Aug. 27, 1946. K. M. HAMMELL 2,406,461

MACHINE GUN RECHARGER

Filed Dec. 18, 1943 2 Sheets-Sheet 1

FIG. 1.

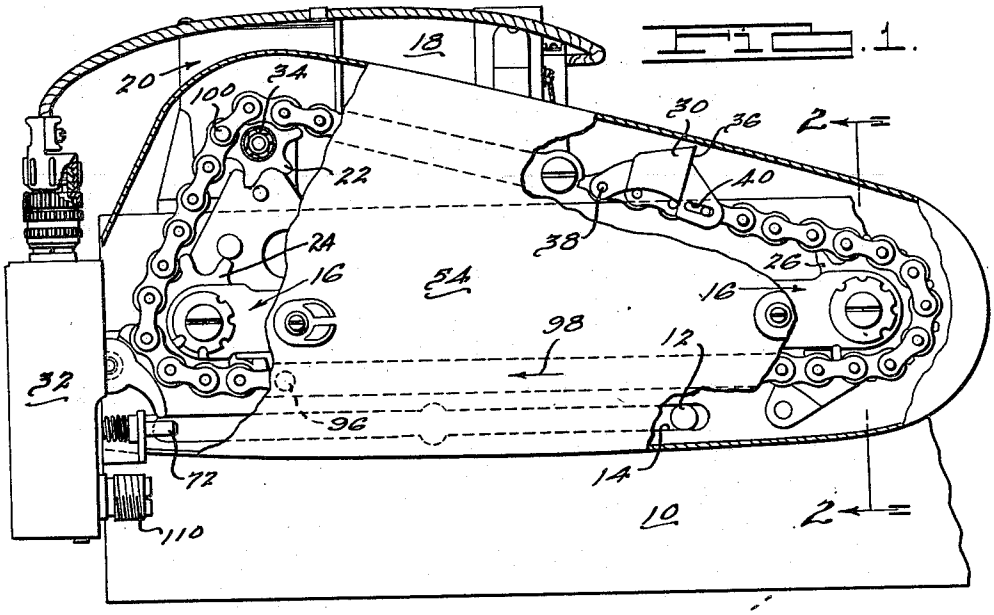
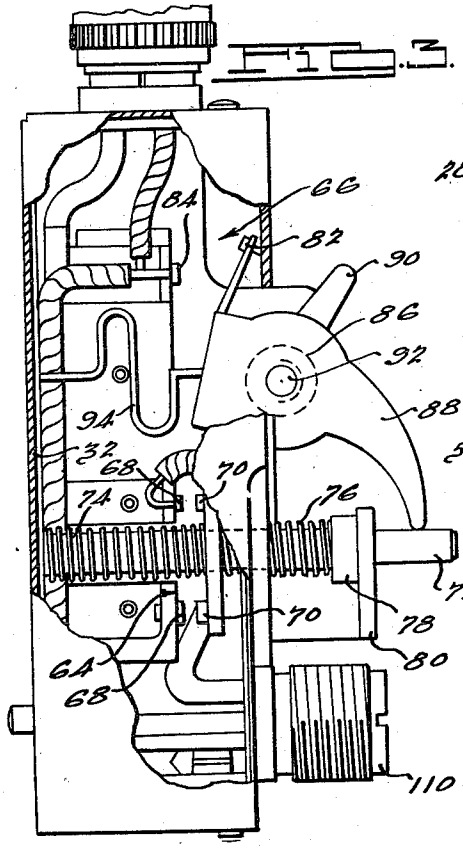


FIG. 3.



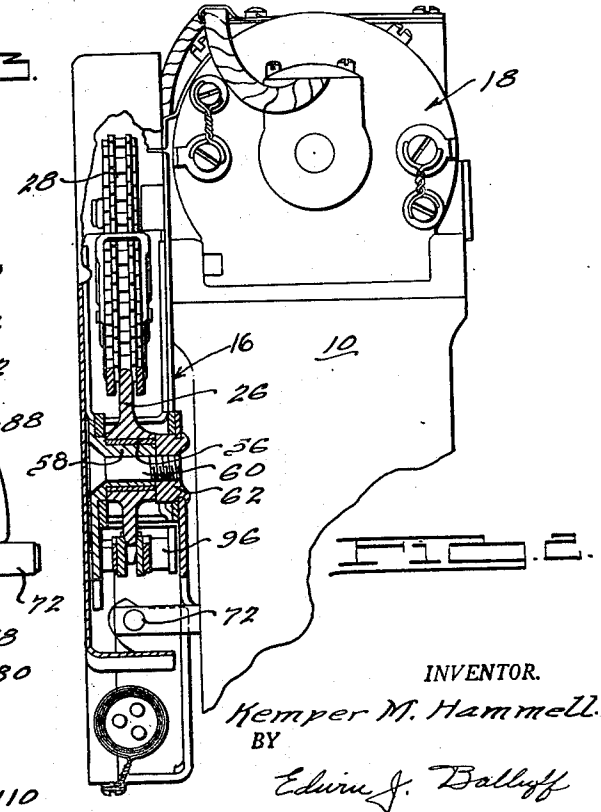


FIG. 2.

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MACHINE GUN RECHARGER

Filed Dec. 18, 1943 2 Sheets-Sheet 2

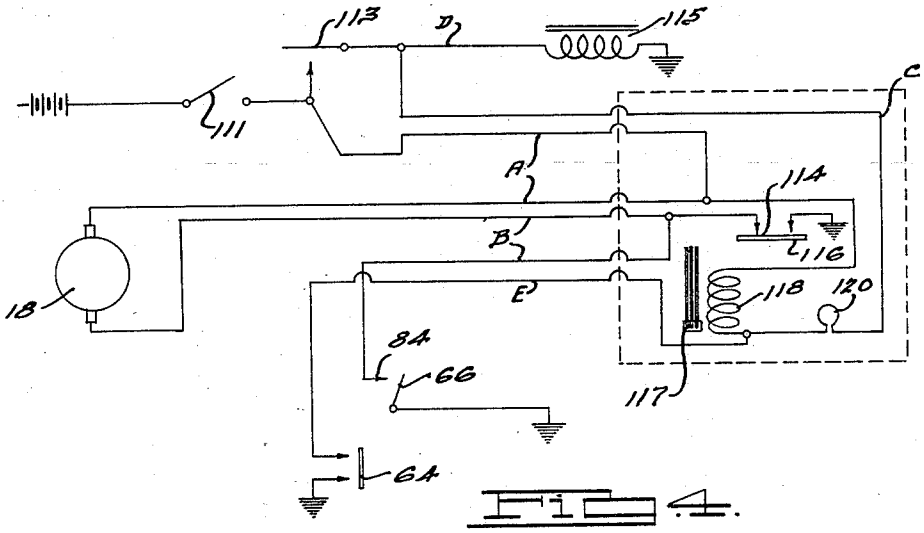

Fig. 4.

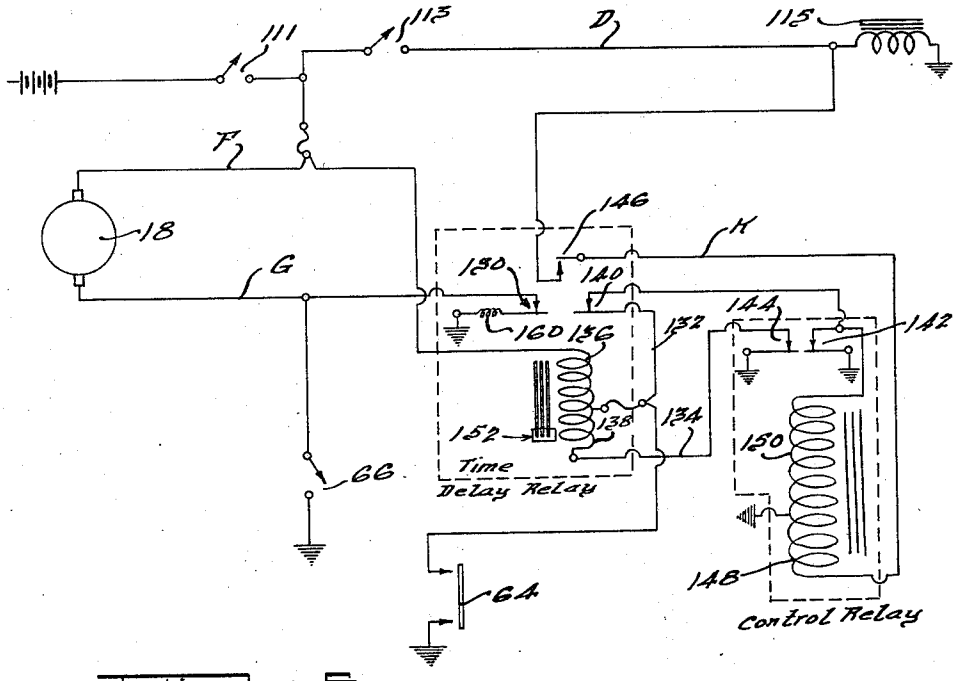

Fig. 5.

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MACHINE GUN RECHARGER

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Application December 18, 1943, Serial No. 514,849

13 Claims. (Cl. 89—1)

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This invention relates to machine gun rechargers and particularly to an automatic mechanism for automatically recharging a machine gun in the event that the bolt thereof fails to retract.

Principal objects of the invention are:

To provide an automatic machine gun recharger;

To provide a new and improved form of automatic machine gun recharger;

To provide a lightweight, efficient, simple and dependable machine gun recharger adapted to be applied to a machine gun on a plane for automatically retracting the bolt thereof when a dead shell is in the breech of the gun barrel; and

To provide an electrical control circuit for a machine gun recharger adapted to be attached to a machine gun which is operated under the control of an electric circuit.

Other objects and advantages of the invention will be apparent from a consideration of the following specification taken in conjunction with the accompanying drawings, of which there are two sheets and wherein:

Fig. 1 is a side elevational view of a device embodying the invention, with certain parts thereof broken away;

Fig. 2 is a sectional view taken generally along the line 2—2 of Fig. 1, looking in the direction of the arrows;

Fig. 3 is an enlarged view of the switch box and assembly;

Fig. 4 is a diagrammatic illustration of one form of circuit for the recharger; and

Fig. 5 is a diagrammatic illustration of another form of circuit for the recharger.

Referring now to Fig. 1, there is indicated a portion of a machine gun 10 having a bolt 12 which is adapted to reciprocate during the operation of the gun. The bolt 12 is associated with the firing mechanism of the gun and is retracted by the recoil due to the firing of the shell. While these machine guns generally are not operated for more than a few seconds at a time, there are some which will fire as many as seven hundred rounds of ammunition per minute, which means that the bolt 12 may reciprocate as frequently as approximately twelve times per second. The bolt 12 is indicated in the general position to be released upon closing of the firing circuit for firing the shell which is positioned in the breech of the gun barrel and after firing of such shell the recoil will move the bolt 12 to the left along the path indicated by the slot 14 of the gun through which the bolt 12 projects.

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A device embodying the invention consists of a mechanism for automatically retracting the bolt 12 against the tension of the spring (not shown) thereof if the shell fails to fire, and this mechanism in general comprises a frame 16 adapted to be suitably secured to a machine gun 10 as illustrated in Figs. 1 and 2, said frame forming a support for an electric motor 18, a reduction gear 20, a plurality of sprockets 22, 24, and 26, a chain 28 operatively associated with the sprockets, a lug 30 on the chain 28, and a switch box 32. In addition to the mechanism disclosed in Fig. 1, a circuit such as that illustrated in Figs. 4 or 5 is employed in connection therewith, and such circuits include certain control mechanism which may be mounted in a box or on a panel elsewhere than on the recharger itself.

The sprocket 22 is mounted on a shaft 34 which projects from the reduction gear 20. The reduction gear 20 may comprise a suitable housing having gearing therein connected to the shaft of the motor 18 and driven thereby, the gearing functioning to drive the shaft 34 at a speed much less than that of the motor during the operation thereof. The teeth of the sprocket 22 operatively engage the links of the endless chain 28 for driving the same, the sprockets 24 and 26 supporting the chain so that it has a path of movement parallel to the path of movement of the bolt 12. The lug 30 is carried by the chain and has a shoulder 36 which when the chain is driven in the direction indicated by the arrow 38 is adapted to move through a path so as to engage the bolt 12 at the right hand end of slot 14 and move it to the left for the purpose of retracting the same against the spring which is conventionally associated therewith.

The lug 30 at one end thereof is pivoted at 38 to the chain, and at the other end thereof has a pin and slot connection 40 with the chain so as to not interfere with the passage of the chain over the sprockets. When the lug 30 has moved the bolt 12 to its leftmost or retracted position (approximately the lefthand end of the slot 14) the path of the lug 30 veers away from the path of the bolt 12 so as to disengage the lug 30 from the bolt 12, thereby permitting the spring associated with the bolt to return it in order to fire the shell in the breech of the gun.

The frame 16 may be suitably formed of sheet metal and have suitable brackets by means of which the reduction gear 20, the motor 18 and switch box 32 may be assembled to the frame 16 to form a unit, and the unit may be assembled to the machine gun 10 in the relative position in-

dicated. Cover or guard 54 may be removably secured to the frame 16 so as to at least partially enclose the operating mechanism of the unit.

The sprockets 24 and 26 are each individually journaled on a bearing 56 which is carried by an eccentric sleeve 58 which in turn is carried by screw 60 which in turn is threaded into nut 62 carried by the frame 16. Thus the sprockets 24 and 26 may each be adjusted vertically or horizontally and independently of each other so as to properly position the chain 28 and tension the same.

The switch box 32 has arranged therein a double contact switch 64 which will hereinafter sometimes be referred to as a bolt-operated switch, and another switch 66 which will hereinafter sometimes be referred to as a chain-operated switch. The bolt-operated switch 64 includes stationary contacts 68 and movable contacts 70, the contacts 70 being carried by a member which is mounted on a pin or plunger 72. Plunger 72 is reciprocally mounted in the switch box 32 and the righthand end thereof, as illustrated in Fig. 1, is positioned so as to be engaged by the bolt 12 at the end of each retractile stroke thereof. A spring 74 arranged around one end of the plunger 72 and confined between one wall of the case 32 and the movable contacts 70 biases the same out of engagement with the stationary contacts 68 so that the bolt switch 64 is normally open.

The stationary contacts 68 preferably are resiliently mounted. A spring 76 may be arranged between the member which carries the movable contacts 70 and a nut 78 secured to the plunger which cooperates with bracket 80 so as to limit the movement of the plunger 72 to the right. The plunger 72 extends through a suitable hole in bracket 80. The member which carries the movable contacts 70 is not fastened on the plunger 72 but is positioned thereon by the springs 74 and 76. When the bolt 12 strikes the end of the plunger 72 and thereby moves the same to the left, the switch 64 will be closed for a fraction of a second. The actual time interval that the switch 64 is closed will to some extent depend upon the speed of firing of the machine gun. Under some circumstances it may be desirable to provide some means to retard slightly the opening movement of the switch 64.

Switch 66 includes movable contact 82 and stationary contact 84. This switch is normally open and is adapted to be closed and opened by the chain during each cycle of movement. Movable contact 82 is carried by a switch-operating member 86 having arms 88 and 90. The member 86 in cross section is U-shaped, and the arm 88 is positioned at one side of the chain 28 while the other arm 90 is positioned on the opposite side of the chain 28. The member 86 is pivoted at 92 and is held in either its open or closed position by a spring 94, one end of which bears against the end of the member 86. For example, in the position illustrated, the end of the spring 94 bears against the member 86 to one side of the pivot 92, thereby holding the same in its open position. When the switch is closed the member 86 pivots in a counterclockwise direction, thereby shifting the end of the spring 94 to the other side of the pivot 92 for holding the switch 66 closed. The switch arm 90 is, in the position in which it is illustrated, arranged in the path of a pin 96 which projects laterally from one of the links of the chain. The pin 96 projects toward the machine gun and after the chain has moved a limited

amount in its driven direction, which is indicated by the arrow 98, the pin 96 will engage the arm 90 and shift the member 86 to its other position so as to close the switch 66.

The chain 28 is provided with another laterally extending pin 100 which projects from one of the links of the chain in a direction away from the gun and which pin 100 is adapted to engage the arm 88 and return the member 86 to the position illustrated in Fig. 1 so as to open the switch 66. Thus, after the chain 28 and lug 30 have been moved a small amount from their starting position in which they are indicated in Fig. 1, the pin 96 will by acting on the switch arm 90 close the chain-operated switch 66, and shortly before the chain 28 and lug 30 are returned to their starting position the pin 100 will engage the switch arm 88 and open the switch 66. After the switch 66 is open the inertia of the motor 18 and gearing 20 will permit the lug 30 to return approximately to the position illustrated.

The bolt-operated switch 64 is adapted to be closed during the operation of the machine gun by the reciprocation of the bolt 12, and the closing of the switch 64 controls the motor circuit so as to prevent the operation thereof while the machine gun is operating, if the trigger and safety switches thereof are closed as will be further described hereafter. However, should the machine gun fail to operate with the trigger switch and safety switch closed, the bolt 12 will not reciprocate and the switch 64 will remain open, thereby controlling the circuit of the motor so as to initiate the operation thereof. When the motor operates, the chain 28 will be driven in the direction indicated by the arrow 98 and after a relatively small movement of the chain the switch 66 will be closed. The switch 66 controls the motor circuit so as to keep the same closed after the motor begins to operate and until the recharger mechanism completes one cycle of operation.

One cycle of operation consists of movement of the chain 28 sufficiently so as to move the lug 30 from the position in which it is illustrated in Fig. 1 around past the sprockets 26, 24 and 22 and back to the position illustrated. During this movement the lug 30 will, as previously described, retract the bolt 12 and free it for movement under influence of its spring. The switch 66 closes the motor circuit shortly after the motor begins to operate and will keep the motor circuit closed until opened by the pin 100, even though the trigger and/or safety switch of the machine gun circuit are opened before the mechanism completes one cycle of operation.

The wires of the motor circuit are connected to the switches in the switch box 32, and the switches in the switch box 32 are adapted to be connected by suitable current conductors to the controls, the connector 110 being provided on the switch box 32 for cooperation with a suitable connector on the current conductors which lead to the controls.

The switches and controls and circuits are diagrammatically illustrated in Fig. 4 wherein the same reference characters have been employed to indicate the switches as described in connection with Fig. 1. Conductor A is connected by the master gun or safety switch 111 of the firing circuit for the machine gun to a suitable source of current, and when such switch is closed the conductor A is energized. This conductor A is connected to one side of the motor 18 and a conductor B leads from the other side

of the motor 18 to contact 84 of switch 66. This conductor B is adapted to be grounded by the switch 66 when the same is closed so as to close the circuit through the motor. The conductor B is also connected to one of the stationary contacts of a double contact relay switch 114. The other stationary contact of switch 114 is grounded. The movable contact or armature 116 of relay switch 114 is positioned so that the switch 114 is normally closed when the safety switch 111 is open. Whenever the conductor B is grounded, either through switch 66 or through switch 114, the motor will operate. The conductor A is connected to one end of the coil 118 of the relay of switch 114, while the other end of such coil is connected by conductor C to the firing circuit D which includes the firing solenoid 115. A 28-volt, 13-watt lamp 120 is arranged in series with relay coil 118 and between the same and conductor C.

As the switch 114 is closed when the safety switch 111 is open, the circuit through the motor 18 will be closed upon closing of the switch 111, but as the coil of relay switch 114 is arranged in parallel with the motor 18 and grounded through the firing circuit D and solenoid 115, the relay will act immediately to open switch 114. While the circuit through the motor 18 is closed momentarily, such circuit is not closed for a sufficient length of time to enable the motor to do any more than turn through several degrees of movement. The coil 118 of the relay preferably has a voltage rating of 4½ volts, much less than the rating of the motor circuit which may be 18-28 volts, so that the relay 118 will be excited quickly in order to open the switch 114 very quickly after the safety switch 111 is closed. The resistance of the lamp 120 when the same is cold is comparatively low, but this resistance increases rapidly and considerably when the lamp is lighted, thereby protecting the relay 118 from overload.

When the trigger switch 113 is closed the machine gun firing circuit D will be closed, thereby actuating the solenoid 115 to release the firing pin thereby initiating the operation of the machine gun. When the trigger switch 113 is closed, both ends of the relay coil 118 will be connected through conductors C and A to the positive side of the circuit, thereby tending to neutralize or deenergize the coil 118. However, as soon as the firing solenoid 115 is actuated, the gun begins firing and the bolt 12 thereof will engage the movable contact of switch 64 and close the same momentarily, thereby grounding the coil 118 and conductor C through conductor E and switch 64. The relay switch 114 is of the delay type and is adapted to be energized rapidly relative to its time of deenergization. A timing slug 117 is provided on relay 118 to delay the drop out thereof. That is, during the time that the bolt-operated switch 64 is closed, which may be for .005–.010 second per cycle, the relay coil 118 must be excited sufficiently in order to hold switch 114 open until the next cycle of excitation, and the characteristics of the relay coil 118 must be such that approximately ⅛ of a second must elapse after the circuit through the relay is opened before the armature 116 is released. Because of this the switch 114 will remain open during the reciprocation of the bolt 12. As soon as such reciprocation stops the relay coil 118 will become deenergized and permit the closing of switch 114, thereby closing the circuit through the motor 18 and initiating the operation thereof. A defective shell in the breech of the machine gun is usually the cause for the failure of the bolt 12 to reciprocate.

The switch 66 will be closed as previously described shortly after the motor begins operating and will remain closed until shortly before the lug 30 completes one cycle of operation. Thus if the trigger switch is opened, which would deenergize the conductor C, the motor circuit would be closed from conductor A through the switch 66, and in this way the recharger mechanism will complete a cycle, once started, irrespective of whether or not the trigger switch is open during a cycle, so that the next time that the trigger switch is closed the machine gun will be cocked for immediate firing.

Thus one form of my invention comprises a recharger for an electrically operated machine gun 10 adapted to be fired by the closing of a firing circuit D, said circuit including a master switch 111, a firing switch 113 and a firing solenoid 115, said firing switch being in series with said master switch and operable upon closing, when said master switch 111 is closed, to energize said firing solenoid 115, thereby to initiate the normal operation of the machine gun (assuming that the gun is loaded and provided with means such as a cartridge belt for supplying live ammunition thereto), said gun having a reciprocable bolt 12 adapted to be retracted normally by the recoil of a fired shell, said recharger comprising a member 30 movable through a path and in its movement through said path being engageable with said bolt 12 for retracting the same and being adapted to release said bolt in its retracted position, an electric motor 18, a driving connection between said motor and member 30 for moving the latter through its path during operation of said motor, a motor circuit A, B having its high potential end connected to said firing circuit D between said switches, a time delay relay including a switch 114 associated with the grounded end B of the motor circuit and operable to open the motor circuit upon closing of said master switch 111, one end of the relay coil 118 being connected to the high potential end A of the motor circuit, the other terminal of the relay coil 118 being arranged, upon closing of said master switch 111, to be grounded through a lamp bulb 120 in series with said firing solenoid 115, when said firing switch 113 is open, for operating said relay switch 114 to open said motor circuit, said other terminal of said relay coil 118 also being arranged to be grounded through a bolt-operated switch 64, periodically momentarily closed by and during the reciprocation of said bolt 12, (during normal operation of said gun) when the firing switch 113 is closed, for energizing said relay coil 118 sufficiently to keep said switch 114 from closing, thereby to keep said motor circuit AB open, a mechanically operated switch 66 adapted to be closed by the cycling of said member 30 and arranged upon closing to ground said motor circuit AB, the voltage rating of said relay coil 118 being materially less than that carried by said motor circuit AB and the initial resistance of said lamp bulb 120 being sufficiently low so that upon closing of said master switch 111, the relay coil 118 will be energized at a sufficiently rapid rate so that the relay switch 114 will open the motor circuit before the motor makes an appreciable starting effort, the characteristics of the lamp bulb 120 being such that upon lighting, the resistance thereof increases thereby limiting the current in the relay coil

118 to a safe value, the closing of said firing switch 113 functioning to energize the firing solenoid 115 and to deenergize said relay coil 118 and lamp bulb 120, the operation of said machine gun and reciprocation of the bolt 12 thereof pursuant to the energization of solenoid 115 functioning to periodically close said bolt-operated switch 64 sufficiently frequently to maintain said coil 118 energized sufficiently to maintain said relay switch 114 open, said time delay relay being constructed to allow a rapid opening of the relay switch 114 and a relatively slow closing thereof, the period of the closing time of said relay being appreciably greater than the period of operation of the machine gun, the coil 118 of the relay being wound so as to have a sufficiently low impedance that a sufficiently high excitation will be produced in the coil upon the periodic momentary closing of the bolt operated switch, failure of said gun to operate when said firing switch is closed deenergizing the coil 118 of said relay and permitting said switch 114 to close said motor circuit thereby initiating a cycle of operation of said recharger to effect the retraction of said gun bolt, said mechanically operated switch being closed by the cycling of said memebr 30, to keep said motor circuit closed until said recharger completes said cycle of operation, said member being operable during said cycle of recharger operation to retract said bolt and free the same, in order to restart the operation of said machine gun if said firing switch 113 and motor switch 111 are closed, restarting of the operation of said machine gun causing the bolt 12 thereof to close said bolt-operated switch 64 to ground said relay coil 118 in order to keep open said motor circuit after said recharger has completed one cycle of operation.

In the modified form of the invention using the circuits illustrated in Fig. 5, in lieu of that illustrated in Fig. 4, the machine gun is adapted to be fired by the closing of firing circuit D, said circuit including master switch 111, firing switch 113 and firing solenoid 115, said firing or trigger switch being in series with said master switch and operable upon closing, when said master switch 111 is closed, to energize firing solenoid 115, thereby to initiate normal operation of the machine gun (assuming that the gun is loaded and provided with means such as a cartridge belt for supplying live ammunition thereto) and reciprocation of the bolt 12 thereof.

The motor 18 is operatively arranged in a motor circuit FG having its high potential end connected to the firing circuit D between switches 111 and 113. Certain parts of these circuits duplicate parts of the circuits illustrated in Fig. 4 and in such cases the same reference characters as used in Fig. 4 have been employed in Fig. 5 to designate corresponding parts. The motor circuit is adapted to be grounded through relay switch 130 or through the mechanically operated switch 66, which as previously indicated is normally open, but closed during cycling of the recharger. Relay switch 130 forms part of a time delay relay means which includes a low impedance circuit 132 and a normal impedance circuit 134 connected in parallel to the high potential side of the motor circuit. Low impedance circuit 132 includes a relay coil 136 (which may have a resistance of 1.4 ohms) which is arranged in series with coil 138 (which may have a resistance of 200 ohms) of the normal impedance circuit 134. Low impedance circuit 132 is adapted to be grounded either through bolt-operated switch

64, periodically momentarily closed by and during the reciprocation of bolt 12, (during normal operation of the machine gun) or through serially arranged switches 140 and 142. Switches 130 and 140 are simultaneously opened by energization of coil 136 and circuit 132, which occurs (starting with the circuits arranged as illustrated) immediately upon energization of the motor circuit FG due to the closing of master switch 111. Thus the low impedance circuit 132 is energized only momentarily. Normal impedance circuit 134, arranged in parallel with circuit 132, is energized simultaneously therewith being grounded through switch 144, the energization of coil 138 functioning to keep switches 130 and 140 open after the low impedance circuit is opened. As thus arranged the circuits are in what might be termed "stand by" position. A switch 146 also forms a part of the time delay relay and is arranged so as to close before switches 130 and 140 open.

Closing of firing switch 113 will, as hereinbefore indicated, energize the firing circuit D and firing solenoid 115, thereby initiating operation of the machine gun. If live ammunition is in the gun, the gun will operate thereby causing reciprocation of bolt 12, which in turn will periodically momentarily close switch 64. The closing of the firing circuit D will also energize the circuit K in which switch 146 (now closed) is arranged, circuit K having its high potential side connected to the firing circuit D and being grounded through pull-in coil 148 (100 ohms) of a control relay means which further includes lock-in coil 150 (240 ohms) and switches 142 and 144. Energization of coil 148 will open switches 142 and 144, thereby opening the normal impedance circuit 134 and deenergizing coil 138 (low impedance circuit 132 previously having been deenergized by opening of switch 140). The coil 148 operates to open switches 142 and 144 before the bolt 12 closes switch 64, but the coils 136 and 138 of the time delay relay are provided with a timing slug or means 152 which holds open the switches 130 and 140 until the low impedance circuit is grounded through the bolt-operated switch 64; that is, the timing slug 152 delays the deenergization of coil 138 for a period of time (a fraction of a second) until the coil 136 is energized by the closing of switch 64. The coils 136 and 138 of the time delay relay are constructed to allow a rapid opening of the relay switches 130 and 140 and a relatively slow closing thereof, the period of the closing time of the relay being appreciably greater than the period of operation of the machine gun. The grounding of the low impedance circuit 132 through the bolt-operated switch 64 functions during normal operation of the machine gun to keep the pull-in coil 136 energized sufficiently to keep the switches 130 and 140 open and the switch 146 closed.

So long as the switches 66 and 130 are open, the motor circuit FG will be open, and this condition will prevail during normal operation of the machine gun. If after closing of the trigger switch 113, the gun fails to start or stops, the bolt-operated switch 64 will remain open, thereby deenergizing the low impedance circuit 132, as a result of which the coil 136 of the time delay relay will become deenergized, thereby allowing switches 130 and 140 to close and switch 146 to open. The closing of switch 130 will close the motor circuit FG, thereby initiating operation of the motor which, through the mechanism previously described, will retract the bolt 12, as a consequence

of which a new piece of ammunition will be inserted in the gun barrel for firing.

The switches of the time delay relay are set so that the switches 130 and 140 will close before switch 146 opens. The closing of switch 140 will close the low impedance circuit 132 and ground the same through the lock-in coil 150. The resulting energization of the lock-in coil 150 will function to keep the switches 142 and 144 open even though the coil 148 might become deenergized due to the opening of the switch 113 or switch 146. The lock-in coil 150 has a resistance of about 240 ohms so that when the low impedance circuit 132 is grounded through such coil 150, the latter will draw practically all of the current in the circuit, with the result that the coil 136 will not be energized sufficiently to open the switches 130 and 140 or to close the switch 146. Between the switch 130 and the ground, a resistance 160 of one ohm is provided in order to reduce the load across the contacts of the switch 130 during the opening and closing thereof. When the switch 130 closes, the operation of the motor will be initiated to begin the cycling of the recharger, but as hereinafter explained the motor will be operated under substantially no load until after the chain-operated switch 66 closes, which occurs as soon as the chain 28 has moved sufficiently to engage and actuate the switch arm 90 by the pin 96.

Toward the end of the cycle of operation of the recharger the pin 100 will, through engagement with the arm 88 of the switch 66, open the same after the recharger has been relieved of the load of the bolt 12. The retraction of the bolt 12 by the recharger will close the switch 64 before the switch 66 is opened as just described. Such closing of the switch 64 will thereby close the circuit through the low impedance coil 136, thereby energizing the same to open the switches 130 and 140 and close the switch 146, such switch 146 closing before the switches 130 and 140 open. While the lock-in coil 150 will be deenergized by the opening of switch 140, the previous closing of switch 146 will close the circuit K through the pull-in coil 148. As a result of the foregoing actions following the closing of the switch 64 by the bolt 12 upon the retraction thereof by the recharger, the circuits will be restored to their stand-by position. If the new shell injected into the gun barrel is a piece of live ammunition, the normal operation of the gun will be resumed with the result that the bolt 12 will periodically momentarily close the switch 64, thereby closing the low impedance circuit 132 sufficiently frequently to keep the coil 136 energized in order to keep the switches 130 and 140 open and the switch 146 closed. It will be observed that the motor circuit is closed through the switch 66 in order to permit the recharger to complete its cycle of operation and that the opening of firing switch 113 during a cycle will not interfere with the completion thereof. The opening of switch 146 will prevent an inductive reactance from the firing solenoid 115 from momentarily deenergizing the coil 148 of the control relay under certain conditions.

While the circuits disclosed herein form a part of a recharger mechanism, I contemplate that such circuits may be employed in other types of cyclic mechanisms for restarting the operation thereof. In its broadest aspect the invention disclosed and claimed herein comprises a mechanism operable at a substantially constant cyclic rate (the machine gun), electric means (the firing solenoid 115 and circuit therefor) to initiate operation of such mechanism, restoring means electrically operated and mechanically operable (the motor driven member 30) to reestablish motion in said mechanism when said cyclic rate is interrupted due to accidental cause, electrical discriminating means (the time delay relay and the low impedance circuits) actuated at least once per operating cycle of said mechanism and operable to initiate functioning of said restoring means, interlocking means (lock-in coil 150, switches 142 and 144, and the chain operated switch 66) associated with said discriminating means and operable to cause the completion of the cycle of the restoring means once the discriminating means has initiated operation thereof, and unlocking means (switch 64, coil 136 which operate when the bolt 12 is retracted by the member 30 to cause the deenergization of the lock-in coil 150 and the opening of switch 142) associated between said discriminating and interlocking means and operable to restore said discriminating and interlocking means to a stand-by condition.

If the coil 148 is provided with some time delay action to delay the drop-out thereof, then it becomes immaterial whether the switch 146 closes before the switches 130 and 140. This time delay for the coil 148 may be obtained by utilizing a timing slug, such for example, as the type employed in connection with the coil 138 as indicated by the reference character 152.

While the invention has been described with some detail, it is to be understood that the description is for the purpose of illustration only and is not definitive of the limits of the inventive idea. The right is reserved to make such changes in the details of construction and arrangement of parts as will fall within the purview of the attached claims.

I claim:

1. A recharger for an electrically controlled machine gun adapted to be fired by the closing of a firing circuit, a trigger switch operable for closing said firing circuit, said machine gun having a reciprocable bolt adapted to be retracted normally by the recoil of a fired shell, said recharger comprising a member movable through a cycle and in its movement through said cycle being engageable with said bolt for retracting the same and being constructed and arranged to release said bolt in its retracted position in order to restart the operation of said gun if said firing circuit is closed, an electric motor, a driving connection between said motor and member for moving the latter through its cycle during operation of said motor, an electric circuit in which said motor is included, a relay including a switch in said motor circuit and a coil, one side of said coil being connected to the high potential side of said motor circuit, said coil upon being energized functioning to open said switch in said motor circuit, the closing of said firing circuit by said trigger switch functioning to initiate the operation of the machine gun and the reciprocation of said bolt, means operable upon the closing of said firing circuit to deenergize said coil, the drop out time of said relay coil being greater than the period of reciprocation of said bolt, and means including a circuit for said coil having a normally open switch provided with an actuating member positioned in the path of said bolt and constructed and arranged to be actuated thereby normally to close said switch momentarily and periodically during the reciprocation of said bolt for ener-

gizing said relay coil sufficiently frequently to keep said relay switch open, failure of said gun to operate when said trigger switch is closed causing the deenergization of said coil and the resultant closing of said motor circuit, thereby to initiate a cycle of operation of said recharger to effect the retraction of said gun bolt.

2. The construction defined in claim 1 in which a safety switch is provided in said firing and motor circuits for opening the same.

3. The construction defined in claim 1 in which means are provided to keep the motor circuit closed if the firing circuit is deenergized before the recharger has completed said cycle of operation.

4. A recharger for an electrically controlled machine gun adapted to be fired by the closing of a firing circuit, a trigger switch operable for closing said firing circuit, said machine gun having a reciprocable bolt adapted to be retracted normally by the recoil of a fired shell, said recharger comprising a member movable through a cycle and in its movement through said cycle being engageable with said bolt for retracting the same and being constructed and arranged to release said bolt in its retracted position in order to restart the operation of said gun if said firing circuit is closed, an electric motor, a driving connection between said motor and member for moving the latter through its cycle during operation of said motor, an electric circuit in which said motor is included, a relay including a switch in said motor circuit and a coil, one side of said coil being connected to the high potential side of said motor circuit and the other side of said coil being grounded through said firing circuit when said trigger switch is open, said coil being energized immediately upon the closing of said motor circuit, to open said switch in said motor circuit, the closing of said firing circuit by said trigger switch functioning to initiate the operation of the machine gun and the reciprocation of said bolt, means operable upon the closing of said firing circuit to deenergize said coil, the drop out time of said relay being greater than the period of reciprocation of said bolt, and means including a circuit for said coil having a normally open switch therein provided with an actuating member positioned in the path of said bolt and constructed and arranged to be actuated thereby normally to close said switch momentarily and periodically during the reciprocation of said bolt for energizing said relay coil sufficiently frequently to keep said relay switch open, said relay switch operating to close said motor circuit upon failure of said bolt to reciprocate when said firing circuit is closed.

5. The construction defined in claim 4 in which means are provided to keep the motor circuit closed if the firing circuit is opened before the motor has driven said member through a complete cycle.

6. The construction defined in claim 4 in which a safety switch is provided in said firing and motor circuits for opening the same.

7. A recharger for an electrically controlled machine gun adapted to be fired by the closing of a firing circuit, a trigger switch operable for closing said firing circuit, a safety switch in said firing circuit ahead of said trigger switch, said machine gun having a reciprocable bolt adapted to be retracted normally by the recoil of a fired shell, said recharger comprising a member movable through a cycle and in its movement through said cycle being engageable with said bolt for retracting the same and being constructed and arranged to release said bolt in its retracted position in order to restart the operation of said gun if said switches are closed, an electric motor, a driving connection between said motor and member for moving the latter through its cycle during operation of said motor, an electric circuit in which said motor is included, the high potential side of said motor circuit being connected to said firing circuit between said switches, a time delay relay having a switch in said motor circuit and a coil, one side of the coil of said relay being connected to the high potential side of said motor circuit, said coil being energized by the closing of said safety switch immediately to open said relay switch in the motor circuit, the closing of said firing circuit by said trigger switch functioning to initiate the operation of the machine gun and the reciprocation of said bolt, means operable upon the closing of said firing switch to deenergize said coil, the drop out time of said relay coil being greater than the period of reciprocation of said bolt, means including a circuit for said coil having a normally open switch therein provided with an actuating member positioned in the path of said bolt and constructed and arranged to be actuated thereby normally to close said switch momentarily and periodically during the reciprocation of said bolt for energizing said relay coil sufficiently frequently to keep said relay switch open, failure of said gun to operate when said trigger and safety switches are closed causing the deenergization of said coil and the resultant closing of said motor circuit, thereby to initiate a cycle of operation of said recharger to effect the retraction of said gun bolt.

8. The construction defined in claim 7 in which means are provided to keep the motor circuit closed if the firing circuit is deenergized before the recharger has completed said cycle of operation.

9. A recharger for an electrically controlled machine gun adapted to be fired by the closing of a firing circuit, a trigger switch operable for closing said firing circuit, a safety switch in said firing circuit ahead of said trigger switch, said machine gun having a reciprocable bolt adapted to be retracted normally by the recoil of a fired shell, said recharger comprising a member movable through a cycle and in its movement through said cycle being engageable with said bolt for retracting the same and being constructed and arranged to release said bolt in its retracted position in order to restart the operation of said gun if said firing circuit is closed, an electric motor, a driving connection between said motor and member for moving the latter through its cycle during operation of said motor, an electric circuit in which said motor is included, a time delay relay having a switch in said motor circuit and a coil, one side of the coil of said relay being connected to the high potential side of said motor circuit and the other side of said coil being grounded through said firing circuit when said trigger switch is open, an electric lamp in series with said coil and arranged in the connection between said coil and said firing circuit, said coil being energized upon the closing of said safety switch immediately to open the said relay switch in said motor circuit, the closing of said firing circuit by said trigger switch functioning to initiate the operation of the machine gun and the reciprocation of said bolt, means operable upon the closing of said firing switch to deener-

gize said coil, the drop out time of said relay being greater than the period of reciprocation of said bolt, and means including a circuit for said coil having a normally open switch therein provided with an actuating member positioned in the path of said bolt and constructed and arranged to be actuated thereby normally to close said switch momentarily and periodically during the reciprocation of said bolt for energizing said relay coil sufficiently frequently to keep said relay switch open, said relay switch operating to close said motor circuit upon failure of said bolt to reciprocate when said firing circuit is closed, and means to keep the motor circuit closed if the firing circuit is opened before the motor has driven said member through a complete cycle, said last-mentioned means comprising a circuit for said motor circuit having a normally open switch therein provided with an actuating member engaged and actuated by a part of said bolt engaging member at the beginning of said cycle for closing said motor circuit and at the end of said cycle for opening said motor circuit.

10. A recharger for an electrically controlled machine gun adapted to be fired by the closing of a firing circuit, a trigger switch operable for closing said firing circuit, a safety switch in said firing circuit ahead of said trigger switch, said machine gun having a reciprocable bolt adapted to be retracted normally by the recoil of a fired shell, said recharger comprising a member movable through a cycle and in its movement through said cycle being engageable with said bolt for retracting the same and being constructed and arranged to release said bolt in its retracted position in order to restart the operation of said gun if said switches are closed, an electric motor, a driving connection between said motor and member for moving the latter through its cycle during operation of said motor, an electric circuit in which said motor is included, a time delay relay including a coil and a switch associated with the motor circuit and operable to open the motor circuit, one end of the coil of said relay being connected to the high potential end of the motor circuit, the other terminal of the relay coil being arranged to be grounded through a lamp bulb in series with the firing circuit whereby said relay switch may operate to open said motor circuit, said other terminal of said relay coil also being arranged to be grounded through a bolt operated switch periodically momentarily closed by and during the reciprocation of said bolt for energizing said relay coil sufficiently to keep said relay switch from closing thereby to keep said motor circuit open, the electrical rating of said relay coil being materially less than that of said motor circuit and the initial resistance of said lamp bulb being sufficiently low so that upon closing of the relay circuit, the coil will be energized at a rapid rate to open the motor circuit, the characteristics of the lamp bulb being such that upon lighting, the resistance thereof increases thereby limiting the current in the relay coil to a safe value, the closing of the firing switch functioning to energize the firing circuit and to deenergize said relay coil and lamp bulb, said time delay relay being constructed to allow a rapid opening of the relay switch and a relatively slow closing thereof, the period of the closing time of said relay being appreciably greater than the period of operation of the machine gun, the coil of said relay being wound so as to have a sufficiently low impedance that a sufficiently high excitation will be produced in the coil upon the periodic momentary closing of said bolt operated switch, failure of said gun to operate when said firing switch is closed deenergizing the coil of said relay and permitting said relay switch to close the motor circuit thereby initiating a cycle of operation of said recharger to effect the retraction of said gun bolt.

11. The construction defined in claim 10 in which a mechanically operated switch is provided for closing the motor circuit, said mechanically operated switch being closed by and during the cycling of the recharger.

12. A recharger for an electrically controlled machine gun adapted to be fired by the closing of a firing circuit, a trigger switch operable for closing said firing circuit, a safety switch in said firing circuit ahead of said trigger switch, said machine gun having a reciprocable bolt adapted to be retracted normally by the recoil of a fired shell, said recharger comprising a member movable through a cycle and in its movement through said cycle being engageable with said bolt for retracting the same and being constructed and arranged to release said bolt in its retracted position in order to restart the operation of said gun if said switches are closed, an electric motor, a driving connection between said motor and member for moving the latter through its cycle during operation of said motor, an electric circuit in which said motor is included, said motor circuit being arranged to be closed through a switch of a time delay relay means when the safety switch is closed, said time delay relay means including a low impedance circuit, a normal impedance circuit connected to the high potential side of said motor circuit and a coil, the coil of said relay comprising a low impedance coil in said low impedance circuit and a normal impedance coil in said normal impedance circuit, said low impedance circuit further including a switch constructed and arranged to be opened simultaneously with said relay switch in said motor circuit by energization of said low impedance circuit, a fire control relay including a switch for closing said low impedance circuit and a lock-in coil through which said low impedance circuit may be grounded when said last-mentioned switch is open, said low impedance coil functioning to open the low impedance circuit and the motor circuit immediately upon the closing of said safety switch, said control relay further including a switch in said normal impedance circuit for closing the same so as to energize said normal impedance coil, said last-mentioned coil functioning to keep said switches of said time delay relay in said motor and low impedance circuits open, said control relay including a pull-in coil which is arranged in a circuit that is energized upon the closing of said firing switch, said pull-in coil functioning to open the switches of said control relay so as to open the normal impedance circuit, a bolt operated switch constructed and arranged upon closing to close the low impedance circuit, said bolt operated switch being constructed and arranged to be closed periodically momentarily by the reciprocation of the bolt during the normal gun operation, means to prevent the deenergization of the coils of said time delay relay after opening of the normal impedance circuit and before said low impedance circuit is closed through said bolt operated switch, the drop out time of said time delay relay being greater than the period of reciprocation of said bolt, closing of said bolt operated switch functioning to energize the low impedance coil sufficiently frequent to keep said relay switch

in said motor circuit open, failure of said gun to operate when said trigger and safety switches are closed permitting the deenergization of the coil of said time delay relay and the closing of said relay switch in said motor circuit.

13. The construction defined in claim 12 in which the deenergization of the low impedance circuit permits the closing of the low impedance circuit through the lock-in coil of the control relay so as to keep the motor circuit closed during the cycling of the recharger, the resistance of the low impedance coil being materially less than that of the lock-in coil of the control relay so that when the low impedance circuit is grounded through said lock-in coil said low impedance coil will not be energized sufficiently to open the switches of the time delay relay in either of the motor or low impedance circuits.

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