

Jan. 22, 1952

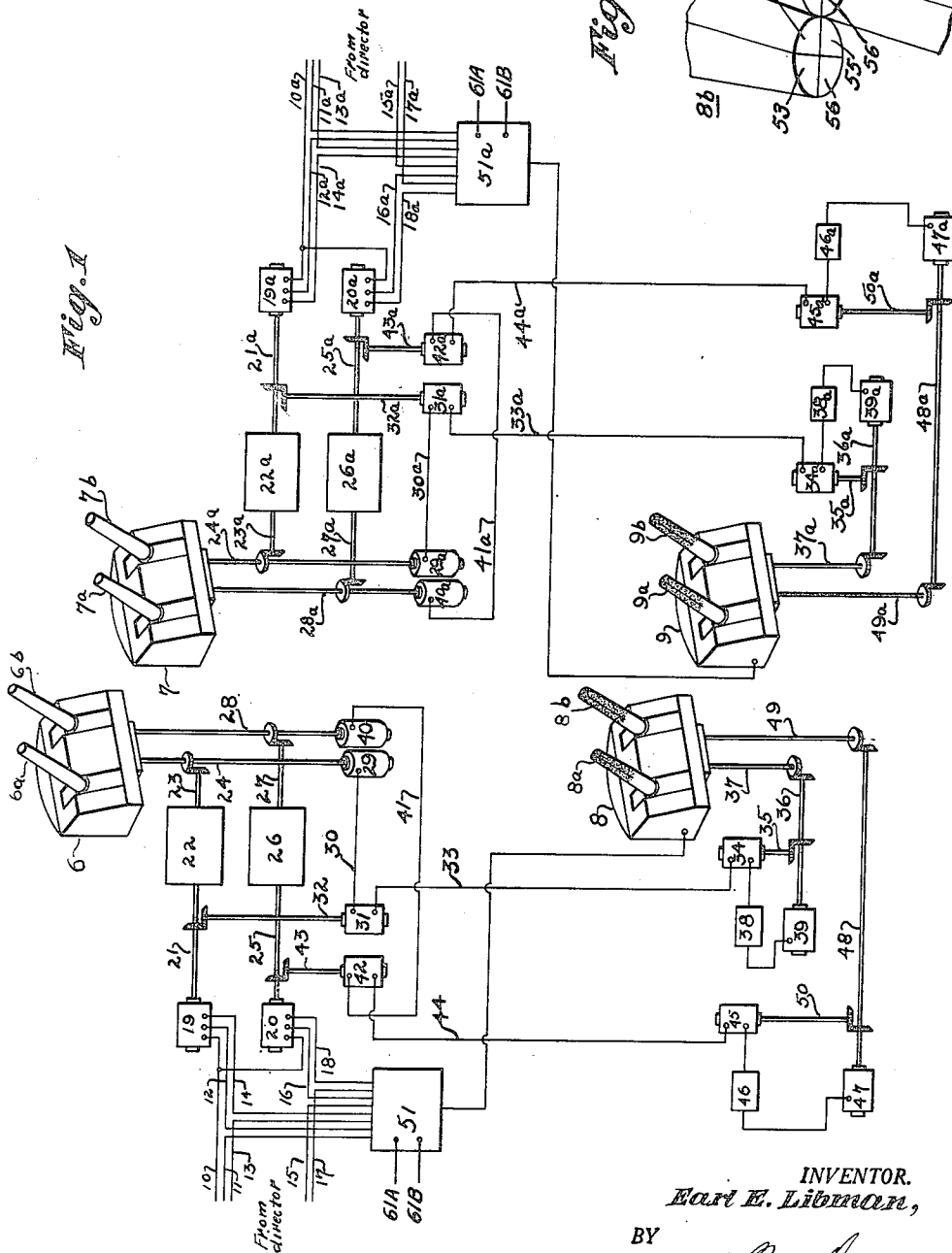
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2,583,058

INTERZONE INTERFERENCE DEVICE FOR GUNS

Filed Dec. 17, 1947

4 Sheets-Sheet 1



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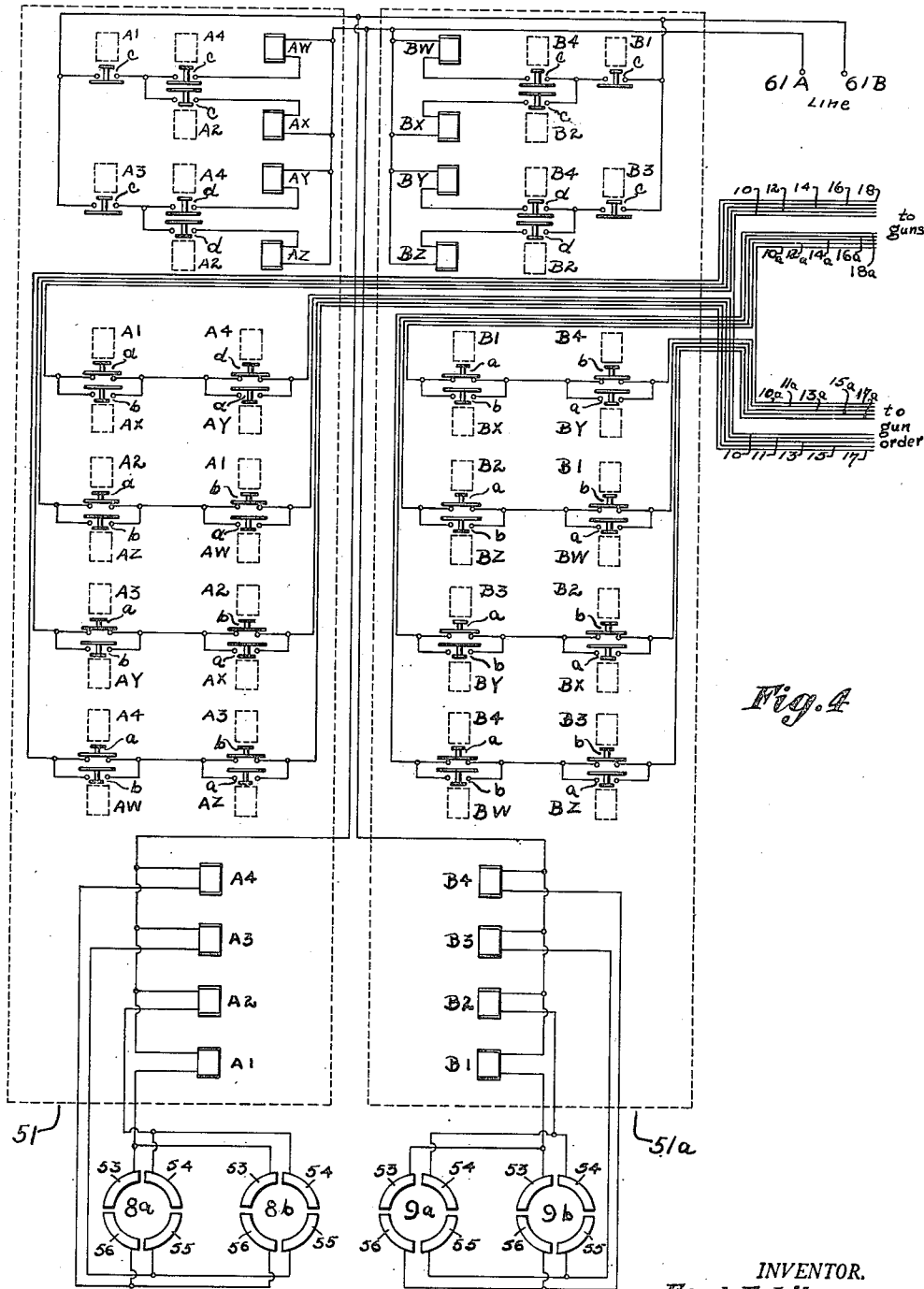
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INTERZONE INTERFERENCE DEVICE FOR GUNS

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4 Sheets-Sheet 2



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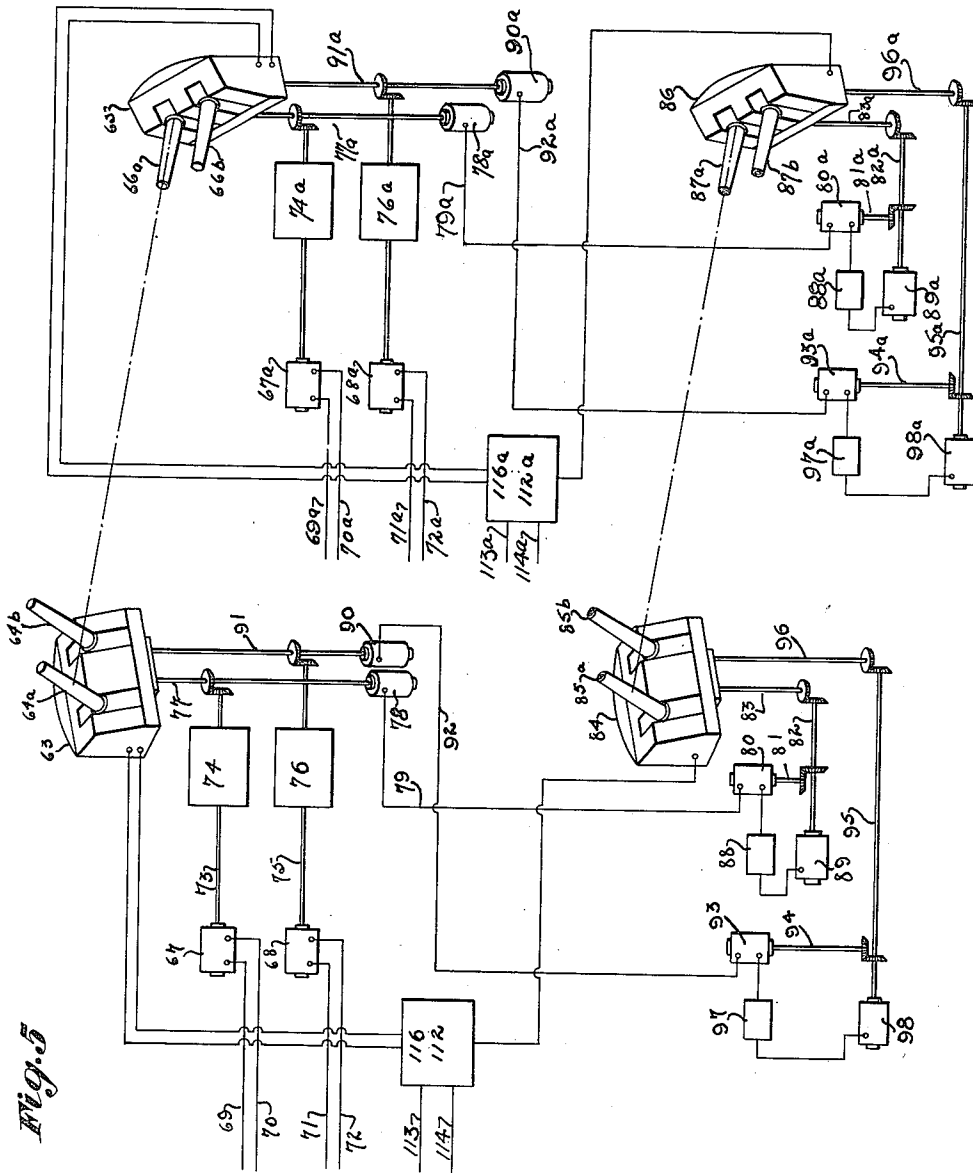
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INTERZONE INTERFERENCE DEVICE FOR GUNS

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4 Sheets-Sheet 3



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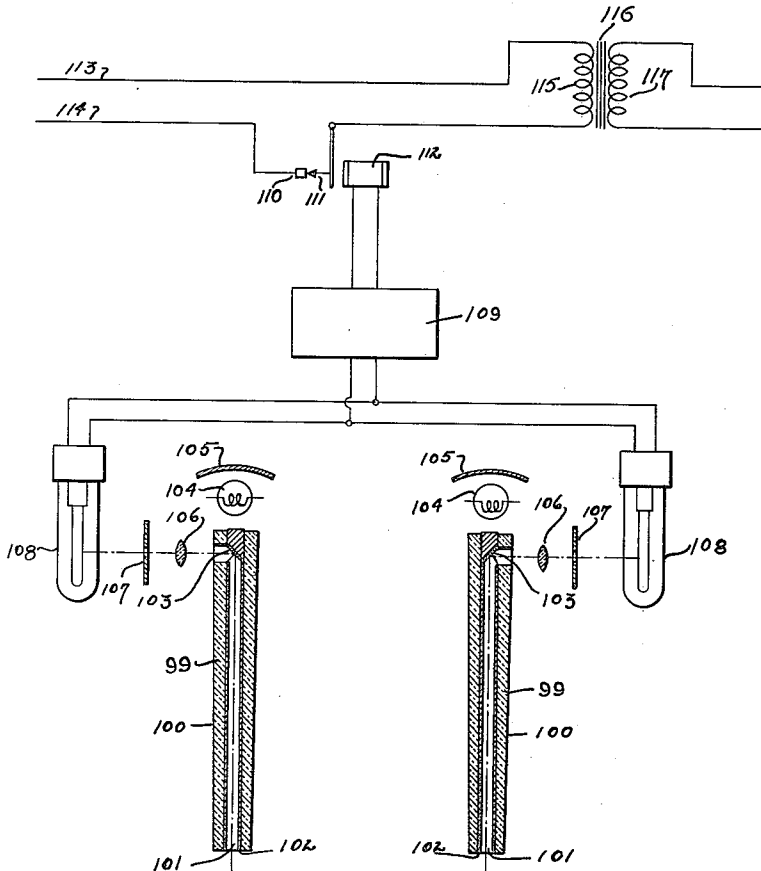
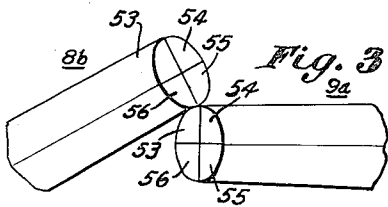
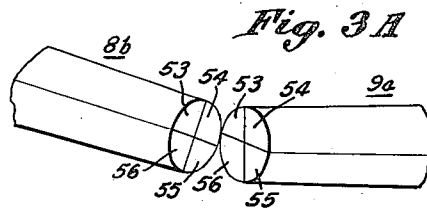
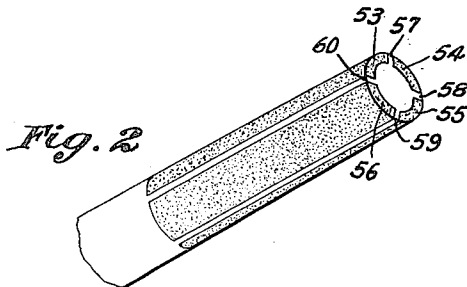
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INTERZONE INTERFERENCE DEVICE FOR GUNS

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4 Sheets-Sheet 4

Fig. 6



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INTERZONE INTERFERENCE DEVICE
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Application December 17, 1947, Serial No. 792,117

3 Claims. (Cl. 89-41)

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This invention relates to improvements in gunnery fire control systems and has particular reference to a system for the prevention of damage to guns due to interference between their zones of action.

Certain conditions exist among secondary batteries aboard naval craft in freedom of train and elevation which may cause damage thereto in that it is possible for certain combinations of train and elevation of different guns to produce collision between their barrels, or to cause the barrel of one gun to intercept the line of fire of another.

The purpose of this invention is, therefore, to prevent the occurrence of such damage; and to do so in such a manner as to cause a minimum of interference in the freedom of action of the guns so that they remain free to be operated and moved in any direction and fired at any time except in those directions and at those times which will produce damage to the guns.

The inventive idea herein involved is capable of receiving a variety of expressions one of which, for the purpose of illustration, is shown in the accompanying drawings; it being expressly understood, however, that the said drawings are employed merely to facilitate the description of the invention as a whole and not to define the limits thereof, reference being made to the appended claims for that purpose.

In the drawings:

Fig. 1 is a schematic representation of the device utilized to prevent collision;

Fig. 2 is an isometric view of one of the scale model barrels utilized in the collision preventing device;

Figs. 3, 3A and 3B are diagrammatic illustrations of the various possible types of collision;

Fig. 4 is a diagrammatic view of the circuits utilized in the collision preventing device;

Fig. 5 is a diagrammatic representation of the line of fire interference prevention device; and

Fig. 6 is a schematic representation of the circuits employed in the line of fire interference prevention device.

Damage due to collision is ordinarily possible only between batteries which are mounted at different levels so that depression of one battery and elevation of the other might lead to a collision if the batteries were trained in opposite directions, or in the same directions at different rates.

To prevent damage due to collision, the invention utilizes a scale model of the batteries involved, so that one battery, as illustrated by the

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gun turret 6 in Fig. 1, is coupled to a corresponding model 8, and the other battery illustrated by turret 7 is coupled to the model 9. In this way the motions of the model guns will duplicate, with a precision restricted only by the accuracy of the servo mechanism coupling, the motions of the battery and thus act to prevent damage thereto.

To eliminate any error due to lag in the servo mechanism, it is desirable that any collision between the model guns 8a, 8b and 9a, 9b occurs before actual contact between the turret guns 6a, 6b, 7a, 7b so that the control sequence hereinafter described will be set in motion in advance of such contact. For this purpose, the model guns are made slightly larger than the latter and will thus contact each other before actual collision occurs between said turret guns.

In the usual practice, the gun orders of train and elevation are delivered to a pair of servo motors such as 19 and 20 over a set of conductors such as 10, 12, 14, 16 and 18. The order over leads 10, 12 and 14 positions the motor 19 which is coupled by means of shaft 21 to the tilt plate of the hydraulic drive 22, which drive furnishes the power over shafts 23 and 24 to rotate the turret and train the guns and, in the same way, the order over leads 10, 16 and 18 positions the motor 20 which is coupled by means of shaft 25 to the tilt plate of the hydraulic drive 26, which drive furnishes the power over shafts 27 and 28 to elevate or depress the guns.

The turret 6 is trained by being coupled to the hydraulic drive 22 by means of shaft 23 which shaft is also coupled to the control transformer 29 so that a voltage proportional to the position on lead 30, at any instant, is available.

By means of proper amplifiers and servo motors this voltage could be utilized to cause the model turret 8 to duplicate identically the position of the actual turret 6; however, a turret such as 6 has considerable inertia and its motion cannot be instantaneously arrested upon a collision of the models so that it is necessary to order its motion stopped in anticipation of its actual necessity, and therefore to cause the motion of the models to anticipate the motion of the corresponding battery.

The tilt plate of the hydraulic drive 22 determines the velocity of train of the turret 6; that is to say, in its neutral position the gun is held stationary and upon being tilted or displaced, the rate at which the gun will be driven by the hydraulic drive 22 is very nearly proportional to the degree of the displacement of the tilt

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plate. Therefore, a differential control transformer 31 may be coupled to the shaft 21 by means of shaft 32 and to the output of the control transformer 29 by means of lead 30 so that the combined output as a voltage on lead 33 is a function both of the displacement and of the velocity of the gun turret 6. This voltage, in the manner usual in the servo mechanism art, is compared with the voltage of the control transformer 34 which control transformer by means of shafts 35, 36 and 37 is positioned by the model turret 8. The difference voltage, if any, is then amplified in amplifier 38 and utilized to drive the servo motor 39 which by means of shafts 36 and 37 is utilized to train the model turret 8. The motion of the turret 8 therefore will be a composite of the difference of position between the turret 6 and turret 8, and of the velocity of turret 6, so that, when in motion, the model turret 8 will lead the motion of the gun turret 6 by some angle proportional to velocity but when at rest will be positioned identically therewith. Since the same form of control couples the turret 7 and the model 9 as indicated by similar controls bearing the same number and a distinguishing subscript, a collision between the models will occur in anticipation of a collision between the actual guns 6 and 7 so that their respective drives may be interrupted in time to allow them to coast to a safe stop within the limit allowed by their inertia.

The voltage output of control transformer 40 which is coupled to the elevation shaft 28 of mount 6 is indicative of the elevation of the guns of turret 6 and in the same way as indicated in the train servo mechanism, the voltage output thereof on lead 41 is modified by the differential control transformer 42 which by means of shafts 43 and 25 is coupled to the tilt plate of the hydraulic drive 26 and is then utilized as found on lead 44 in conjunction with control transformer 45, amplifier 46 and control motor 47 and the shafts 48, 49 and 50 to cause the elevation of the models of turret 8 to correspond in position or to anticipate the motion of the actual guns of turret 6 in elevation.

The training and elevation order of the guns are routed through relay cabinets 51, 51a, whose relays, A1, A2, A3, A4, AW, AX, AY, AZ, B1, B2, B3, B4, BW, BX, BY and BZ are connected to the model guns which serve to actuate said relays as hereinafter described to interrupt the train or elevation mechanism of the guns toward an imminent collision. These orders are supplied over the leads 10, 11, 13, 15 and 17 for mount 6 and over 10a, 11a, 13a, 15a and 17a for mount 7 which leads enter the relay cabinets 51 and 51a, and leave them as 10, 12, 14, 16 and 18 so that the manipulation of proper relays in any one of the input circuits may be opened and the gun order disconnected from the gun. Fig. 4 illustrates diagrammatically how this may be accomplished. Both relay cabinets and the manner in which the relays are interconnected between themselves, the director and the gun mounts are diagrammatically shown and the sequence and consequence of a collision between the gun models may therein be traced.

As illustrated in Fig. 2, the model gun barrels are scale models of the actual gun barrels 8, to a somewhat larger scale than that of their position with reference to each other. Each model comprises a barrel formed of a dielectric material to which are fastened conducting sectors 53, 54, 55 and 56 with spaces 57, 58, 59 and 60 therebetween

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so that the aforesaid sectors do not make electrical contact with each other. In the event of a collision between the models, various conducting surfaces will thereby be brought into contact and the electrical connections so made are utilized to effect control of the motion of the guns.

In Figs. 3, 3A and 3B some of the various possibilities of collision are illustrated. If, for instance, the guns of mount 6 are being depressed and the guns of mount 7 are being elevated so that a collision between guns 6b and 7a is imminent, the collision would take the form indicated in Fig. 3. At the moment that collision is imminent between the guns 6b and 7a, contact takes place between strip 55 of model 8b and strip 53 of model 9a which are the corresponding models. Referring to Fig. 4, a circuit is then established allowing current to flow from the 61B side of the power supply line through relay A3, contact strip 55 of the colliding model gun on mount 8, contact strip 53 of the colliding gun on mount 9 and relay B1 and thence back to the A side of the line. Activating relay A3 will cause the contacts A3a to open, thus interrupting the left train circuit of mount 6 and will further cause contacts A3b to open, thus interrupting the depression circuit of gun mount 6. At the same time and in the same way, relay B1 is activated to open the contacts B1a and B1b, thus effectively stopping the right train and elevation of the mount 7. Thus further motion in the direction of collision is rendered impossible, and since only these circuits of train and elevation are interrupted, motion away from a collision is permitted.

If mount 6 and mount 7 are both so oriented and trained that the depression of both guns 6a and 7a would result in collision if the rate of depression of the guns of mount 6 exceeded that of those on mount 7 a collision is possible such that the condition of collision will be the same as is noted in the preceding case. The same relay sequence will be operated and the same disabilities will occur in the guns. However, since both mounts were being depressed and the elevation circuit of mount 6 is the only circuit of that mount which is disabled the result is that the guns of mount 7 can continue their motion and be depressed further away from collision with those of mount 6, whose motion will have been arrested by the operation.

If, as a second case, the guns of mount 6 were being trained to the right and those of mount 7 were being trained to the left resulting in an imminent collision between the barrel 6b and 7a the collision between the model barrels 8b and 9a would take the form illustrated in Fig. 3A so that sector 54 of 8b would contact sector 56 of 9a. The resulting circuit (Fig. 4) which would be established would go from the line 61B to the relay A2 through sector 54 on the model 8b to sector 56 on 9a to relay B4 and thence to side 61A of the line. This would in turn open the contacts A2a and A2b thus preventing further right train and depression of the guns of mount 6, and the contacts B4a and B4b thus preventing further left train and elevation of the guns of mount 7, any of which motions would lead to a collision of the guns.

In either of the foregoing cases if the guns had been trained in the same direction or elevated or depressed simultaneously it is to be noted that opposing training circuits and only like circuits of elevation and depression would have been interrupted. In such a case the overtaking gun, if a collision becomes imminent, would have its control circuit open and thereby

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be stopped. The remaining gun would not be interfered with, unless its direction of motion were to be reversed.

There are special cases in which casualty can be produced only by one motion in only one direction. For example, it may be that both guns could train simultaneously in opposite directions but that a change in elevation would produce a casualty or, on the other hand, two guns may elevate simultaneously with safety but could not train toward each other without a casualty. In such cases it would be desirable to restrict the motion of the guns only in that one direction which might produce a casualty. It may be noted that for these special cases the point of contact of the barrels would necessarily lie in a plane bisecting one of the barrels and including its trunnion axis or in a plane at right angles thereto including the center line of the barrel. In such a case, obviously, at least one of the model barrels will make contact with the other barrel with two of its contact strips.

As an example of the control action initiated when such a multiple contact occurs, let us consider the case illustrated by the two guns of Fig. 3B and assume that turret 6 is being elevated or depressed simultaneously with but at a different rate from turret 7. At the instant of contact between the model barrels 8b, 9a, the contact surfaces 54 and 55 of model gun 8b meet the contact surfaces 53 and 56 of model gun 9a. Only left train of 8b and right train of 9a need be inhibited, and all other motions are permissible. As shown in Fig. 4, the relays A2, A3, B1 and B4 will be energized, A2 interrupts the elevation and the left train circuits of gun 6, and A3 interrupts left train and depression circuits of gun 6 so that it may only move in right train; also, B1 interrupts right train and elevation and B4 the right train and depression of gun 7 so that it may move only in left train.

However, energizing the combination of relays A2 and A3 operates their back contacts A3c and A2d so that relay AZ is energized from lines 61A and 61B, which in turn operate contacts AZa and AZb, which contacts parallel A2a and A3b so that elevation and depression circuits are reconnected; and in the same way, the combination of relays B1 and B4 energizes relay BW so that contacts BWa and BWb which parallel contacts B1a and B4a are operated to keep the elevation and depression circuit of gun 7 connected, leaving only the desired left train of gun 6 and right train of gun 7 impossible.

In this way only those circuits essential to prevent damage are interrupted, and no others, and there is a minimum of interference with the gun operation when interruption is required.

Damage due to a projectile fired from one gun and striking the barrel of another is possible between batteries which are mounted on the same or different levels, and to prevent such damage the invention utilizes scale models of the batteries involved which are similar in operation to those which prevent damage due to collision, but of different construction so that, without any physical contact between the elements which may cause the damage, the imminence of that danger may be utilized by them, and thus prevented.

As shown in Fig. 5 two gun batteries 63 and 65 are illustrated, so oriented that a projectile fired from the barrel 66a would strike the barrel 64a. The scale model batteries 84 and 86 utilized to prevent such damage are coupled to their re-

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spective guns by a servo mechanism similar in its nature, with the exception of the motion anticipation device, to that utilized in the already described servo of the collision preventing device. Thus the orders of gun train and elevation are delivered to a pair of servo motors such as 74 and 76 over a set of conductors such as 69, 70, 71, 72. Orders over leads 69 and 70 position servo motor 67 which is coupled by means of shaft 73 to the tilt plate of the hydraulic drive 74 which drive furnishes the power to rotate the turret 63 and train the guns; and in the same way the orders over leads on 71 and 72 position servo motor 68 which is coupled by means of shaft 75 to the tilt plate of the hydraulic drive 76, which drive furnishes the power to elevate or depress the guns on turret 63.

The turret 63 is trained by being coupled to the hydraulic drive 74 by means of shaft 77 which is coupled to the control transformer 78 so that a voltage proportional to the position of the turret 63 at any instant is available on lead 79. This voltage in the manner usual in the servo mechanism art is compared with the voltage of the control transformer 80 which control transformer by means of shafts 81, 82 and 83 is positioned by the model turret 84. The difference voltage, if any, is then amplified in amplifier 88 and utilized to drive the servo motor 89 which by means of shafts 82 and 83 is utilized to train the model turret 84 so that at every instant the position of the model turret 84 corresponds identically to the position of the actual turret 63.

The voltage output of the control transformer 90 which is coupled to the elevation shaft 91 of the gun mount 63 is indicative of the elevation of the guns of turret 63 and in the same way as indicated in the servo mechanism for training the model 84, the voltage output thereof on lead 92 is compared with the voltage output of control transformer 93 which, by means of shafts 94, 95 and 96, is coupled to the elevation of the model guns on the model turret 84. The difference voltage, if any, is amplified in amplifier 97 and utilized to drive the servo motor 98, which servo motor by means of shafts 95 and 96 is utilized to drive the elevation mechanism of the model guns 85A and B1. By means of a similar servo mechanism whose members are numbered with the same numbers and a differentiating subscript, the position, in train and elevation, of the model guns of turret 86 is made to duplicate identically the position of the turret 65 and guns 66a and 66b.

As shown in Fig. 6 the model guns 100 are fabricated of light-conducting material such as a methyl-methacrylate resin 99. In order to offset any error due to servo mechanism lag they are made slightly larger in diameter than the scale of their relative position would indicate, were they to be true scale models. The barrels of the model guns are frosted along their length and have an opening 101 along their axis which is lined with a tube 102 of some light-impervious material such as brass. The opening 101 terminates at the trunnion axis of the model in a mirror 103 oriented at 45° to the axis, so as to reflect any light traversing the tube out along the trunnion axis. Behind the gun model, there is placed a high intensity light source comprising a lamp 104 and mirror 105 so that the entire length of the barrel is illuminated uniformly along its length.

Any light traversing the barrel along the opening 103 and reflected from the mirror 105 along the trunnion axis is collimated by the lens 106

and the iris 107 so that only those rays which enter the opening 101 parallel to each other will be permitted to impinge upon the elements of the photo tube 108.

Light striking the photo tube 108 serves to control the output of amplifier 109 in such a manner that the normally closed relay contacts 110 and 111 of relay 112 will thereby be caused to open.

The firing order to the guns on leads 113 and 114 may thus be interrupted by the action of the contacts 110 and 111, since they are in series in lead 114. When these contacts are closed the gun fire order impulse is communicated to the primary 115 of transformer 116 and the voltage across the secondary 117 thereof serves to fire the gun. However, opening of the contacts 110 and 111 would prevent such an impulse from reaching transformer 118 thus effectively disabling the gun.

Referring again to Fig. 5, if the gun mounts 63 and 65 are positioned so that a projectile fired from the gun 66a will be directed at the barrel 64a, then the mounts 84 and 86 and the model guns thereon are so oriented that the model gun 87a is directly in line with the model barrel 85a and, therefore, model gun 87a's associated photocell is affected by the illuminated barrel thereof. In the manner hereinbefore described, the firing mechanism of gun 87a will therefore be disabled, and no casualty can result while the guns remain thus positioned. If either of the mounts should be moved so that the gun of one mount is no longer in a line of sight with another the relay 112 would be deactivated, the normally closed contacts 110 and 111 would be reclosed, and the guns once again would be capable of being fired.

Only that gun whose direct line of fire is intercepted by another is prevented from firing so that a minimum number of guns are deactivated when a danger of damage due to a shell from one gun striking the barrel of another is imminent, and no interference occurs in the mechanism utilized to position the gun.

I claim:

1. A mechanism to prevent damage due to interference between guns which have control means for operating the same, said mechanism comprising model means coupled to and operated by said control means for simulating the positions of said guns, said model means each having a barrel longitudinally divided into contacting surfaces each independent of the other and each capable of contact with any other surface of another barrel in various positions of said barrels, and means interposed in said control means and selectively operable by the position of contact between said contacting surfaces of said barrels for interrupting only that function of said con-

trol means whose continued operation would result in damage to the guns.

2. A mechanism to prevent damage due to interference between guns which have control means for operating the same, said mechanism comprising model means coupled to and operated by said control means for simulating the positions of said guns, means to regulate the rate of change of motion of said model means to exceed that of the gun it represents during acceleration or deceleration of the latter, said model means each having a barrel longitudinally divided into electrically conducting surfaces each insulated from the other, and relay means interposed in said control means and selectively energized by contact between different conducting segments of said barrels for interrupting only that function of said control means whose continued operation would result in damage to the guns.

3. A mechanism to prevent damage due to interference between guns which have control means for operating the same, said mechanism comprising model means each having a barrel of a light conducting substance with an opaque bore extending therethrough, said model means being coupled to and operated by said gun control means for simulating the positions of said guns, means to so couple said model means with said control means, a light source incorporated in each of said model means for illuminating the barrel thereof, a light sensitive element incorporated in each of said model means to respond to illumination transmitted along the opaque bore thereof, and relay means interposed in said control means and energized by the response of the light sensitive element aforesaid for interrupting that function of said control means whose continued operation would result in damage to the guns.

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