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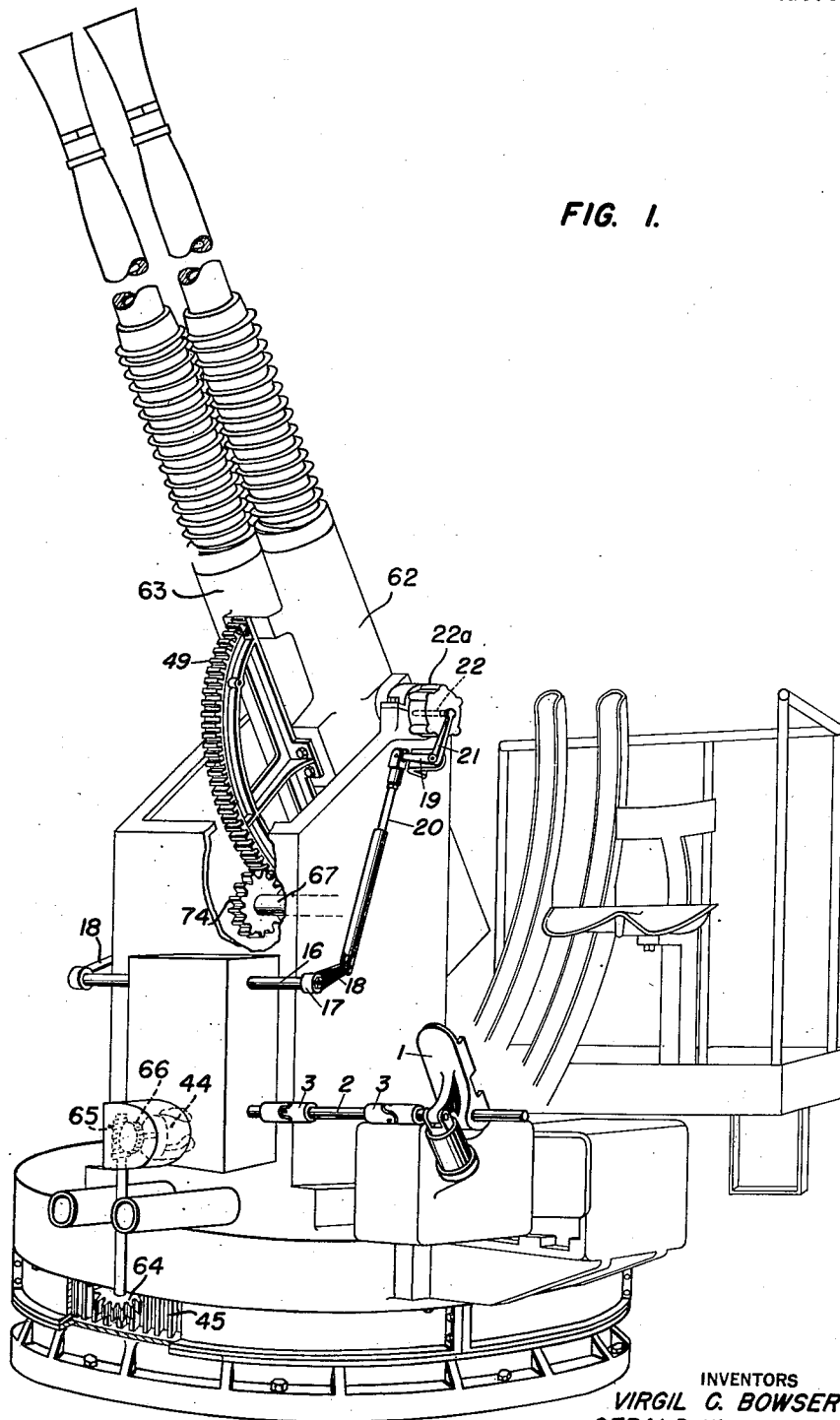
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GUN FIRING MECHANISM WITH CUTOUT DEVICE

Filed Dec. 9, 1946

4 Sheets-Sheet 1

FIG. 1.



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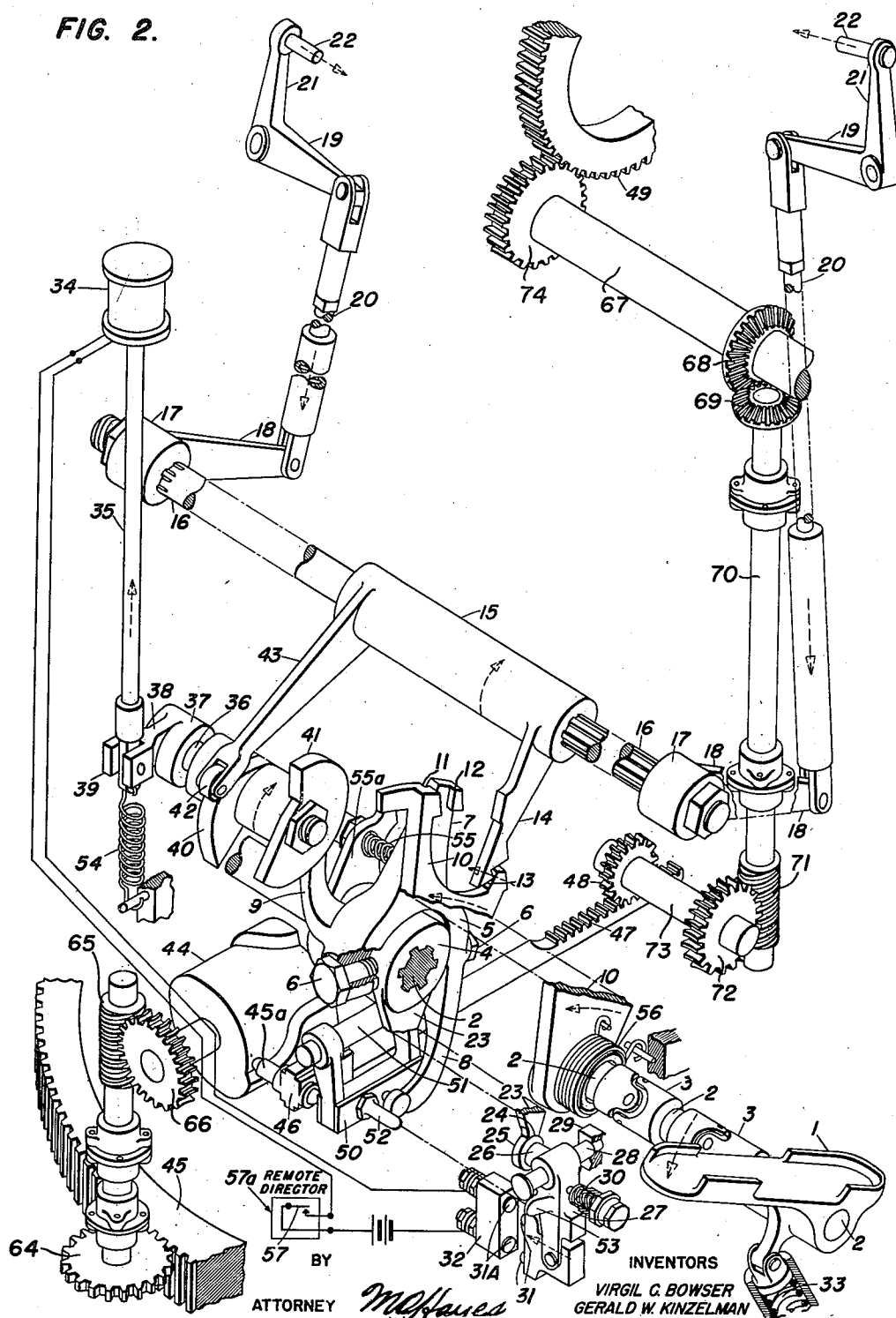
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FIG. 2.



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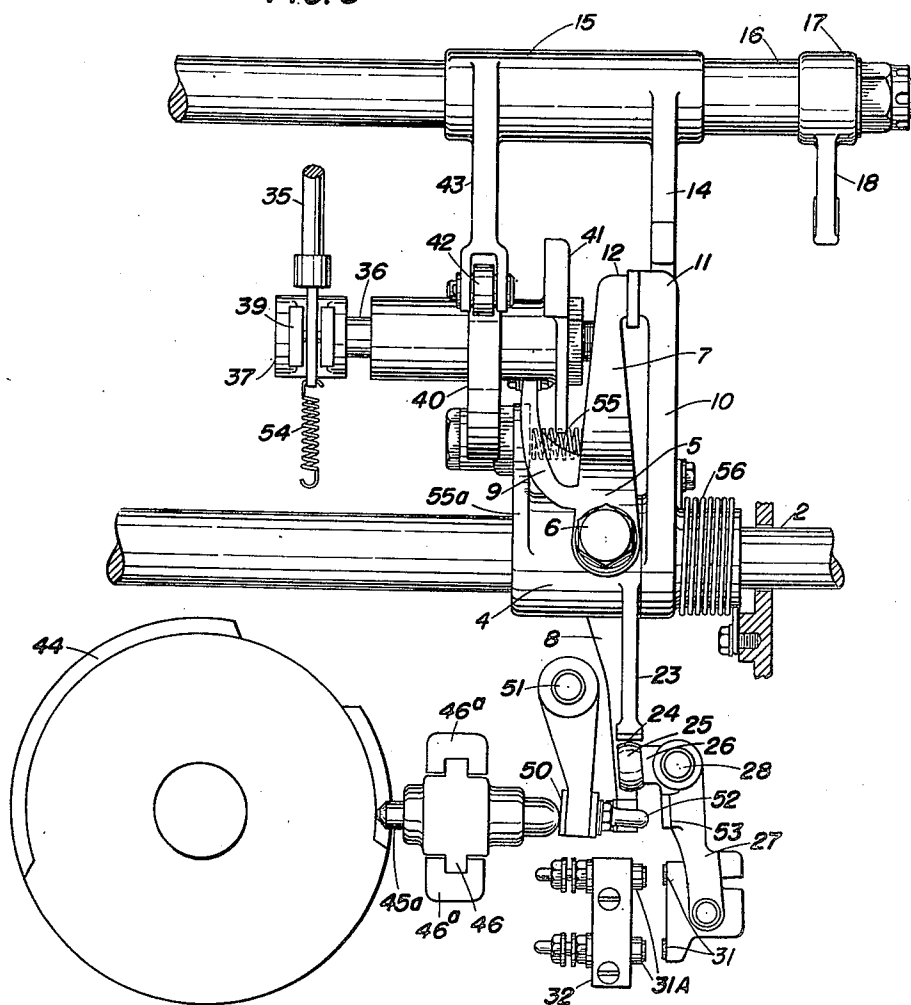
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GUN FIRING MECHANISM WITH CUTOUT DEVICE

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FIG. 3



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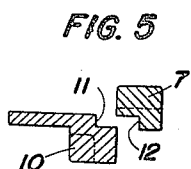
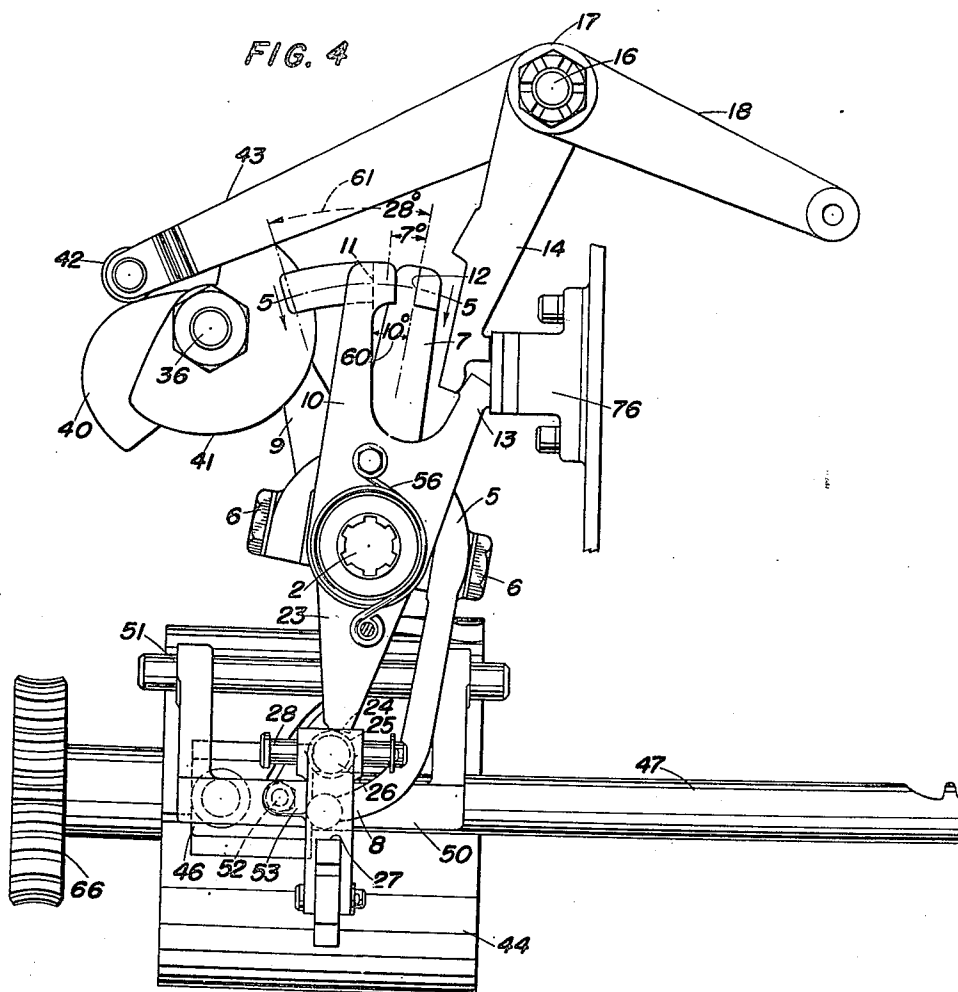
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GUN FIRING MECHANISM WITH CUTOUT DEVICE

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4 Sheets-Sheet 4



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GUN FIRING MECHANISM WITH CUTOUT DEVICE

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Gun firing mechanisms have been provided in the past with firing cutout devices which disable the firing mechanism when the gun is pointed at any portion of the vessel upon which the gun is mounted.

The firing mechanism is normally actuated by a pedal which closes the firing switch to initiate firing electrically when the pedal is partially depressed and which fires through a mechanical linkage when the pedal is depressed further in the event of an electrical failure.

An electric switch stationed at a remote gun director is wired in series with the firing switch and firing will normally cease when either of these switches is open unless the pedal is depressed all the way.

The above-stated firing cutout mechanism is provided with a switch in series with both the firing switch and the director switch and which is opened when the gun is pointed in a direction in which the firing is desired to be restricted. The firing cutout mechanism also opens a latch connection interposed between the foot firing pedal and the gun's firing mechanism in order to break the mechanical connection between the two to prevent mechanical firing.

Accidents have occurred in the past due to the fact that when the director firing switch was open the gun continued to be fired by the mechanical linkage due to the pedal being held down all the way by the operator.

1. It is an object of this invention to provide means to stop firing when the director firing switch is open.

2. It is a further object to stop firing when the director switch is open, in such a manner that firing can be continued mechanically at the mount in the event of an electrical power failure, by releasing the foot firing pedal and then depressing it again.

3. It is a further object of this invention to provide in a gun having a manually operable firing device and a power operated firing device, a means to render the manual firing device inoperative while the power operated device is functioning.

4. It is a further object of this invention to provide in a gun having a manually operable firing device and a power operated firing device, a means to render the manual firing device inoperative which means consists of a breakable connection interposed in the manual firing device and adapted to be disengaged when the power operated means is in firing position, in such fashion that return of the power operated means to inoperative position cannot initiate firing by the manually operated means without further movement thereof by the operator.

5. It is a further object to employ the breakable connection of the firing cutout mechanism for the above-stated purpose.

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6. It is a further object of this invention to provide a firing mechanism which employs a single switch which performs the functions of a firing cutout switch and a manually operated firing switch.

7. It is a further object of this invention to provide a novel structure to accomplish the above-stated objects as shown in the drawing in which:

10 Fig. 1 is a perspective view of a portion of a gun mount embodying the invention;

15 Fig. 2 is an isometric projection which schematically illustrates one embodiment of this invention, the mechanism being shown in non-firing position and the arrows indicating the directions the parts move to fire the gun, portions of the gun engaged by this novel firing mechanism also being shown;

20 Fig. 3 is a front elevation of the principal parts of the structure illustrated in Fig. 2;

Fig. 4 is an end elevation of the mechanism in Fig. 3, and

Fig. 5 is a detail cross section taken on the line 5-5 of Fig. 4.

25 The foregoing objects are accomplished in the following manner, attention being directed first to the mechanism involved in *Manual Firing*: A pedal 1 is pinned to one end of a shaft 2 consisting of several sections joined by universal joints 3. The end of shaft 2 opposite to the pedal is splined to a hub 4 which rotates therewith. A yoke 5 is mounted on the hub 4 by diametrically extending trunnions in the form of cap screws 6, in order to rotate yoke 5 with the hub and to permit movement perpendicular to this rotation. Yoke 5 has three integral arms 7, 8 and 9 whose functions will shortly be described. A bell lever 10 is freely journaled on shaft 2 for rotation with respect thereto and is spring urged clockwise by spring 56. Abutment surfaces 11 and 12 constituting a separable connection between levers 10 and 7, respectively, inter-engage to rotate bell lever 10 counterclockwise when arm 7 is moved in this direction, providing the yoke 5 is in a position in which abutment surfaces 11 and 12 are substantially in the same plane. Abutment portion 13 on bell lever 10 engages a firing arm 14 formed integrally with hub 15 which is secured to firing shaft 16. Because of its structure and free journaling the lever 10 is aptly called a floating clutch. Hubs 17 of lever arms 18 are splined to shaft 16. These arms rock bell levers 19 by means of adjustable links 20. Bell levers 19 have arms 21 which engage firing plungers 22 located in the gun trunnions 22a (see Fig. 1).

Said plungers extend inwardly of the gun trunnions where, at their ends, they are adapted to actuate conventional trigger mechanisms (not shown). The operation of manual firing involving the previously described mechanism is as

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follows. The gun pointer's pedal 1 is depressed with his right foot through an arc of 28°, turning the shaft 2 counterclockwise (Fig. 4) and causing the hub 4, carrying hinged lever 7, to pick up the floating clutch lever 10. This is done after the first 10° of counterclockwise movement indicated 60. The abutments 11, 12 engage at that time.

From then on the lever 10, which it will be remembered is loose on the shaft 2, will be turned the remaining 18° to compose the total arc of 28° indicated 61 in Fig. 4. The spring 56 will then be loaded. Clockwise turning of the firing arm 14 (Fig. 4) began with the movement of lever 10 after the engagement at 11, 12, the abutment 13 and a similar abutment on lever 10 then leaving a bumper 76 (Fig. 4) which is supplied and acts as an initial stop for 10 and 14.

The aforesaid turning of the firing arm 14 rocks the right and left levers 18 clockwise, pulling down on the links 20 and projecting the plungers 22 inwardly to fire the guns 62, 63 (Fig. 1). Firing stops when the operator lets up on the pedal 1, whereupon a spring 33 in a pedal-return assembly restores the pedal and its dependent parts to the initial position, the spring 56 doing the same for the floating clutch lever 10.

The first 10° movement of the foot pedal 1 mentioned above, is for the purpose of permitting the closure of an electrical firing switch when, as later described, the mechanism is put to that use. It should also be stated at this point that the necessary depression of the pedal for manual firing will not initiate the electrical mode of firing involved in the aforesaid 10° movement. Although the electrical firing switch is permitted to close during said 10° movement, the circuit which it controls is supposed to be open, at least at one remote director station.

Electrical firing

The gun may be fired electrically by depressing the foot pedal part way, in actual practice about 7°, by the following mechanism: Hub 4 has an integral arm 23 having a camming surface 24 which normally rides on and depresses a roller 25 and arm 26 on which roller 25 is journaled. Switch member 27 is pivoted on pin 28 which is fixed in bracket 29. A spring 30 urges switch member 27 clockwise toward a closed position in which contacts 31 on switch member 27, engage and short circuit contacts 31A in fixed contact strip 32. The switch is thus closed by spring 30 except when the foot firing pedal is released at which time arm 23 holds the switch open.

A remote director 57a is provided with a firing switch 57. When the firing switch 31, 31A and the remote director firing switch 57, which is wired in series therewith, are both closed, solenoid 34 is energized thus raising rod 35 attached to the solenoid plunger (not shown). Shaft 36 is rotated clockwise by this upward movement of rod 35, by means of a hub 37 fixed to shaft 36 and having an integral arm 38 pivoted to rod 35 by clevis 39. Fixed to shaft 36 is cam 40. Cam 40 is a radial cam which rotates clockwise and lifts roller 42 journaled on arm 43, when the solenoid 34 is energized. Arm 43 is integral with hub 15 and firing thus occurs as explained for manual firing.

Firing cutout mechanism

The firing cutout mechanism operates to prevent firing when the gun is trained and elevated into preselected non-firing zones. This mechanism consists of a drum cam 44 rotated by the

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gun mount training circle 45, by any suitable gearing such as the pinion 64, worm 65, worm gear 66 and necessary shafting. The cam 44 will rotate 360° through 360° of training of the gun. A cam follower 45a is slidably mounted in a slide block 46 which is mounted in guides 46a (Fig. 3) for movement axially along the cam. This axial movement is caused by a rack 47 secured to block 46 and translated by pinion 48 which is rotated by the same gun elevating drive shaft 67 which actuates the elevating arc 49. For that purpose the drive shaft 67 has a bevel gear drive 68, 69 to a shaft 79 which, in turn, has a worm drive 71, 72 to a countershaft 73 which carries the pinion 48. The drive shaft 67 also has a pinion 74 in mesh with the arc 49. The actuation of the shaft 67 for elevating the guns 62, 63 thus also causes the reciprocation of rack 47. The maximum number of degrees of elevation is an index of the extent of travel of the cam follower 45a along the cam drum. In practice the contour of the cam is determined after the gun is mounted on the ship, and at that time is profiled to demarcate areas intended to constitute the non-firing zones mentioned above.

A U-shaped frame 50, swingably mounted on a fixed stud 51 is moved counterclockwise by cam follower 45 when the latter is moved to the right by high portions of cam 44. This cuts out electrical firing by means of a pintle 52 secured to frame 50 and adapted to engage abutment 53 on switch member 27 to open switch contacts 31, 31A, and thus de-energize solenoid 34. This allows spring 54 to rotate cam 40 counterclockwise to cease firing electrically.

Manual firing is also interrupted when follower 45a rides on a high portion of cam 44, since when frame 50 is swung counterclockwise by follower 45, it engages arm 8 of yoke 5 to swing it counterclockwise about pivot 6, against the resiliency of compression spring 55. This spring 55 is supported in a bracket 55a which is secured to hub 4. This will move arm 7 of yoke 5 counterclockwise about trunnions 6 and swing abutment surface 12 out of the path of surface 11, to break the mechanical connection between the foot firing pedal and the gun. When the cam follower 45a returns to a low portion of cam 44, representing a safe firing zone, compression spring 55 urges abutment surface 12 toward realignment with surface 11. From what has been stated immediately above, it can be understood that the low parts of the cam 44 represent safe areas while the high parts represent danger areas. If the guns are either trained or elevated while the follower 45a rides the high part, both the electrical and manual firing facilities are suspended. A depression of the pedal 1 during that period will not yield any response, it being remembered that the mechanical connection between the pedal and the firing shaft 16 is broken by the offsetting of the abutments 11, 12.

Electrical and mechanical firing interlock

Under this heading mention is desired to be made of a circumstance which can and does occur in gun firing. The gun pointer will have depressed the pedal a distance commensurate with the 10° electrical firing zone 60 (Fig. 4) to permit closure of the switch 31, 31A. At the same time the remote director switch 57 will have been closed to in turn close the electrical firing circuit. The gun starts firing electrically and the gun pointer, due to natural fatigue, may inadvertently depress the pedal beyond the 10° into the manual operating zone. Should it suddenly ap-

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pear necessary to cease firing from the remote director prompting the opening of switch 57, but due to the position of the foot pedal the guns continue to fire under manual operation, use is made of a novel interlock which nullifies the foot pedal. This interlock comprises a cam 41 fixed to shaft 36 and rotated clockwise when the solenoid is energized.

Arm 9 on yoke 5 extends in back of and engages the rear surface of cam 41 which surface is formed as a face cam. As cam 41 rotates clockwise, as would occur during electrical firing, a thicker portion of cam 41 shifts push arm 9 and integral yoke 5 counterclockwise about pivots 6 to disengage abutment surfaces 11 and 12, so that arm 7 which is actuated by the inadvertent depression of the foot firing pedal, is moved out of range and becomes inoperative to move bell lever 10 to fire the gun. If the foot pedal were held depressed at the lower limit of its travel while electrical firing was in progress due to director switch 57 being closed, arm 7 would remain at the end of its travel in a counterclockwise direction but its abutment surface 12 would remain out of the path of surface 11 on lever 10 because of the engagement of arm 9 with the high portion of cam 41. This condition would permit spring 56 to rotate bell lever 10 clockwise, leaving a clearance space between abutment portion 13 and arm 14. If the director switch is then opened this clearance space will allow crank 14, 15, 43 to be rotated counterclockwise to cease firing position, by a spring in the gun mechanism (not shown) when spring 54 rotates cam 40 counterclockwise.

If it is then desired to fire the gun manually, it is necessary to permit the pedal 1 to be returned to elevated position by spring 33.

Shaft 2 and arm 7 will then be rotated clockwise until abutment surface 12 thereof is abreast of surface 11 on lever 10, at which time spring 55 will swing arm 7 and yoke 5 clockwise about pivots 6 to align surfaces 11 and 12. Depression of the foot pedal will then result in manual firing as previously described.

It will be noted that the above-described arrangement permits the use of a single normally closed switch such as 31, 31A which is opened either by elevation of the foot firing pedal or by the firing cutout mechanism, rather than by two separate switches as formerly used.

The invention herein described may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

We claim:

1. In a firing control system for a gun having a firing member, a firing linkage in operative engagement with said firing member, power operated means for actuating said firing linkage to fire said gun, manually operable means operatively connected to said firing linkage and operative alternatively with said power operated means to fire said gun, means responsive to movement of said power operated means to firing position to render said manually operable means inoperative, and means operative upon return of said power means to non-firing position to render the manually operable means operative to fire the gun only upon further movement of said manually operable means.

2. In a firing control system for a gun having a firing member, power operated means for firing said gun, manually operable means operatively

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coupled with said member for firing said gun, said manually operable means having a breakable connection in its operative coupling with said member, means responsive to movement of the power operated means to firing position to disengage said breakable connection to render said manually operable means inoperative, and means operative upon return of said power means to non-firing position to urge the breakable connection toward a re-engaged position to render said manually operable means operative to fire the gun upon further movement of said manually operable means.

3. In a firing control system for a gun having a firing element, a firing linkage in operative engagement with said firing element, power operated means operatively connected to said firing linkage to actuate it and fire said gun, manually operable means also operatively connected to said firing linkage to actuate it and fire said gun, said manually operable means comprising a firing pedal and a separable connection in the latter operative connection and consisting of a driving member and a driven member movable thereby with portions of both of said members in a common plane, driving means interposed between said driving member and said firing pedal, an operative connection between said firing linkage and said driven member, means responsive to movement of said power operated means to firing position to laterally move one of said members out of said plane to disengage said separable connection and render said manually operable means inoperative, and means operative upon return of said power operated means to non-firing position to urge said laterally movable member back toward said plane to render said manually operable means operative to fire the gun upon further movement of said firing pedal.

4. In a firing control system for a gun having a firing element, a firing linkage in operative engagement with said firing element, power operated means operatively connected to said firing linkage to actuate it and fire said gun, manually operable means also operatively connected to said firing linkage to actuate it and fire said gun, said manually operable means comprising a firing pedal and a separable connection in the latter operative connection and consisting of a driving lever and a driven lever actuated thereby, said driving and driven levers being pivotally mounted for movement in a given general direction, driving means interposed between said driving lever and said firing pedal, an operative connection between said firing linkage and said driven lever, one of said levers being articulated for lateral rockable movement perpendicular to said given direction, means responsive to movement of said power operated means to firing position to rock said articulated lever laterally to disengage said separable connection and render said manually operable means inoperative, and means operative upon return of said power operated means to non-firing position to urge said articulated lever laterally back into engagement with the other of said levers to render said manually operable means operative to fire the gun upon further movement of said pedal.

5. In a firing control system for a gun having a firing element, a firing linkage in operative engagement with said firing element, power operated means comprising a rotary shaft for actuating said firing linkage to fire said gun, a cam on said shaft, manually operable means for actu-

ating said firing linkage to fire said gun alternatively with said power operated means, said manually operable means comprising a firing pedal and a coupling to the rotary shaft, a separable connection consisting of a driving lever and a driven lever actuated thereby, said driving and driven levers being pivotally mounted for movement in a given general direction, driving means interposed between said driving lever and said firing pedal, an operative connection between said firing linkage and said driven lever, one of said levers being articulated for lateral rockable movement perpendicular to said given direction, an arm on said articulated lever engaging said cam, said arm and cam being adapted to rock said articulated lever laterally upon movement of said power operated means to firing position, to disengage said separable connection and to render said manually operable means inoperative, and spring means operative upon return of said power operated means to non-firing position to urge said articulated lever laterally back into engagement with the other of said levers to render said manually operable means operative to fire the gun upon further movement of said pedal.

6. In a firing control system for a gun having a firing element, a firing linkage in operative engagement with said firing element, power operated means for actuating said firing linkage to fire said gun, manually operable means for actuating said firing linkage to fire said gun, a firing cutout mechanism comprising a separable connection in said manually operable means, means operative when the gun is aimed in an unsafe direction, to sever said connection and thereby render said manually operable means inoperative, additional means responsive to movement of said power operated means to firing position to disengage said separable connection to render said manually operable means inoperative, and means operative upon return of said power means to non-firing position to urge said separable connection toward a re-engaged position, to render said manually operable means operative to fire the gun upon further movement of said manually operable means.

7. In a firing control system for a gun having a firing element, a firing linkage in operative engagement with said firing element, power operated means comprising a rotary shaft for actuating said firing linkage to fire said gun, a cam on said shaft, manually operable means for actuating said firing linkage to fire said gun, and including a firing cutout mechanism comprising a separable connection in said manually operable means, means operative when the gun is aimed in an unsafe direction, to sever said connection and thereby render said manually operable means inoperative, said separable connection consisting of a pivotally mounted driving lever adapted to be rotated by a firing pedal, and a pivotally mounted driven member operatively connected to said firing linkage and adapted to be engaged by said driving lever and rotated thereby to fire the gun, one of said levers being shiftably mounted for movement out of driving engagement with the other of said levers, an arm on said shiftable lever engaging said cam, said arm and cam being adapted to shift said shiftable lever out of driving engagement with the other of said levers, upon movement of said power operated means to firing position to disengage said separable connection and render said manually operable means inoperative, and means operative upon return of said power op-

erated means to non-firing position to urge said shiftable lever back toward engagement with the other of said levers, to render said manually operable means operative to fire the gun upon further movement of said firing pedal.

8. In a firing control system for a gun having a firing element, a firing linkage in operative engagement with said firing element, power operated means comprising a rotary shaft for actuating said firing linkage to fire said gun, a cam on said shaft, manually operable means including a firing pedal attached to the rotary shaft for actuating said firing linkage and fire said gun, said manually operable means including a firing cutout mechanism comprising a separable connection, adapted to be disengaged when the gun is aimed in an unsafe direction, to render said manually operable means inoperative, said separable connection consisting of a driving lever pivotally mounted on the rotary shaft and adapted to be rotated by the firing pedal, and a driven member rotatably mounted on the rotary shaft, being operatively connected to said firing linkage and adapted to be engaged by said driving lever and rotated thereby to fire the gun, the pivoted mounting of the driving lever enabling its movement out of driving engagement with the driven member, an arm on said driving lever engaging said cam, said arm and cam being adapted to shift said driving lever out of driving engagement with the driven member upon movement of said power operated means to firing position to disengage said separable connection and render said manually operable means inoperative, a drum cam, means to rotate said cam in synchronism with said gun, a slide block, guide means mounting said slide block for movement longitudinally of said drum cam, a drum cam follower mounted on said slide block for movement radially of said drum cam, means responsive to elevation and depression of the gun to slide the slide block longitudinally of said cam, a second arm on said driving lever, means interposed between said second arm and drum cam follower to move said second arm and said driving lever out of driving engagement with the driven member in response to movement of said drum cam follower by said drum cam in non-firing zones to render said manually operable means inoperative, and means operative upon return of said power operated means to non-firing position and upon return of said firing cutout mechanism to firing position to urge said driving lever back toward engagement with the driven member, to render said manually operable means operative to fire the gun upon further movement of said firing pedal.

9. In a firing control system for a gun, power operated means to fire the gun, a firing pedal, an electrical switch controlling operation of said power operated means, said switch being spring urged toward a closed position in which the power operated means is operative to fire the gun, a firing cutout having means to open said switch when the gun is pointed in an unsafe direction, cam means normally holding said switch open to prevent power firing, and means responsive to depression of said pedal to move said cam means out of engagement with said switch to allow it to close and fire the gun when the firing cutout permits.

10. In a gun firing control system, power operated means for firing said gun, manually operable means for firing said gun, said manually operable means comprising a separable drive

connection, an electric switch controlling operation of said power operated means, firing cutout means comprising a cam, means to move the cam in response to training of the gun, a cam follower engaging said cam, means to move said cam follower with respect to said cam in response to gun elevation, means responsive to movement of said cam follower by said cam when the gun is aimed in an unsafe direction, to disengage said separable drive connection and to open said switch to prevent firing by either manual or power means, and means responsive to movement of said power operated means to firing position, to disengage said separable connection.

11. In a firing mechanism for a gun having a firing element, a mount for a gun, a manually movable element located on the gun mount, mechanical linkage including a driving and a driven member in normal engagement and interposed between said manually movable element and said gun firing element and adapted to actuate the firing element to fire the gun when said firing element is moved to a firing position, an electric switch actuated by movement of said manually movable element, power firing means including a switch serially connected with the first switch, adapted to fire said gun in response to closing said first switch and means actuated by movement of the power firing means to firing position, to disconnect the driving and driven members in order that the manually movable element may be rendered inoperative when the power firing means is in the firing position.

12. In a gun firing control, at least one firing plunger to cause firing of a gun, at least one linkage system connected to the firing plunger, power operated means for actuating the firing plunger, manually operated means connected with the linkage system for actuating the firing plunger, a floating clutch incorporated in said linkage system and including a driving member and a driven member initially in coupled relation to transmit a manual effort upon the manual means through said linkage system to the firing plunger, means operable by the act of starting power operation to displace the driving and driven members from coupled relation thereby rendering said manually operated means inoperative, and means put under stress by the uncoupling of the driving and driven members to restore the operability of the manually operable means at the termination of power operation.

13. In a gun firing control, at least one firing plunger to cause firing of a gun, power operated means for actuating the firing plunger, manually operated means for actuating the firing plunger including a shaft turnable by the manual operation, a linkage system connecting the manual means to the firing plunger, said system including the following, a firing arm, a lever loose on the shaft and being in abutment with the firing arm, a yoke mounted on the shaft to turn with it yet rock independently of it, and a separable connection initially coupled between a part of the yoke and the lever; and means operable by the act of starting power operation to rock the yoke and uncouple the separable connection thereby rendering said manually operated means inoperative.

14. In a gun firing control, at least one firing plunger to cause firing of a gun, power operated means for actuating the firing plunger, manually operated means for actuating the firing plunger including a shaft turnable by the manual operation, a linkage system connecting the manual

means to the firing plunger, said system including the following, a firing arm, a lever loose the shaft and being in abutment with the firing arm, a yoke mounted on the shaft to turn with it yet rock independently of it and having a plunger arm extending off from it to be shifted, and a separable connection initially coupled between a part of the yoke and the lever; and a cam engaging the push arm, operable by the act of starting power operation to shift the push arm, rock the yoke and uncouple the separable connection thereby rendering said manually operated means inoperative.

15. In a gun firing control, at least one firing plunger to cause firing of a gun, power operated means for actuating the firing plunger, manually operated means for actuating the firing plunger including a shaft turnable by the manual operation, a bracket affixed to hence turnable with the shaft, a driving member turnable with the shaft and rockable independently in respect to it, a linkage system connecting the firing plunger with the shaft, said linkage system including a driven member loosely mounted on the shaft, a separable connection between the driving and driven members being initially coupled together means operable by the act of starting power operation to rock the driving member and so sever said separable connection to sever the driving member from the driving member, and means based on the bracket and engaging a part of the driving member, being put under stress by the rocking of the driving member later to restore the operability of the manual means at the termination of power operation.

16. In a gun firing control, at least one firing plunger to cause firing of a gun, manual means with linkage to the plunger, said manual means being movable into a first position, electrical power means with linkage also to the plunger for electrically operating the plunger, an electrical circuit containing the power means and having a first closable switch, a second switch in said circuit closable by assumption of said first position by said manual means, thereby to complete the circuit and actuate the plunger by the electric power means to fire the gun, said manual means being movable at some other time into a second position to mechanically fire the gun, and disconnect means operated at the closure of the first switch and by the ensuing electrical power operation to sever the manual linkage and thereby prevent possible continued manual mechanical firing upon a sudden requirement to cease fire by opening of the first switch.

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