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SWITCH OPERATING MECHANISM

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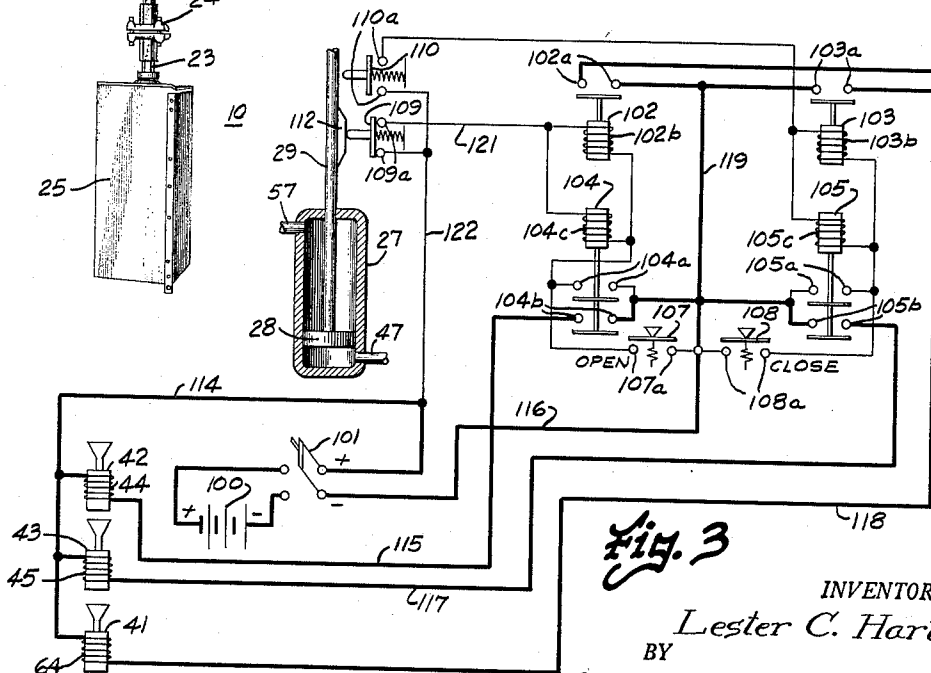
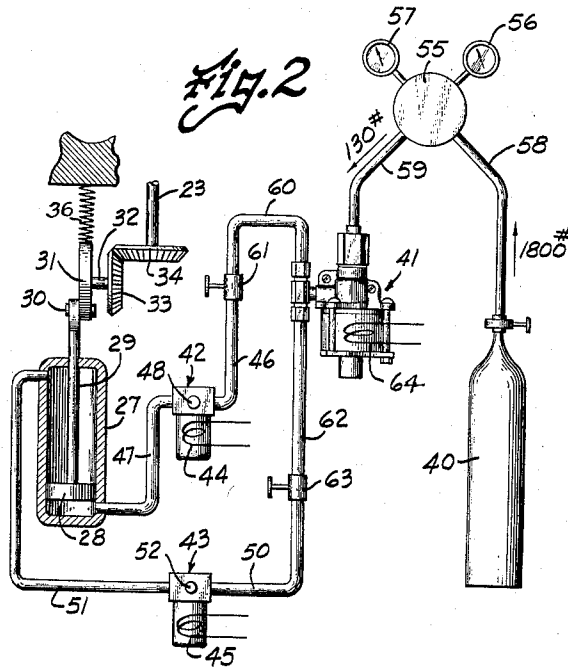
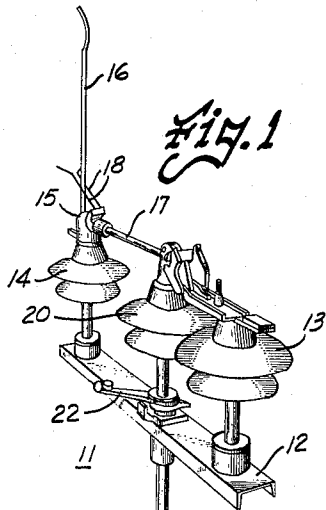


Fig. 3

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SWITCH OPERATING MECHANISM

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2 Claims. (Cl. 121—38)

The present invention relates to a switch operating mechanism and more particularly to a completely dependable automatic operating mechanism for air break switches or similar devices which requires no outside source of power.

Air break switches have numerous applications such as for sectionalizing transmission lines, disconnecting branch lines, transferring loads from one power source to another and the like. Such air break switches for one or more of the above mentioned applications must many times be located where there is no dependable source of electric power either at any time or under the conditions when the switch must be operated. In many sections of our country such switches are located at a distance from cities or villages and furthermore are located in a terrain where a dependable source of electric power is not available. It would be desirable, therefore, to provide a completely dependable automatic operating mechanism for air break switches specifically, but which may equally well be used for operating circuit breakers or other apparatus which has a minimum maintenance and which will give many years of fool-proof service.

Accordingly, it is an object of the present invention to provide a new and improved operating mechanism for switches.

It is a further object of the present invention to provide a completely dependable automatic gas operating mechanism for air break switches which requires no outside source of power.

Still another object of the present invention is the provision of a completely self-contained operating mechanism for switches or the like capable of providing 25 to 30 complete operating cycles without any attention and without any connection to an outside source of power.

Still another object of the present invention is to provide a completely dependable trouble-free operating mechanism which is simple and inexpensive, which is fool-proof in operation and which is of sturdy construction so that it may be depended upon to perform its function without attention so that it is especially well suited for use in out of the way and inaccessible locations.

Further objects and advantages of the present invention will become apparent as the following description proceeds and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of the present invention, reference may be had to the accompanying drawings in which:

Fig. 1 is a perspective view of one pole of an air break switch having associated therewith the gas or fluid automatic operated mechanism of the present invention with the switch shown in the closed position;

Fig. 2 is a schematic diagram of a portion of the gas operated mechanism showing the pneumatic circuit thereof

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and the operating parts shown in the switch closed position;

Fig. 3 is a schematic diagram of a portion of the automatic gas operated mechanism of the present invention showing the electrical circuits involved and with the parts in the same position as in Fig. 2;

Fig. 4 is an enlarged top view partly in section of the main operating valve of the fluid or gas operated mechanism of the present invention shown somewhat schematically in Figs. 2 and 3 of the drawings;

Fig. 5 is a sectional view taken on line 5—5 of Fig. 4; Fig. 6 is a sectional view with certain portions cut away taken on line 6—6 of Fig. 5 assuming that Fig. 5 shows the complete structure; and

Fig. 7 is an enlarged longitudinal sectional view showing a detail of Fig. 5.

Briefly, the present invention comprises an operating mechanism for air break switches which uses a source of nitrogen or other gas under pressure as the main operating source of power and a six volt storage battery capable of holding at least 85 per cent of its charge for a whole year for the electrical source of control power. A piston operated mechanism is involved including means for converting longitudinal motion to rotary motion. Preferably, means are employed to hold the switch in either its open or its closed position with a predetermined force which must be overcome before either opening or closing thereof can occur thereby insuring against inadvertent switch operation.

Referring now to the drawings and specifically to Fig. 1, there is illustrated an operating mechanism generally designated at 10 which comprises the operating mechanism of the present invention for operating a switch or circuit breaker specifically designated as air break switch 11. The specific construction of the air break switch 11 forms no part of the present invention, but is illustrated by way of example only to show an application of the present invention. Actually, air break switch 11 comprises one pole of a multipole switch of the type disclosed and claimed in United States Letters Patent 2,514,263 Seaman and Hart, granted July 4, 1950 and assigned to the same assignee as the present application. Briefly, the air break switch 11 comprises a support 12 upon which are mounted two stationary insulators 13 and 14. A fixed contact 15 including a stationary arcing horn 16 is supported on the insulator 14 while the movable switch arm 17 including the movable arcing horns 18 is supported for movement on stationary insulator 13. As is fully disclosed in the above mentioned Seaman and Hart patent, the movable contact rod 17 moves endwise along its longitudinal axis for a portion of the switch opening or switch closing movement and swings through an arc for the remainder of its movement during either the switch opening or switch closing operation. For the purpose of causing relative movement between the contacts 15 and 17, there is provided a third insulator 20 which is rotatable and which is connected by a rotary shaft like member 21 with the operating mechanism 10 of the present invention. For the purpose of operating the switch 11 as a multipole switch, one or more crank arms such as 22 may be provided to pivot in response to rotation of insulator 20, and the free end of the crank arm such as 22 may be connected by suitable rods for interrelating the operation of a plurality of poles of a multiple switch thereby to insure simultaneous operation of all the switch poles with a single operating mechanism 10. The connecting rod 20 is preferably coupled to a rotatable shaft portion 23 of the operating mechanism 10 through a suitable coupling member 24.

In accordance with the present invention, the gas or fluid operated mechanism 10 comprises a compact unit

adapted to be disposed within a suitable housing 25 from which projects the rotatable shaft 23 for operating a switch such as 11. Referring now to Fig. 2 of the drawings where the pneumatic circuit and mechanical elements disposed within the housing 25 of the operating mechanism 10 are schematically shown, there is illustrated a fluid or gas operated mechanism comprising a cylinder 27 within which is reciprocally mounted a piston 28. The piston 28 is connected by a connecting rod 29, the end of which is coupled by a suitable joint 30 to a crank arm 31 pivotally mounted by means not shown and drivingly connected to a horizontal shaft 32. The shaft 32 is drivingly connected to the shaft 23 which protrudes from the operating housing 10 by means of a pair of intermeshed bevel gears 33 and 34. The mechanism is illustrated in Fig. 2 in the position corresponding to the closed position of the switch of Fig. 1. Preferably, there is provided an over-center spring 36 which acts between a fixed portion of the gas operated mechanism 10 and the crank arm 31 so as to serve as an over-center spring which holds the air break switch 11 in either its open or closed position with a force of a predetermined magnitude thereby to insure that the switch 11 remains in either its open or closed position until positively actuated to the other of these positions.

For the purpose of causing reciprocal movement of the piston 28 within the cylinder 27 to open and close the switch 11, there is provided a source of gas under pressure generally designated as 40 which is supplied through suitable conduits described in detail hereinafter through a main operating valve generally designated as 41 and through either a switch opening valve 42 or a switch closing valve 43 to the cylinder 27. As schematically illustrated in Fig. 2, the switch opening and switch closing valves 42 and 43 are solenoid actuated valves comprising windings 44 and 45, respectively. Moreover, these valves are of identical construction and are effectively three-way valves. The switch opening valve 42 has its inlet end connected to a gas or fluid inlet conduit 46 while a gas or fluid outlet conduit 47 connects the valve 42 with one end of the cylinder 27. The valve 42 is furthermore provided with an opening 48 to atmosphere whereby when the valve 42 is in its so called open position, namely, when the winding 44 is deenergized, the end of the cylinder connected to conduit 47 is vented to atmosphere through conduit 47 and opening 48. Similarly, the switch closing valve 43 has its inlet port connected to a gas or fluid inlet conduit 50 and its outlet port connected to the other end of the cylinder 27 by a conduit 51. An opening 52 to atmosphere in the valve 43 is provided so that when the winding 45 is deenergized, the end of the cylinder 27 to which the conduit 51 is connected is vented to atmosphere.

In accordance with the present invention, the source of fluid or gas under pressure 40 comprises preferably a conventional gas cylinder and although it may comprise air or any other suitable gas under pressure, cylinders of nitrogen are preferably employed. The reason why nitrogen is suggested is that it is readily available in standard containers of small size which can readily be disposed in the small housing 25 of the operating unit 10. Moreover, nitrogen is an inert gas. As conventionally available, these gas cylinders contain nitrogen under a pressure of 1800 pounds per square inch. In addition, there is conventionally available with such cylinders suitable pressure regulating means generally indicated at 55 for suitably reducing the pressure within cylinder 40 to a suitable working pressure. For the particular application of the present invention, pressure regulator 55 preferably reduces the pressure from 1800 pounds per square inch to 130 pounds per square inch as indicated in Fig. 2 of the drawings. A suitable pressure gauge 56 indicates the pressure at the source 40 and the pressure gauge 57 indicates the working pressure which has been specifically indicated as being of the

order of 130 pounds per square inch, but which might be some other value. The pressure regulating mechanism 55 is illustrated as being connected by a suitable conduit 58 to the gas source 40. Similarly, the pressure regulating mechanism 55 is indicated as being connected by a conduit 59 with the main control valve 41.

The main control valve 41 is a two-way solenoid operated valve and supplies gas under pressure when energized to both opening valve 42 and closing valve 43. The passageway between valves 41 and 42 is defined by a conduit 60, an adjustable needle valve 61 and the inlet conduit 46. The passageway between valves 41 and 43 is defined by a conduit 62, an adjustable needle valve 63 and the conduit 50. The adjustable needle valves 61 and 63 are provided in order to regulate the speed of operation of the piston 28 to any desired value which could be different for the switch opening and switch closing strokes if desired.

The main operating valve 41 best shown in Figs. 4 to 7 of the drawings is a solenoid actuated valve comprising the solenoid winding 64. Since the operating mechanism of the present invention is unattended and may be inspected only once or twice during a period as long as a year, it is essential that the main operating valve 41 when closed prevents any gas leakage. It is well known that the conventional automobile tire valve is one of the most satisfactory valves for preventing the leakage of air or gas and there has been embodied in the main operating valve 41 a mechanism designated by the reference numeral 65 which comprises a tire valve stem for threadedly receiving a tire valve 66 having an elongated extension or pin 66a. As illustrated in Fig. 5, there is provided a valve casing 67 which is preferably a suitable casting or the like which may be supported by suitable fastening means such as screws 68 from a fixed support designated as 69 which may be fixed within the housing 25. Suitable sleeves such as 70 properly position the casing 67 from the support 69, these sleeves being coaxial with the screws 68. The upper end of the casing 67 is provided with a tubular externally threaded extension 67a to which may be attached a suitable clamping nut 71 for providing a gas-tight connection between a suitable connector 72 which may be connected in sealed relationship as by welding or the like with conduit 59 leading to the pressure regulating mechanism 55. The connector 72 preferably is provided with an annular shoulder 72a which seats upon the upper end of the tubular extension 67a of the casing 67. The lower end of the connector 72 is counterbored as indicated at 73 to receive the tire valve stem 65 as by a press fit or the like.

The tire valve 66 includes a passageway 74 therethrough for the flow of gas or fluid from conduit 59 into a chamber designated as 75 defined in the lower end of the casing 67. This passageway is closed by the valve member 76 of the tire valve 66. The chamber 75 in accordance with the present invention is designed to receive a gas-tight housing including an elongated cylinder or sleeve 79 which is coaxially disposed with the solenoid winding 64. The lower end of cylinder 79 is closed by a bottom pole piece 80 pinned thereto by the pin 81 and also otherwise sealed thereto. The upper end of the cylinder or sleeve 79 is received within a cylindrical opening in casing 67 defining chamber 75. For the purpose of connecting chamber 75 with conduits 60 and 62, a fluid passageway is defined by a threaded passage 82 in casing 67 and an aligned opening 83 in sleeve 79. A suitable T-connector 84 is connected to threaded passage 82 which T-connector in turn may be connected as by clamping nuts 85 with the conduits 60 and 62. Also disposed within the gas-tight housing is an annular upper pole piece 86 suitably fixedly related thereto as by a pin 87. The space between the upper and lower pole pieces is such as to define within the sealed gas-tight housing a cylinder within which a solenoid plunger 90 is adapted to move. This solenoid

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plunger 90 is connected by means of a connecting rod 91 pinned to the plunger as indicated at 92 and extends through the opening in the annular pole piece 86 for connection with the elongated pin 66a of the tire valve 66, whereby reciprocal movement of the solenoid plunger 90 will cause opening and closing of the valve member 76 of the tire valve 66; upward movement causing opening of the valve and downward movement causing closing of the valve. The tire valve member 76 is, moreover, disposed so that the gas pressure tends to bias it into sealing engagement whereby the higher the pressure, the more effective the seal.

For the purpose of supporting the solenoid winding 64 in position around the sleeve 79 and the plunger 90 disposed therein, there is effectively provided a solenoid housing comprising a top plate 95, a solenoid casing of annular shape 96 and a solenoid bottom plate 97 which are held in interfitting assembled relationship as shown in Fig. 5 of the drawings by suitable bolts 98 extending through the solenoid bottom plate 97 and a flange portion of the valve casing 67. Whenever the solenoid winding 64 is energized, the solenoid plunger 90 is pulled from the position shown in Fig. 5 into engagement with the top pole piece 86 with the consequent opening movement of valve member 76. Fluid under pressure may then flow from conduit 59 into the chamber 75 through the opening 83, the passage 82 and the T-connector 84 into conduits 60 and 62. Upon deenergization of the solenoid winding 64, the valve member 76 is immediately reclosed.

It will be apparent that it is necessary to provide suitable control means for energizing the main valve 41, the switch opening valve 42 and the switch closing valve 43 selectively to produce the desired operating conditions of the gas operated mechanism 10. The simplified control circuit of the present invention is illustrated in Fig. 3 of the drawings where some of the mechanical and electrical parts of the system are schematically shown and designated by the same reference numerals as in the other figures of the drawings. Since the fluid or gas operated mechanism of the present invention has its principal application at locations where there is no dependable source of electric power at the time or under the conditions that the switch must be operated, the mechanism is designed to be operated from a suitable storage battery generally designated at 100 which is preferably one of the well known charge retaining type of batteries which is built for low drain and which will retain 85 per cent of its charge for at least a year. Such batteries are practically unaffected by temperature down to as low as forty degrees below zero provided they are sufficiently charged. This battery can be tested with a hydrometer before the cold season. Such a battery is commonly used for marine beacons, railway and highway signals, etc., and has a minimum life of the order of ten years. As illustrated in Fig. 3, the battery or source of electric energy 100 is connected through a main control switch 101 to a control circuit which comprises a main opening relay 102, a main closing relay 103, an opening control relay 104 and a closing control relay 105. The main opening and main closing relays 102 and 103, respectively, are each provided with normally open contacts designated as 102a and 103a, respectively, which are closed when the respective relays are energized. The relay 102 is provided with a winding 102b while the relay 103 is provided with a winding 103b. The opening control relay 104 and the closing control relay 105 are identical relays, the former comprising a pair of normally open seal-in contacts 104a and a pair of normally open control contacts 104b. Similarly, the closing control relay 105 comprises a pair of normally open seal-in contacts 105a and a pair of normally open control contacts 105b. The winding of the relay 104 is designated as 104c while the winding of the relay 105 is designated as 105c. The control circuit of Fig. 3 also includes an opening switch 107 and a closing switch 108 for controlling normally open contacts 107a and 108a, respectively.

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These contacts could comprise manually actuable switch contacts for controlling the operation of the operating mechanism 10. Preferably, however, these contacts 107a and 108a are relay contacts whereby the operating mechanism 10 may be controlled from a remote point through any well-known manner such as by telemetering, radio signals or a direct operating connection. The particular manner in which the contacts 107a and 108a are selectively operated forms no part of the present invention and the contacts are merely schematically indicated.

It will be understood that the control circuit of Fig. 3 will also include suitable limit switches and as illustrated schematically, these limit switches are designated as an opening limit switch 109 and a closing limit switch 110 which control contacts 109a and 110a, respectively. These switches 109 and 110 are normally biased to the open position and are closed by suitable cam means such as schematically designated at 112 in response to the movement of the connecting rod 29. When the switch 11 reaches its closed position, the cam 112 opens the contacts 110a of the closing limit switch 110 thereby terminating the closing operation. It also closes the contacts 109a of the opening limit switch 109, thereby conditioning the apparatus for a subsequent opening operation.

To provide a control circuit for the solenoid valves 41, 42 and 43, one terminal of the windings 44, 45 and 64 of the opening valve 42, the closing valve 43 and the main operating valve 41, respectively, are connected to a common conductor 114 which is illustrated as connected to the positive terminal of the battery 100 through the manual switch 101. The other terminal of the winding 44 is connected by a conductor 115 through the control contacts 104b of the opening control relay 104 to the negative terminal of the battery through a conductor 116 and the switch 101. Similarly, the other terminal of the winding 45 of the closing control valve 45 is connected through a conductor 117 and the control contacts 105b of the closing control relay 105 to the negative terminal of the battery 101 through the path including the conductor 116. Also, the other terminal of the winding 64 of the main operating valve 41 is connected by a conductor 118 through the contacts 102a or 103a of the main opening and main closing relays 102 and 103, respectively, and conductors 119 and 116 to the negative terminal of the battery 100.

For the purpose of controlling the energization of the relays 102, 103, 104 and 105, a control circuit controlled by the contacts 107a of the opening switch or relay 107 is completed from the negative battery terminal through conductor 116, the contacts 107a, the winding 104c of the opening control relay 104, conductor 121, the contacts 109a of the opening limit switch 109 and conductor 122 to the positive battery terminal. The winding 102b of the main opening relay 102 is in parallel with the opening control relay winding 104c so that when the contacts 107a are closed, simultaneous energization of the relays 102 and 104 will occur. The seal-in contacts 104a of the relay 104 are arranged to by-pass the contacts 107a so that only momentary closing of the switch 107 is required whereupon the relays 102 and 104 will remain energized until the limit switch 109 opens contacts 109a. In a similar manner the windings 103c and 105c of the relays 103 and 105, respectively, are connected in parallel across the battery terminals through the contacts 108a of the closing switch or relay and the contacts 110a of the closing limit switch 110. Hence, closing of the contacts 108a when the air switch 11 is in the open position will cause simultaneous energization of the relays 103 and 105. Energization of either the relay 102 or the relay 103 will complete the energization circuit for the solenoid winding 64 of the main valve 41. Closing of the contacts 105b of the closing control relay 105 will cause immediate energization of the winding 45 of the closing valve 43 and closing of the contacts 105a will

seal-in the energization circuit for the relays 103 and 105 until the limit switch 110 opens.

In view of the detailed description included above, the operation of the present invention will readily be understood by those skilled in the art. Assuming the air break switch 11 is in the closed position shown in Fig. 1 which means the piston 28 is in the position shown in Figs. 2 and 3 of the drawings, the air switch 11 may be opened through closing of the contacts 107a which may be done from a remote point by various means. It is, of course, assumed that the switch 101 will be closed at all times except when the battery 100 is being recharged or replaced or some repairs are being made to the mechanism. Upon closing of the contacts 107a, the energization circuit is completed for the main opening relay 102 and the opening control relay 104 which are simultaneously energized to close their contacts with the resultant simultaneous energization of the main valve 41 and the opening valve 42. Under these conditions fluid under pressure may be transmitted through the main valve 41 and through conduits 60, needle valve 61 and conduit 46 through the opening valve 42 thereby causing upward movement of the piston 28 as shown in Fig. 2 of the drawings. The space within the cylinder 27 above the piston 28 is vented to atmosphere through the port 52 of the closing valve 43. During the course of the opening movement of the piston 28, cam 112 moves away from the cam actuated switch 109 and at a predetermined point in the opening operation these contacts are opened to deenergize the relays 102 and 104 with the consequent deenergization and closing of the valves 41 and 42. Upon the final movement of the connecting rod 29 the closing limit switch 110 is closed to condition the circuit for a subsequent closing operation in response to the closing of the contacts 103a. The same process is repeated in the event contacts 103a are closed except that in this case the relays 103 and 105 are energized with the resultant opening of the valves 41 and 43. The seal-in contacts 105a maintain the circuit closed until the limit switch 110 interrupts this circuit, even though the contacts 103a are opened.

It will be understood that suitable cam controlled switches may also be employed for actuating indicating lights to indicate at any time the condition of the switch 11 if this is desirable. In a commercial embodiment of the present invention, it was found that a cylinder of nitrogen charged at 1800 pounds per square inch would provide for twenty-five to thirty opening and closing operations with the pressure regulator 55 reducing the pressure to 130 pounds per square inch for the operating cylinder 27. In this commercial embodiment the relay currents at six volts were six-tenths of an ampere which is low enough so that any kind of an actuating relay could be used to start operation. The operating time involved was approximately three seconds and this could be controlled to some extent by adjustment of the needle valves 61 and 63. For different sizes of switches 11, it is possible to employ different sized cylinders 27 and pistons 28. In commercial embodiments built in accordance with the present invention, three inch, four inch and four and a half inch cylinders were employed delivering a maximum of 250, 400 and 500 foot pounds of operating effort, respectively. Also in a commercial embodiment built in accordance with the present invention, the over-center spring 36 was designed to hold the switch 11 open or closed with a force of 37 pounds.

From the above discussion it will be apparent that there has been provided an improved gas operated mechanism which is simple and compact and completely self-contained requiring only a small gas cylinder and a six volt storage battery for operation.

While there has been illustrated and described a particular embodiment of the present invention, it is not desired that the invention be limited to the construction shown and described, for it will, of course, be obvious to those skilled in the art that various changes and modi-

fications may be made without departing from the invention, and it is therefore aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of this invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A gas operated mechanism for producing relative movement between the contacts of an electric switch comprising a fluid motor including a cylinder and reciprocal piston, a self-contained source of fluid under pressure, a self-contained source of electric energy, a solenoid actuated switch opening valve connected to one end of said cylinder, a solenoid actuated switch closing valve connected to the other end of said cylinder, conduit means including a solenoid actuated main control valve connecting said source of fluid under pressure to both said opening and closing valves, said main control valve comprising a valve member biased to the closed position by the force of the fluid pressure of said source thereby to insure against leakage from said source, and electric control means connected to said source of electrical energy for controlling the energization of said solenoid actuated valves including means for selectively and independently energizing either said opening or closing valve, said last mentioned means including means for causing simultaneous energization of said main control valve whenever either of said other valves are actuated, said electric control means including switch means operable in response to predetermined movement of said piston in at least one direction for simultaneously deenergizing both said main control valve and the one of the opening or closing valves which was actuated to cause said predetermined movement of said piston.

2. A gas operated mechanism for producing relative movement between the contacts of an electric switch of the type having a rotatable drive for said switch contacts, comprising a fluid motor including a cylinder and reciprocal piston means for converting reciprocal movement of said piston to rotary motion of said rotatable drive, a self-contained source of fluid under pressure, a self-contained source of electric energy, a solenoid actuated switch opening valve connected to one end of said cylinder, a solenoid actuated switch closing valve connected to the other end of said cylinder, conduit means including a solenoid actuated main control valve connecting said source of fluid under pressure to both said opening and closing valves, said main control valve comprising a valve member biased to the closed position by the force of the fluid pressure of said source thereby to insure against leakage from said source, and electric control means connected to said source of electrical energy for controlling the energization of said solenoid actuated valves including means for selectively and independently energizing either said opening or closing valve, said last mentioned means including means for causing simultaneous energization of said main control valve whenever either of said other valves are actuated, said electric control means including switch means operable in response to predetermined movement of said piston in at least one direction for simultaneously deenergizing both said main control valve and the one of the opening or closing valves which was actuated to cause said predetermined movement of said piston.

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