore, the light-sighting which must be required in the actual clay shooting cannot be simulated by this system. Furthermore, since the clay pigeon flies actually, the recovery thereof is required.

The present invention intended to provide a novel clay shooting simulation system which can simulate the actual clay shooting almost completely.

SUMMARY OF THE INVENTION

The present invention comprises, in combination, a screen, at least a first projector adapted to project a visible light mark to be focussed on the screen, at least a second projector adapted to project an invisible mark to be focussed on the same screen, at least one mirror means adapted to reflect the two marks projected by the first and second projectors respectively to the screen, at least one means for providing continuous movements of the mirror means and the second projector with a specific continuous relative movement between the two marks on the screen such that the visible mark moves along a locus simulating an actual flying locus of a clay pigeon and the invisible mark always exists at a position leading the visible mark so that the invisible mark simulates a lead-sighting point with respect to the visible mark, at least one light-receiving type gun adapted to receive a light beam reflected from the invisible mark on the screen and means responsive to a reception of the light beam by the gun for informing the hitting to an operator.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates schematically the present system,
FIG. 2 is a plane view of the system of FIG. 1,
FIG. 3 shows an embodiment of an iris means of a visible mark projector,
FIG. 4 is a cross sectional view taken along a line IV—IV in FIG. 3,
FIG. 5 is a cross section taken along a line V—V in FIG. 4,
FIGS. 6 and 7 illustrate a change in aperture size of the iris means,
FIGS. 8 and 9 show relative positions of the mirror with respect to the projectors,
FIG. 10 shows a change in position of the invisible mark on the screen according to the relative positions in FIGS. 8 and 9,
FIG. 11a shows another relative position and FIG. 11b shows the result obtainable by the relative position in FIG. 11a,
FIG. 12 is a perspective view of the mechanical portion of the present system,
FIG. 13 shows one of the cam mechanisms used in the mechanism in FIG. 12,
FIGS. 14a to 14d show the operations and the effects of the cam mechanism in FIG. 13,
FIG. 15 A to 15D is a plane view of the mechanism in FIG. 12,
FIG. 16A to 16C is a similar plane view to FIG. 15 and shows the movements of the invisible mark on the screen due to the movement of the invisible projector,
FIG. 17 shows locuses of the marks on the screen which are obtained by combining the locuses of FIGS. 14a and 16c,
FIG. 18 is various locuses of the marks on the screen,
FIG. 19 shows an example of the light receiving type guns suitable to use in the present system,
FIG. 20 is a detail of a portion of the gun of FIG. 19,
FIG. 21 is a cross section of a case and a charging means thereof,
FIG. 22a shows an electric system of the present system,
FIG. 22b is an example of a possibility determination circuit in FIG. 22a,
FIG. 22c is a graph of the pulse trains showing the pulse delay,
FIG. 23 is a modification of the present mechanical arrangement,
FIG. 24a is a perspective view of a main portion of the arrangement of FIG. 23,
FIG. 24b is a schematic plane view of the main portion of FIG. 24a,
FIG. 24c is a schematic side view of the main portion of FIG. 24a and,
FIG. 25 is another example of the iris means of the projector.

DETAILED DESCRIPTION OF THE INVENTION

Returning to the drawings, an embodiment of the present invention will now be explained.

FIG. 1 is a schematic illustration of a laser clay shooting simulation system according to the present invention and FIG. 2 is a plane view of the system in FIG. 1.
In general, a scene in a landscape is projected onto a screen 4 by a suitable projector 6 disposed behind of the screen 4 or by a projector 6 disposed in front of the screen 4, if necessary. On the same screen 4, a visible target mark A is also projected through a mirror 8 at which a clay shooter looks. Further, an invisible real target mark B is projected onto the same screen 4 in the similar manner. The visible imaginary target mark A and the invisible real target mark B are made to move on the screen 4 with a special interrelation therebetween in such a manner that they simulate an actual flying locus of a clay pigeon in the clay shooting area. The special interrelation between the marks A and B are provided by a special relative movements of the mirror 8 and the projectors 2A and 2B associated with the respective marks A and B. When the shooter who has been recognizing the imaginary mark A moving on the screen 4 makes a correct over-sighting or lead-sighting with a receiving-light type gun 10, the muzzle of the gun will be directed to the real mark B and a light beam reflected from the mark B on the screen 4 is received by the gun through the muzzle thereof. At that instance, if a trigger of the gun is operated by the shooter, a light receiving means housed in the gun 10 is actuated. Upon the actuation of the light receiving means an electric receiver 12 and a control circuit are actu-
ated to distinguish the imaginary mark A and simultaneously to display a hitting mark C at the same position as that of the mark A. At the same time an explosion sound simulating an actual explosion of gun powder is produced by a sound device 14 and a recoil action may be produced by a suitable mechanism which may also be housed in the gun 10, if necessary.

As will be clear from the foregoing general explanation of the present system, the mark A is visible target and is formed by focussing on the screen 4, an image having a particular shape which is emitted from a visible light source of such as a Xenon lamp of the projector 2A and reflected by the mirror 8. The mark B is an invisible target mark and is formed on the screen 4 as a spot of such as infra red laser beam emitted from the projector 2B and reflected from the mirror 8. The invisible mark B is an effective target mark for the light-receiving type gun 10.

The mirror 8 is supported by a suitable structure in such a manner that the angle thereof with respect to the projector means 2 is variable and that the locuses of movements of the marks A and B on the screen 4 simulates a flying locus of a clay pigeon in an actual clay shooting.

The visible projector 2A includes a light source such as Xenon lamp and an iris device disposed at a forward position on its optical axis. By selecting the configuration of an aperture of the iris device suitably, the shape of the mark A on the screen 4 can be made similar to the shape of an actually flying clay pigeon. An example of the aperture shape is shown in FIG. 3. The visible projector 2A comprises a lamp housing 18 containing the light source such as Xenon lamp, a shutter device 20 provided at a forward position on the optical axis thereof, the iris device 22 also disposed in front of the shutter device 20 and an optical lens system 24 disposed forwardly of the iris device 22 to collimate the light ray past through the iris device 22. The shutter device 20 has a rotatable plate (not shown) which is held normally at a block position for the light ray and by a magnetization of an electric magnet (not shown) upon a suitable open signal rotates to pass the light to the mirror 8. The signal may be, for example, a voice signal of the shooter ordering a discharge of a clay pigeon, and the shutter device 20 is actuated through a suitable switch by this signal. The structure of the shutter device 20 itself may be suitably selected. Since the structure is easily designed by those skilled in the art, the details thereof is omitted in this explanation.

FIG. 4 is a cross section of the iris device 24 taken along a line IV—IV in FIG. 3 and FIG. 5 is a cross section taken along a line V—V in FIG. 4. The iris device comprises a rotatable disk 28 having a central opening and a fixed disk 40 having a central opening. The rotatable disk 28 is provided with a peripheral piece 28', which protrudes outwardly through a slot 26, and pins 54 (in this embodiment, four pins 54 are shown). The pins 54 are disposed circumferentially of the central opening of the disk 28 with angularly equally spaced relations and protrude toward the fixed disk 40. The fixed plate 40 is provided with a plurality of slots 52 for permitting the arcuate movements of the pins 54 due to the rotation of the disk 28. A pair of vertical guide members 42 and a pair of horizontal guide members 44 are secured to the fixed plate. A pair of vertical iris plates 46 and a pair of horizontal iris plates 48 are slidably supported by the vertical guide members 42 and the horizontal guide members 44 respectively. The iris plates 46 and 48 are smoothly guided by the guide members in vertical and horizontal directions respectively. Each of the iris plates is provided with an inclined slot 50. The pins 54 implanted to the plate 28 penetrate the fixed plate 40 through the slots 52 thereof and enter the 50 of the iris plates.

The piece 28' of the plate 28 is biased anticlockwise by a compression spring 32 provided between the piece 28' and a post 30 fixed on the outer casing. One end of a wire 38 is connected to the piece 28' and the other end of the wire is connected through rollers 34 and 36 to a slidable support to be described later. Accordingly, the plate 28 is rotated in anticlockwise direction or clockwise direction upon the forward or backward movement of the slidable support or base. Upon the rotation of the plate 28, the pins 54 implanted thereto perform arcuate movements. Each pair of the iris plates are moved vertically and horizontally by the movements of the pins 54 to provide an iris effect. The distances of movements of the iris plates 46 and 48 and hence the reduction of aperture size of the iris device is determined by the inclination of the slots 54. That is, when the piece 28' is at the leftmost position in the slot 26 of the outer casing, the upper and lower iris plates 46 are at the lowest position and the uppermost position respectively and the left and right iris plates 48 are at the rightmost and the leftmost positions respectively, providing the maximum iris effect as shown in FIG. 6. On the other hand, when the piece 28' is the rightmost position in the slot 26, the iris effect will be the minimum as shown in FIG. 7.

Accordingly, when the base approaches to the projector 2A, the piece 28' is rotated gradually in anticlockwise direction to thereby increase the iris effect, resulting in the decrease of the size of the mark A. This effect is utilized in this invention to simulate the perspective feeling of the target with the flying time thereof. The shape of the ends of the iris plates, that is, the shape of the light pattern provided by the iris plates may be suitably selected. However, it will be better to match the shape with the actual shape of the flying clay. In this embodiment, the shape of the target A projected onto the screen 4 is substantially elliptical which is similar to the actual looking of the flying clay.

Although the amount of the lead-sighting in actual shooting increases with the flying time elapse of the clay, the corresponding amount of lead-sighting, when simulated on the screen 4, decreases with the time elapse. Therefore, the positional relation between the targets A and B projected by the projectors 2A and 2B respectively should also be changed accordingly, that is, the distance between the targets A and B on the screen 4 should be decreased gradually with time. A geometrical and mechanical relations between the projectors 2A and 2B for providing such change in mutual distance will be described hereinafter.

FIG. 8 is a plane view showing a relative positional relations between the mirror 8 and the projectors 2A and 2B. The projector 2A is fixed and the projector 2B is rotatably supported at a position such as 60 on the optical axis. Where the mirror 8 and the projectors 2A and 2B (which are assumed having a common optical axis) are in a fixed relation as shown in FIG. 8, the mark A to be projected onto the screen 4 is stationary as shown in FIG. 10 and the mark B is also stationary as shown by B1 overlapping with the mark A. On the
other hand, if the projector 2B is rotated leftwardly about the fulcrum 60 in a horizontal plane as shown in FIG. 9 and then fixed at a position, the mark B is shifted as shown by B2 in FIG. 10, while the mark A remains stationary. When, therefore, the projector 2B is rotated in an anticlockwise direction as shown by an arrow and at the same time the mirror 8 is rotated in the arrow direction from the position in FIG. 11a, the marks A and B projected on the screen 4 are shifted as shown in FIG. 11b, resulting in the decrease of the distance between the marks A and B which substantially correctly simulate the actual lead-sighting distance. Further, since the actual clay flies along a parabolic locus as mentioned previously, the mark A should be moved on the screen 4 along a parabolic locus and this is true for the mark B. In order to realize this movements of the marks it is needed to rotate the mirror 8 in a vertical plane.

An example of the mechanical constructions for providing these movements are described with respect to FIG. 12 which shows a main mechanical part of the present invention.

In FIG. 12, the projectors 2A and 2B are disposed at one end of a support rail 66. The projector 2A is fixed such that the optical axis thereof is substantially common to the optical axis of a hitting mark projector 2C. The hitting mark projector 2C projects a suitable mark at substantially the same position as that of the mark A on the screen at the instance when the shooter catches the mark B. The projector 2B is fixed on a base, the rear end of which is supported by a universal joint 112. The other end, that is, a forward end of the base is provided with a folk 110. At the other end of the rail, a support post 68 is fixedly mounted. On the rail 66, a support table 80 is disposed slidably therealong. A horizontal extending arm 68a is provided at the lower end of the post 68 and a compression spring 106 is provided between the arm 68a and the table 80 to thereby bias the table 80 toward the arm 68a.

At about the center of the post 68, an arm 68b is provided. The upper portion of the post is provided with a pair of arms 68c and 68d. The mirror 8 is supported by a frame 76 rotatably in a vertical plane, which frame is in turn supported by the arm 68c and 68d rotatably in a horizontal plane.

An arm 76a is provided in a portion of the frame 76, extending rearwardly.

An arm 102 is provided at the left end of the rail 66 rotatably about a point on the axis of the rail. Upon the rotation of the arm 102, the table 80 is pushed forwardly against the spring 106.

A cam means is provided on the table 80 to swing the mirror 8 in a vertical plane. Also on the table, a means for shifting the projector 2B correspondingly to the swing of the mirror 8 is provided. The constructions and effects of the last two means will be described in detail with respect to FIGS. 13 and 14. A swinging means is also provided on the table 80, which will be described in detail with respect to FIGS. 15 and 16.

The wire 38 which is described previously as one end thereof being connected to the piece 28 which is a part of the rotating disk 28 of the projector 2A as shown in FIGS. 3 and 4 is connected at the other end to the table 80 through a pulley such as 114. Upon the forward movement of the table 80 along the rail 66 due to the rotation of the arm 102, the rotation disk 28 is controlled to control the size of the mark A. In the embodiment, when the table 80 is forwarded by the rotation of the arm 102 resisting against the spring 106, the plate 28 is rotated anticlockwise to increase the iris effect.

FIG. 13 shows a detail of the cam means shown in FIG. 12. The main part of the cam means comprises a pair of cam members 82a and 82b. These members are joined such that they can swing against each other as shown in the figure. The lower end of the joining part thereof has a suitable contact portion. The free end of the member 82a is secured rotatably to a protrusion 118 formed on the table 80. The cam members may be biased by a suitable spring means provided, for example, around the joining part to lower the joining part thereof or may be merely downwardly forced by gravity. The contact portion provided at the lower end of the joining part of the cam members contacts with a cam surface 102a of an annular cam 120. The shaft of the cam 120 is coupled to a shaft of a gear 122 provided on the lower side of the table and driven thereby.

The upper surface of the joined cam members forms a parabolic cam surface 86. The cam surface 86 is contacted with a roller 84 provided at the top of a piston 88 of a hydraulic cylinder 90 secured suitable to the arm 68b of the post 68. The cylinder 90 has a piston 96, the top of which contacts with the lower edge of the mirror 8 via a conduit 92a of the cylinder 90, and is connected to a cylinder 94 secured suitably to the arm 76a of the frame 76.

The cam surface 120 of the annular cam acts to vertically move the joining part of the cam members 82a and 82b upon the rotation thereof, as shown in FIGS. 14a and 14b.

That is, it is assumed that the cam 120 is rotated through the gear 122 which may be one of a suitable reduction gear mechanism such that the joining part is lifted as shown in FIG. 14a and then stopped. It is further assumed that under the above conditions the table 80 is moved in the arrow direction. In this case, the roller 84 of the piston 88 which contacts with the parabolic cam surface 86 formed by the cam members 82a and 82b traces the surface 86 and thus the piston 88 is vertically moved. The movement of the piston 88 is transmitted to the cylinder 94 fixed to the frame 76 to thereby control the angle of the mirror 8 correspondingly.

A cam member 121 similar to the cam 120 is provided in the lower side of the table, which has a cam surface similar to that of the cam 120. The cam 121 is coaxial to the cam 120 and driven by the gear 122. A bar 87 contacts with the cam surface of the cam 121. The bar 87 is pivotally supported by a support member 119 and biased toward the cam surface by a spring 87'. Therefore the bar 87 is controlled by the cam 121. The lower surface of the bar 87 forms a smooth linear cam surface. A cylinder 91 is suitably fixed at a position corresponding to the position of the cylinder 90 and a roller 85 provided at the top of a piston associated with the cylinder 91 contacts with the linear cam surface. Accordingly, upon the movement of the table in the arrow direction, the piston associated with the cylinder 91 is driven according to the gradient of the linear cam surface which is determined by the position of the cam 121. The cylinder 91 is connected through a conduit 92b to a cylinder 98. The cylinder 98 is fixed to a post 108 fixed at one end of a lever 78 and a piston 100 of the cylinder 98 contacts with the lower end of the folk 110 of the support base of the projector 2B. Therefore,
upon the movement of the table 80 in the arrow direction, the support base is lowered according to the inclination of the cam 87.

The associated relative movements of the mirror 8 and the projectors 2A and 2B due to these camar are illustrated in Fig. 14c. That is, it is assumed that when the mirror 8 is in a position shown as 8a, the direction of the projector 2B is such that it projects a light beam such as Q1. In this case upon the movement of the table in the arrow direction, the mirror 8 is moved from positions 8b to 8c, 8e to 8d and 8d to 8e and then returned to the position 8a. Simultaneously, the projector 2B is gradually lowered to direct the beam from Q1 to Q5, Q9 to Q4, and Q3 to Q2.

Fig. 14d shows a locus of the light spot on the screen 4 as outlined in this manner. That is, the target A is firstly raised as from A1 to A2 and A3 to A4 and then lowered as A4 to A6 and A1 to A2 according to the change in angle of the mirror 8. The target B is also moved along a path from B1 to B5. That is, the target B always leads the target A.

An embodiment of the mechanical construction for providing the relative movements of the mirror 8 and the projector 2B will be described with reference to Fig. 15 which is a plane view of Fig. 12. As mentioned previously, the mirror 8 is supported by the frame 76 which is in turn supported by the arms 68c and 68d and able to rotate three-dimensionally. The frame 76 has an upper and lower members which are rotatably received by the arms 68c and 68d. The lower end of the lower member 70 is extended and bent as shown. The free end of the member 70 is bent downwardly and received in a groove of a guide member 72. On the other hand, the rod 108 which engages with the valley portion of the folk 110 provided at the free end of the support base for the projector 2B as shown in Figs. 12, 13 is fixed to one end of a bar 78 which is supported rotatably in a horizontal plane about a pin 104 provided at a position along the rail 66. The other end of the bar 78 is bent downwardly and enters into the groove of the guide member 72. The free ends of the bars 70 and 78 are slidably along this groove.

In the lower side of the support 80, an electric motor M1, having a suitable reduction mechanism is provided. A suitable gear 128 is fixedly mounted on the output shaft of the motor M1 in the under side of the table 80. The shaft penetrates the table and, in the upper side of the table, a spur gear 124 is fixedly mounted on the shaft. The spur gear has teeth within a predetermined angle and meshes with a gear 74 on which the guide member 72 is fixed. The member 72 is biased in anticlockwise direction by a spring 126.

When the motor M1 is rotated, the spur gear 124 is also rotated in such as the arrow direction. Therefore, the gear 74 and hence the member 72 is rotated in clockwise direction for the predetermined angle and then the member 72 is returned to its original position due to the force of the bias spring 126. That is, the guide member 72 is swung within the predetermined angle for each revolution of the output shaft of the motor M1.

For example, it is assumed that the member 72 is rotated to a position shown by a dotted line. In this case, the position of the bar 70 is not changed and therefore the direction of the frame 76 is not changed. However, the position of the bar 78 is changed as shown by a dotted line and upon this change, the optical axis of the projector 2B is changed.

Accordingly, the optical axis of the projector 2B is reciprocated against the mirror 8 within a predetermined angle range for each swinging of the guide member 72. The effect of this on the screen 4 is illustrated in Fig. 15c since the light source 2A is fixed on the rail 66, the mark A on the screen 4 is stationary so long as the mirror 8 is stationary. The beam spot from the projector 2B changes its position when the angle of the member 72 is the largest with respect to the rail 66 to B5 when the angle is the smallest. Therefore the distance between the spots A and B is proportional to the angle.

As well known, the amount of the lead-sighting in an actual clay shooting should be the largest when an angle α of the direction of the clay with respect to the shooter is the smallest as shown in Fig. 15d. Therefore, when the angle θ of the member 72 with respect to the rail 66 is fixed such that, for example, the spot B1 is obtained, a lead-sighting for a flying clay, the α of which is relatively larger, is simulated. On the other hand, if the member 72 is fixed to obtain, for example, the point B4, a lead-sighting of a clay, the α of which is relatively smaller, is simulated.

The gear 128 of the motor M1 meshes with the gear 124 via a suitable gear mechanism. The shaft of the gear 122 penetrates the table 80 and connected to the annular cam 120. Accordingly the cam 120 is rotated by energizing the motor M1. Upon the rotation of the cam 120, the cam members 82a, 82b are vertically reciprocated to thereby permit the angle of the mirror to change within a predetermined angle range.

As said previously, the table 80 is biased toward the post 68 by the spring 106. The forward movement of the table 80 resisting the baying force is provided by a motor M2 mounted on the underside of the rail 66. The motor M2 may have a suitable reduction gear mechanism including a spur gear similar to the spur gear 124 to provide a low speed intermittent swinging of the output shaft thereof. The shaft of the motor M2 penetrates the rail 66 and the portion of the shaft extending beyond the upper surface of the table is joined with the arm 102. For example, the arm 102 may be designed such that, upon the intermittent rotation of the shaft of the motor M2, it rotates in clockwise direction within a predetermined angle range. Upon the predetermined rotation of the arm, the table 80 is pushed forward by the free end of the arm 102 and, after the forward movement, the table 80 is returned to the original position by the force of the spring 106. The reciprocal movement of the table 80 controls the iris means of the projector 2A via the wire 38.

The selective control of the motor M1 and M2 is performed by a switch S2. The switch S2 has a normally closed contacts. Accordingly, when a main switch S1 is closed, the motor M1 is rotated to thereby swing the guide member 72, resulting in the continuous change in angle between the mirror 8 and the projector 2B and the vertical reciprocation of the cams 82a and 82b.

Under these conditions, when the switch S2 is actuated by a suitable signal which will be described hereinafter, the contact a is opened and a contact b is closed. Therefore, the energization of the motor M1 is terminated, resulting in that the relative position of the mirror 8 with respect to the projector 2B and the height of the parabolic cam surface 86 formed by the cam members 82a, 82b are frozen at the time when the switch S2
is actuated. Simultaneously, the motor $M_3$ is actuated and thereby the table $80$ is advanced with the iris amount of the projector $2A$ being increased.

Next, the relative movement of the mirror $8$ and the projector $2B$ due to the forward movement of the table $80$ will be described with reference to FIG. 16.

As mentioned previously, the arm $102$ is in a position shown in FIG. 16a at the instance when the switch $S_2$ is actuated and accordingly the table $80$ is stationary at the instance. When it is assumed that the frozen position of the guide member $72$ at that time is as shown, the relative position of the mirror $8$ and the projector $2B$ is fixed as shown. The mark $A$ on the screen $4$ projected from the projector $2A$ at this time is in a position on an extension of the rail, but the mark $B$ from the projector $2B$ is in a position remote from the mark $A$ by $B$.

Then, when, upon the actuation of the motor $M_4$, the arm $102$ is rotated in clockwise direction as shown in FIG. 16b, the table $80$ will be advanced by the arm $102$ by $d$. Since at this time, the angle of the member $72$ with respect to the rail is fixed, the end of the bar $70$ extending from the frame $76$ of the mirror $8$ is shifted along the groove of the member $72$ such that the end moves from the axis of the rail $66$, and therefore the frame $76$ supported by the post $68$ is swung in a vertical plane as shown in FIG. 16b. At the same time, the free end of the arm $78$ mounted rotatably about the fulcrum $104$ on the rail $66$ is swung toward the axis of the rail $66$ and accordingly, the optical axis of the projector $2B$ is shifted away from the axis of the rail $66$. For this reason, the spot from the fixed projector $2A$ is shifted as shown in the same figure. Although the spot $B$ from the projector $2B$ is also shifted with the shift of the projector $2B$, the amount thereof is relatively small and therefore, the marks $A$ and $B$ on the screen are shifted in the same direction with decrease in distance therebetween as shown in FIG. 11.

Thus, for the whole mechanism, upon the actuation of the motor $M_4$ and the effect of the spring $106$ shown in FIG. 15a, the member $72$ is intermittently swung within the predetermined angle range and, with this swinging, the projector $2B$ is also swung via the movement of the end of the bar $78$ which is in the groove and simultaneously the contours of the cam $82$ and the cam $87$ are also continuously changed. Upon the actuation of the switch $S_3$, the actuation of the motor $M_4$ is terminated. The position of the member $72$ and hence the direction of the projector $2B$ are frozen at this time to thereby determine the direction of clay discharge. At the same time, the contours of the cam surfaces of the cam $82$ and $87$ are frozen. Accordingly, at the time instance when the motor $M_4$ is stopped, the direction of clay discharge, the contour of the parabolic path to be traced by the clay and the amount of lead-sighting are determined simultaneously. By the motor $M_4$ which has a suitable reduction gears and which is energized at the same time the motor $M_4$ is stopped, the arm $102$ pushes the table forwardly resistng the spring $106$. By the forward movement of the table, the iris effect of the projector $2A$ is controlled and the rollers $84$ and $86$ trace the cam surfaces frozen at that time to thereby produce the relative movements of the mirror $8$ and the projectors $2A$ and $2B$ as shown in FIG. 14d. Simultaneously, the relative movement of the mirror $8$ and the projectors as shown in FIG. 16c are produced through the member $72$. The two relative movements mentioned as above are combined resulting in the locus of the targets $A$ and $B$ such as shown in FIG. 17 on the screen $4$.

As mentioned previously, the discharge direction of the clay, i.e., the target marks is determined by the positions of the member $72$ and the cams $82$ and $87$ at the instance the table $80$ is started, that is, at the instance the switch $S_3$ is actuated. Therefore, the shooter can not be informed previously as to the direction in which the target is discharged. That is, the target is discharged in any one of the directions shown in FIG. 18 according to the time instance of the actuation of the switch $S_3$.

The shooter recognizes the target $A$ projected on the screen $4$ in this way and if the lead-sighting for the mark $A$ is correct, the muzzle of the gun will be directed properly to the target $B$.

FIG. 19 illustrates an example of the light-receiving type guns suitable to use with the present system. The gun is illustrated as so-called over and under type shot gun. In either barrel, for example, the upper barrel $130$, a lens system $146$, a light-receiving system $148$ having an element responsive to, for example, infra-red light beam received by the lens system and a transmitter $150$ operative in response to the reception of the light beam. The electric circuits of the light-receiving system $148$ and the transmitter $150$ may be supplied by a power source housed in the transmitter. Cases such as $152$ are inserted as shown in FIG. 20. Each of the cases $152$ may include a capacitor which will be discharged upon an actuation of a trigger to thereby enable the electric circuits in the gun to operate once a time. Further, if necessary, by employing a mechanism comprising a pair of springs which are charged by folding action of the gun and released to impart the trigger of the gun stock upon operation of the trigger, a recoil feeling which would be similar to that obtained by the explosion of gun power will be obtained.

As the light-receiving system $148$, a photo-diode etc. may be used. The transmitter $150$ is one which produces a fixed frequency signal in response to the actuation of the receiving system $148$. The electric circuits thereof and the associated electrical connection themselves are obvious to these skilled in the art and so, the details thereof are omitted in this specification.

FIG. 22 shows an example of the electric arrangement for performing the present system employing the light-receiving gun and the mechanism such as shown and described previously.

The circuit arrangement shown in FIG. 22 is for an embodiment in which a plurality of the aforementioned mechanical constructions are arranged side by side and a corresponding number of targets are projected on a common screen to which a corresponding number of shooters are assigned, respectively. That is, the present system prevents a specific shooter selects one target erroneously which is assigned to another shooter and another possibility that, where locuses of any two or more targets are crossed on the screen $4$, the specific shooter eventually hits one target on the locus of his own target due to the presence of a plurality of targets on the same screen.

To this end, in the arrangement shown in FIG. 22, the projectors $2B$ are controlled by respective pulse generators such that each of them provides light pulses having a specific frequency corresponding to the common pulse generator in time-shared manner. Correspondingly, a frequency discriminator or time sharing discriminator is provided in a receiving device associated with the
gun to make the receiving device responsive only to the assigned frequency signal or to a signal having the assigned timing.

The system in FIG. 22 is an example of frequency assignment system and actuated by actuating foot switches 160 provided in the respective shooting sheet. The switch 16 is of such as micro-switch, and when the shooter rides on the shooting sheet, the micro-switch is made on.

Upon the closing of the switch 16, a motor control section 162 for clay discharge is actuated. As mentioned previously, the control section 162 controls the switches S1 and S2 as in FIG. 15a. That is, since the switch S2 is connected to a normally closed contact a, and the closing of the switch 160 renders the main switch S1 closed, the motor M1 is started to rotate simultaneously with the closing of the switch 160 and the movements of the members 72, 72 and 87 are commenced immediately. At the same time, the projectors 2A, 2B, 2C are lit to prepare the projections of the marks on the screen. On the other hand, also upon the closing of the switch 160, a signal is applied to a discriminator circuit 174. The discriminator 174 receives clock pulses from a fundamental oscillator 176. The output of the oscillator 176 is also supplied to the projector 2B to control its light emission. Although the output of the main oscillator 176 is also fed to other shooting seats in time-sharing manner, only first seat is shown in this figure.

Then, when a voice signal is produced by the shooter to order the discharge the clay, the voice is collected by such a microphone which is connected to a voice operation circuit 180 which converts the voice to an electric signal which is supplied to the motor control section 162. Upon the receipt of the selection signal, the section 162 actuates the switch 52 to cause the contact a to open and the contact b to close. The controls of the projectors 2A and 2B by the section 162 may be suitably performed as, for example, by using electro-magnetic shutters. The structures thereof are not included in the scope of the mention and since they themselves are obvious to those skilled in the art, the details thereof are omitted.

When the contact b is closed, motor M1 is stopped. By this stoppage, the discharge direction of the clay i.e., the spot is determined. Simultaneously, the motor M2 is started to thereby rotate the arm 102 which pushes the table 80 forwardly along the rail 86. Thus, the targets discharged in the fixed direction move along a parabolic locus determined by the discharge direction.

The shooter recognizes the visible target A, lead-sights it sufficiently with the gun 10 and then actuates the trigger 142 thereof. If the lead-sight is proper, the light beam reflected from the mark B on the screen is received by the lens system of the guns 10 and the transmitter 150 of the gun which is energized by the capacitor 152 in the cartridge and a power source housed therein is actuated to transmit a specific signal according to the frequency or the timing of the mark B via a suitable antenna means thereof.

The transmitted signal is received by a receiver 172 and transferred to the discriminator 170 of the receiving device 12. The signal to be transmitted is constituted with an explosion signal produced by the discharge of the capacitor and a hitting signal received through the light-receiving system 146, 148. The discriminator 170 provides explosion and hitting outputs and by the explosion output, the sound device 166 is actuated to provide an explosion sound stored therein through a speaker 168. On the other hand, the hitting output of the discriminator 170 is fed to the other input of the hitting discrimination circuit 174 which discriminates whether the hitting output of the 170 is one assigned to the seat. If the hitting output is proper, the hitting discriminator 174 provides an output and the output controls the projectors 2A and 2C to distinguish the mark A and project a hitting mark C at the same position as that of the mark A. Is necessary, the output of the hitting discriminator is fed to a hitting probability determination circuit 184.

As well known, the slugs of the shot shell diverge with a specific angle H. Therefore, with the time, the distribution of the slugs is expanded and so the probability of hitting is lowered. The hitting probability determination circuit 184 is employed in the system to simulate such change of the hitting probability with time. That is, a position of the target on the screen is detected by a suitable means as time elapse and a signal representative of the detected position is fed to the circuit 182. An example of the circuit 182 is shown in FIG. 22b.

In FIG. 22b, a probability signal generator is composed of a clock pulse generator 211, a binary shift register 212 and a plurality of AND gates (in this example, ten gates). The clock pulse generator 211 provides a series of clock pulses which are registered in the shift register 212 which is, in this case, 10 digits. The outputs of the respective digits of the register are connected to one inputs of the AND gates respectively. The other inputs of these AND gates are supplied with the output of the oscillator 211. Therefore, upon a first clock pulse, the AND gate G6 is opened to pass the clock pulses. When a second pulse is registered in the second digit of the register, the second AND gate G7 is opened to pass the pulses subsequent to the first pulses and so on. Therefore, on the points A6 – A9, pulse trains each starting with one pulse delay with respect to the previous train appear. This is shown in FIG. 22e. As obvious from FIG. 22c, at one time point during a period T, the probability that there are at least one in the points A6 – A9 is 100%. The probability that there are at least two pulses is 90% and so on. And finally, the probability that there are ten pulses on the points A6 – A9 is 10%. Therefore, in this case, it is assumed that, where all of the gates G6 – G9 have outputs, the probability is 10% and this is indicated by an output of an AND gate G9. In the similar manner, the respective probabilities are indicated by outputs of the gates G2a to G2b. While the probability in this case is selected as linear, any non-linear selection may be made for this purpose.

On the other hand, a pulse train is produced by simulating the flying distance of the target with the movement of a member such as the previously mentioned mirror 8 or the table 80 etc. that is, a member 192 having a low of holes 190 is mounted fixedly on the moving member. A light source 194 is disposed in one side of the member 192, in the other side of which a photo-electric device 196 is disposed. The movement of the moving member is detected by the photo-electric device 196 through the holes of the member 192. The output of the device 196 is connected to a pulse generator 198 to generate a train of pulses each of which is representative of the position of the target at one time. The pulse train is fed to a shift register 212 similar to
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the register 212. Therefore, the first pulse of the train which is produced initially is registered in the first digit of the register 212'. In the similar manner, all positions of the locus of the target is stored in the register 212'.

As mentioned previously, the hitting probability at initial time is the maximum, and this is assigned to the output of the AND gate G_9. Therefore, the output of the first digit of the register 212' together with the output of the gate G_9 is inputted to the inputs of an AND gate G_{30} so that a presence of output of the gate G_{30} indicates a hitting in the initial state. In the similar manner, the respective outputs of the register 212' are inputted to AND gates G_{31} to G_{39} together with the outputs of the associated gates G_{31} to G_{39}. The outputs of the gates G_{30} to G_{39} are connected to inputs of an OR gate G_{40}. The output of the gate G_{50} is, together with the hitting output of the hitting discriminator 174, inputted to an AND gate G_{50}.

Thus, the output of the gate G_{50} indicates that the target at a specific position is properly shot by the shooter and that the distribution of the slugs at the position is sufficient to destroy the target.

The output of the gate G_{50} is fed to a time-delay circuit 184 (FIG. 22a). The delay circuit 184 is adapted to simulate the velocity of the slugs and this may be omitted in some cases. The output of the delay circuit is fed to the projectors 2A and 2C as in the previous case.

FIG. 23 shows another embodiment of the present mechanical system and FIG. 24 is a perspective view of the main portion thereof. In comparison with the mechanism of FIG. 12, the features of the embodiment of FIG. 23 is that the moving direction of the table 80' is reversed and that, instead of the hydraulic connections, mechanical connections are employed.

In this embodiment, the horizontal movement of the mirror 8 is performed by a bar 70'. The bar 70' has a roller at the end thereof and the roller contacts with a member 302 fixed on a circular plate 300 pivotally supported on a slide table 80' and biased in the arrow direction. The member 302 is reciprocated by an arm 74' which rotates in one direction. To this end, instead of the combination of the bar 78 and the post 108 in FIG. 12, a bar 78' provided at opposite ends with rollers is employed. Further, as shown in FIG. 24c which shows a detail of the table 80' in FIG. 24c, the vertical deviation of the mirror 8 is performed by, instead of the pistons and cylinders, a bar 92 having rollers at opposite ends thereof and a connecting member 312 biased by a spring. The cams 82 and 87 are gauged by a member 304 and the base of the projector 2B is connected to the cam 87 by a bar 306 having rollers at the opposite ends thereof. The movement of the table 80' is provided by pushing a lever 310 by a motor provided on its shaft an eccentric cam 308.

FIG. 25 shows another embodiment of the iris device which is particularly suitable to use in the arrangement shown in FIG. 24a. Although, in the construction shown in FIGS. 3 to 5, the iris plates 46 and 48 are moved vertically and horizontally by the pins implanted to the rotating plate 28, iris plates 46' and 48' of this embodiment are provided at their ends rollers are supported suitably such that they can slide vertically and horizontally. The iris plates 46' and 48' are biased away from each other by expansion springs 320 provided therebetween respectively. An annular cam 324 having inner came surfaces 322 is disposed outwardly coaxially and the rollers provided at the ends of the plates contact with the cam surfaces. To this cam the wire 38 is connected through a suitable pulley 326. One end of the wire is fixed through a spring 328 and the other end is connected to the table 80'. Therefore, due to the movement of the table, the cam 324 is rotated in the arrow direction to thereby cause the iris plates 46' and 48' to move toward each other respectively, resulting in the same effect as obtainable by the construction shown in FIGS. 3 to 5.

What is claimed is:

1. A clay shooting simulation system comprising, in combination, a screen, at least a first projector adapted to project a visible light mark to be focussed on said screen, at least one second projector adapted to project an invisible light mark to be focussed on said screen, at least one mirror means adapted to reflect the visible light mark and the invisible light mark projected by said first and second projectors respectively to said screen, at least one means for providing continuous movements of said mirror means and said second projector with a specific continuous relative movement between the visible mark and the invisible mark on said screen such that the visible mark moves along a locus simulating an actual flying locus of a clay pigeon and the invisible mark always exists at a position leading the visible mark so that the invisible mark simulates a lead-sighting point with respect to the visible mark, at least one light-receiving type gun adapted to receive a light beam reflected from the invisible mark on said screen and means responsive only to a reception of the invisible light beam by said gun for informing a hitting.

2. A clay shooting simulation system as set forth in claim 1 wherein said first projector comprises a light source, a shutter means, an iris means and an optical lens system, said iris means including a plurality of iris plates each supported slidably in radial direction and biased outwardly and an annular cam member having inner cam surface, said iris plates being slidably inwardly by the rotation of said cam member to reduce the iris aperture.

3. A clay shooting simulation system as set forth in claim 2 wherein the rotation of said disk is controlled by said means for providing continuous movements.

4. A clay shooting simulation system as set forth in claim 1 wherein said first projector comprises a light source, a shutter means, an iris means and an optical lens system, said iris means including a plurality of iris plates each supported slidably in radial direction and biased outwardly and an annular cam member having inner cam surface, said iris plates being slidably inwardly by the rotation of said cam member to reduce the iris aperture.

5. A clay shooting simulation system as set forth in claim 1 wherein said means for providing continuous movements comprises a first means for moving the visible mark and the invisible mark on said screen in vertical direction and a second means for moving the first and second marks in horizontal direction.

6. A clay shooting simulation system as set forth in claim 5 wherein said means for means for providing continuous movements comprises a first means for moving the visible mark and the invisible mark on said screen in vertical direction and a second means for moving the first and second marks in horizontal direction.

7. A clay shooting simulation system as set forth in claim 6, further comprising means for determining the
shape of the parabolic cam surface of said first cam member and the angle of the linear cam surface of said second cam member.

8. A clay shooting simulation system as set forth in claim 5, wherein said means for providing continuous movements further comprises means for moving said second projector vertically with respect to said first projector.

9. A clay shooting simulation system as set forth in claim 8, wherein said means for moving said second projector includes a second linear cam member, the cam surface of which is associated with the shape of the parabolic cam surface of said first cam member.

10. A clay shooting simulation system as set forth in claim 9, wherein said means for providing continuous movements further comprises means for swinging said second projector in a horizontal plane with respect to said first projector according to said first linear cam.

11. A clay shooting simulation system as set forth in claim 1, wherein said light-receiving type gun includes means for producing a predetermined signal in response to an operation of a trigger thereof and said means for informing a hitting includes means for producing a sound in response to the predetermined signal.

12. A clay shooting simulation system as set forth in claim 11, wherein said gun includes means for producing a signal in response to a reception of a light beam by said gun which is reflected from the invisible mark on said screen and said means for informing the hitting includes means responsive to the last signal for deenergizing said first projector and energizing said third projector to thereby display a hitting mark at the same position where the visible mark existed.

13. A clay shooting simulation system as set forth in claim 1, further comprising means for controlling a completion of the operation of said means for producing continuous movements.

14. A clay shooting simulation system comprising, in combination, at least one guide rail, a first projector projecting a visible mark fixedly mounted adjacent to one end of said rail, an iris device housed in said first projector for changing the shape of the projected mark, a second projector projecting a visible mark having optical axis which is substantially coincident with that of said first projector, a projector projecting an invisible mark rotatably mounted for three dimensional movement at a position adjacent to said first and second projectors, a support means fixedly mounted adjacent to the other end of said rail, a mirror means rotatably supported for three-dimensional movement by said support means to receive light beams from said first and second projectors and said invisible mark projecting projector, a slide base slideable along said rail, a bias means for urging said slide base toward said support means, means for gauging said slide base to said iris device, a first means for moving said slide base against resistance from said bias means, a second means provided on one surface of said slide base for moving said mirror means reciprocally in a vertical plane according to the movement of said slide base, a third means provided on the other surface of said slide base for moving said invisible projector linearly in a vertical direction according to the movement of said slide base, a fourth means provided on said one surface of said slide base for moving linearly said mirror means and said invisible projector relative to one another in a horizontal plane according to the movement of said slide base, a first control means for controlling the operations of said first means, a second control means for exclusively controlling said second, third and fourth means and said first means, a screen adapted to receive light beams projected from said first or second projector and said invisible projector when reflected by said mirror means, a gun means operative in response to a reception of an invisible light beam projected from said invisible projector and reflected by said mirror means and then by said screen to produce an electric signal, means for controlling said first and second projectors in response to said electric signal, and means actuated by an operator for controlling said first and second control means.

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