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PRESSURE OPERATED DEVICE

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12 Claims. (Cl. 121—43)

This invention relates to control devices of the type having an actuating member operable by a pressure fluid and has particular reference to a novel control device of this type which is particularly adapted for use in explosive projectiles, by reason of its inclusion of means responsive to a force of set-back or centrifugal force, or both, for controlling the application of the pressure fluid to the actuating member.

The control mechanism of the invention is employed as a safety means in connection with an initially open electrical switch of a detonator fuze to retain the fuze and the projectile in disarmed condition, and prevent accidental arming of the projectile before it is fired from a gun; and after the projectile has been fired available forces of inertia in the projectile in flight are utilized for arming the projectile. The control unit is mounted within the projectile with the longitudinal axis of the projectile and unit in parallelism and the switch-end of the unit toward the front-end or nose of the projectile.

One object of the invention resides in the provision of a novel pressure-operated device comprising a normally closed valve for controlling the supply of fluid to a pressure-responsive member, and an element operable by a force of set-back for opening the valve to cause the fluid to actuate the member and thereby operate a switch or other control means.

Another object of the invention is to provide a control device having an actuating member responsive to a fluid pressure, and a centrifugally operated valve for controlling the supply of a pressure fluid to the actuating member. In the preferred construction, the centrifugally operated valve is disposed in a plunger movable by a force of set-back to open a second valve between the pressure fluid and the actuating member. With this construction, the device is admirably suited for use in connection with the fuze of an explosive rotating projectile for maintaining the fuze normally unarmed and for arming the fuze in response to the joint action of the centrifugal force and the force of set-back incident to firing the projectile.

These and other objects of the invention may be better understood by reference to the accompanying drawing, in which

Fig. 1 is a longitudinal sectional view of one form of the device suitable for use in a projectile;

Figs. 2 and 3 are sectional views on the lines 2—2 and 3—3 in Fig. 1;

Fig. 4 is an exploded perspective view of part of the device shown in Fig. 1, and

Fig. 5 is a sectional diagram presently referred to.

The new control device, as shown, comprises a casing 10 having a cylindrical bore 11 extending forwardly from the rear end of the casing and terminating short of the front end in a reduced portion 12. The casing is of cylindrical form so that it may be easily mounted in the usual cylindrical body of the explosive projectile 1 (Fig. 5) with the front end of the casing facing the nose of the projectile. The latter has a rotating band 2 which is engraved by the lands 3 of the rifling in the barrel of a gun 4 when the projectile is propelled toward the muzzle. The projectile is thus spun while in flight.

A bushing 13 made of insulating material extends through the front end of the casing and is secured to the casing in any suitable manner, as by peening the inner end 13a of the bushing in the chamber 12. A terminal screw 14 is threaded through the bushing 13 and

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carries a contact 15 in the chamber 12. To the rear of the contact 15 is a second contact 16 mounted on a diaphragm 17 made of spring metal, the diaphragm normally holding contacts 15 and 16 in spaced relation. The diaphragm is clamped in position along its edge portion between a pair of soft metal washers 18 which fit closely in the bore 11 against a shoulder 12a adjacent the chamber 12.

The washers 18 are clamped against the shoulder 12a by a plug 20 screwed into a threaded portion 11a of the bore. In its rear end portion, the plug is provided with an axial cylinder 21 connected through a passage 22 in the front end of the plug to the chamber 23 between the diaphragm and the plug. An annular recess 24 extends around the cylinder 21 intermediate its end. Slidably mounted in the cylinder is a plunger 25 having a passage 26 extending lengthwise through the plunger and aligned at its forward end with the passage 22, the passage 26 terminating at its rear end in a hollow boss 27 on the plunger. The boss 27 has a plurality of lateral openings 28 extending between the passage 26 and the cylinder 21. The ends of the passage 26, as shown, are connected in the plunger by a pair of branch passages 26a extending outwardly from the axis of the plunger. Intermediate its ends, the plunger 25 is formed with an annular groove 30 for receiving the two sections of a split ring 31. The ring sections 31 are normally disposed a substantial distance in front of the recess 24 so that they are held by the wall of the cylinder in their innermost positions, where, collectively acting as a valve, they block the passages 26a so as to cut off communication to the chamber 23.

A metal tube 33 is threaded in the rear end portion of the casing 10 against the plug 20 and has a chamber 34 for containing a pressure fluid, such as carbon dioxide. The tube may be charged with the pressure fluid through an opening in its rear end, which is normally closed by a threaded plug 35. Discharge of the fluid from the tube is controlled by a valve comprising a conical seat 36 in the front end of the tube opening into the cylinder 21, and a conical valve member 37 resting on the seat and engaging the end of the boss 26 on the plunger. The enlarged ends of the valve seat and the valve member are disposed adjacent the chamber 34 so that the pressure of the fluid in the chamber acts to hold the valve member firmly on its seat. The valve member is formed with a head 37a normally engaging an annular seal 38 between the head and the valve seat.

The device is adapted to be connected in a detonating circuit for the projectile fuze suggested in Fig. 5, through a wire 40 connected to terminal screw 14, and a wire 41 connected to another terminal screw 42 threaded in the front end of the casing, whereby the contacts 15 and 16 form a normally open switch in the circuit.

In operation, the pressure of the fluid in chamber 34 normally holds the valve member 37 in its closed position so as to prevent discharge of the fluid through the valve. In this position of the valve member, its reduced end engages the boss 27 on the plunger and holds the plunger in its forward position where the split ring sections 31 are maintained in the passages 26a. Accordingly as already pointed out, the ring sections 31 act as additional valves for preventing passage of the pressure fluid to the diaphragm 17 in the event that valve 37 should be opened accidentally. With the valves 31 and 37 closed, the pressure on opposite sides of diaphragm 17 is the same so that the diaphragm holds contact 16 out of engagement with contact 15 to maintain an open circuit condition.

When the projectile is fired from a gun (see Fig. 5), the force of set-back causes plunger 25 to move to the rear in cylinder 21 and unseat the valve 37. Or, what is the same thing, the inertia of the plunger causes it to lag in the cylinder 21 upon acceleration of the device, positioning the ring sections in line with recess 24. Then centrifugal force due to rotation of the projectile by the usual rifling in the gun barrel urges the valve ring sections 31 outwardly in the plunger, so that as movement of the plunger carries the ring sections 31 in line with the recess

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24, the sections enter the recess and lock the plunger in position to hold the valve 27 open against the pressure of the fluid. It will be understood that when the ring sections 31 enter the recess 24, they move out of the branch passages 26a so as to unblock the passages. The pressure fluid then passes through the valve seat 36 and ports 28 into passages 26 and 26a and through the passage 22 to the chamber 23 adjacent the rear face of the diaphragm. The pressure of the fluid on diaphragm 17 moves the diaphragm forwardly to close the switch 15, 16 and thereby arm the detonating circuit, partly shown in Fig. 5. With the switch closed, current may flow from wire 40 through terminal 14, contacts 15 and 16, diaphragm 17, the casing 10 and terminal screws 42 to the other wire 41. The ring sections 31 are held in recess 24 by centrifugal force while the projectile continues to rotate, and also by the fluid pressure in passages 26a, and as long as the ring sections are held in the recess 24, they act through the plunger to lock the valve 37 in its open position so that the fluid pressure holds the switch contacts closed.

The new control device may be used effectively as a safety means in an explosive projectile, because its operation is dependent upon the joint action of two independent forces, namely, centrifugal force and the force of set-back incident to firing the projectile. The action of centrifugal force alone cannot operate the control switch 15, 16, because without movement of the plunger 25 by a force of set-back, the centrifugal force cannot move the ring sections 31 outwardly to unblock the fluid passages 26a. Also, the switch cannot be operated by centrifugal force alone, because without a force of set-back the plunger cannot open valve 37, and the ring sections 31 cannot be positioned opposite recesses 24 so as to lock the valve 37 in its open position and unblock the passages 26a. The device includes relatively few moving parts, is positive in action, and may be made in a compact form.

I claim:

1. In a projectile accelerated to produce centrifugal and set back forces sequentially within said projectile, a pressure operated device including a normally closed valve for controlling the supply of a pressure fluid, an actuating member responsive to fluid pressure, means for conducting pressure fluid from the outlet side of the valve to said member, means operable by a force of set-back for opening the valve, and means operable by said set-back and subsequently responsive to centrifugal force for locking the valve opening means with the valve in its open position.

2. In a projectile accelerated to produce centrifugal and set back forces sequentially within said projectile, a pressure operated device including an actuating member responsive to fluid pressure, means including a passage for conducting fluid pressure to said member, a valve operable by a force of set-back for controlling the flow of fluid through the passage, and a valve operable by centrifugal force for controlling the flow of fluid through the passage.

3. In a projectile accelerated to produce centrifugal and set back forces sequentially within said projectile, a pressure operated device including a normally closed valve for controlling the supply of a pressure fluid, an actuating member responsive to fluid pressure, means for conducting pressure fluid from the outlet side of the valve to said member, means operable by a force of set-back for opening the valve, and means normally blocking said conducting means and operable by centrifugal force to open the conducting means.

4. In a projectile accelerated to produce centrifugal and set back forces sequentially within said projectile, a pressure operated device including a normally closed valve for controlling the supply of a pressure fluid, an actuating member responsive to fluid pressure, means for conducting pressure fluid from the outlet side of the valve to said member, means operable by a force of set-back for opening the valve, and valve means for controlling the flow of fluid through said conducting means and operable by centrifugal force to lock said valve-opening means with the valve in its open position.

5. In a projectile accelerated to produce centrifugal and set back forces sequentially within said projectile, a pressure operated device including a normally closed valve for controlling the supply of a pressure fluid, an actuating member responsive to fluid pressure, means for con-

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ducting pressure fluid from the outlet side of the valve to said member, means movable by a force of set-back for opening the valve, and an element movable with said last means and operable by centrifugal force to lock the valve in its open position.

6. In a projectile accelerated to produce centrifugal and set back forces sequentially within said projectile, a pressure operated device including a normally closed valve for controlling the supply of a pressure fluid, an actuating member responsive to pressure fluid, means movable by a force of set-back for opening the valve and including a passage for conducting pressure fluid from the outlet side of the valve to said member, and a valve movable with said last means to control the flow of fluid through said passage.

7. In a projectile accelerated to produce centrifugal and set back forces sequentially within said projectile, a pressure operated device including a normally closed valve for controlling the supply of a pressure fluid, an actuating member responsive to pressure fluid, means movable by a force of set-back for opening the valve and including a passage for conducting pressure fluid from the outlet side of the valve to said member, and means movable with said last means and operable by centrifugal force to control the flow of fluid through said passage and to lock the valve in its open position.

8. In a projectile accelerated to produce centrifugal and set back forces sequentially within said projectile, a pressure operated device including for use in a rotating projectile, a casing having a chamber for receiving a pressure fluid, an actuating member in the casing responsive to fluid pressure, the casing having a passage for conducting pressure fluid from said chamber to said member, a normally closed valve in the passage, a plunger in the casing movable by a force of set-back to open the valve, and means coacting with the plunger and operable by centrifugal force to lock the plunger with the valve in its open position.

9. In a projectile accelerated to produce centrifugal and set back forces sequentially within said projectile, a pressure operated device including, for use in a rotating projectile, a casing having a chamber for receiving a pressure fluid, an actuating member in the casing responsive to fluid pressure, the casing having a cylinder between the chamber and the actuating member and communicating with the chamber and said member through passages, a normally closed valve in the passage between the chamber and the cylinder, a plunger in the cylinder movable by a force of set-back to open the valve, the plunger having an opening therein for conducting fluid between said passages, an element slidably mounted in the plunger and normally blocking said opening, the cylinder having a recess in its side wall and normally spaced axially from the slidable element, said element being movable into the recess by centrifugal force to clear said opening and lock the plunger on movement of the plunger by set-back, and control means operable by the actuating member.

10. In a projectile accelerated to produce centrifugal and set back forces sequentially within said projectile, a pressure operated device including, which is subject to sequential acceleration and centrifugal forces, a source of pressure fluid, an actuating member responsive to the fluid pressure, valve means capable of occupying two positions, namely a first position wherein it is sheltered from response to centrifugal force and obstructs the fluid flow and a second position wherein it is responsive to centrifugal force and unobstructs the fluid flow, and a plunger carrying the valve means and having a fluid passage leading from the source to said member, said passage being controlled by said valve means, said plunger being movable because of its inertia upon acceleration of said device, to transfer the valve means from its first position to its second position.

11. In a projectile accelerated to produce centrifugal and set back forces sequentially within said projectile, a pressure operated device including, which is subject to acceleration and centrifugal forces, a source of pressure fluid, an actuating member responsive to the fluid pressure, a cylinder having a lateral recess, valve means capable of occupying two positions in the cylinder, namely, a first position wherein it is sheltered from response to centrifugal force by the wall of the cylinder and obstructs the fluid flow and a second position wherein it occupies the recess in response to centrifugal force and

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unobstructs the fluid flow, and a plunger in the cylinder, carrying the valve means and having a fluid passage leading from the source to said member, said passage being controlled by said valve means, said plunger being movable in the cylinder because of its inertia upon acceleration of said device, to transfer the valve means from its first position to its second position.

12. In a projectile accelerated to produce centrifugal and set back forces sequentially within said projectile, a pressure operated device including, which is subject to acceleration and centrifugal forces, a valve structure for controlling the flow of pressure fluid therein comprising a plunger subject to inertia, hence movable upon acceleration of the device, confining means containing the plunger and having a lateral recess, and valve means carried by the plunger, initially repressed by the confining means to obstruct the fluid flow and later displaceable into the recess by centrifugal force to unobstruct the fluid flow upon said plunger movement.

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