March 9, 1965 H. THOMMEN 3,172,980

COMPRESSED AIR SWITCH WITH MULTIPLE INTERRUPTION

Filed June 13, 1960 2 Sheets-Sheet 1

Fig. 1.

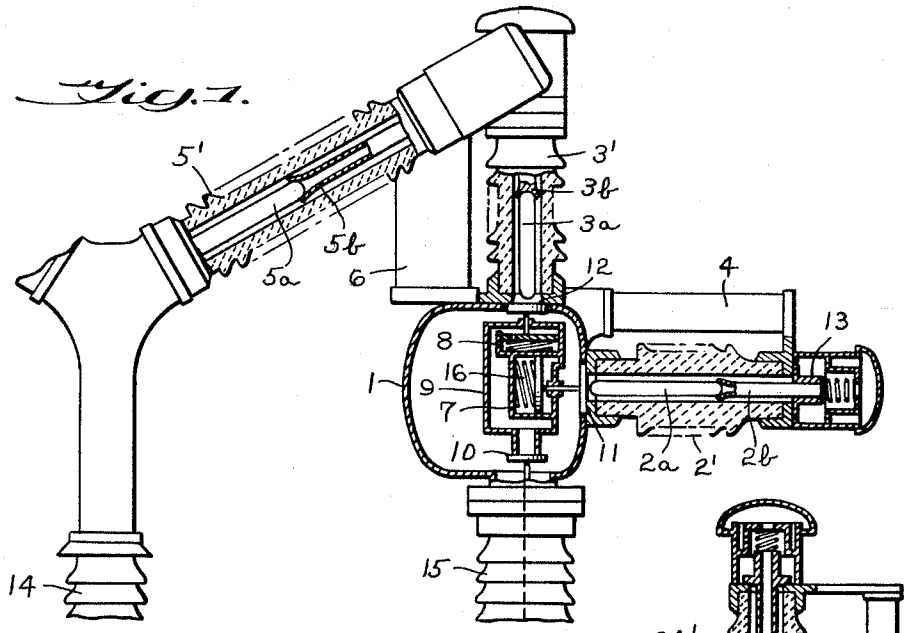


Fig. 2.

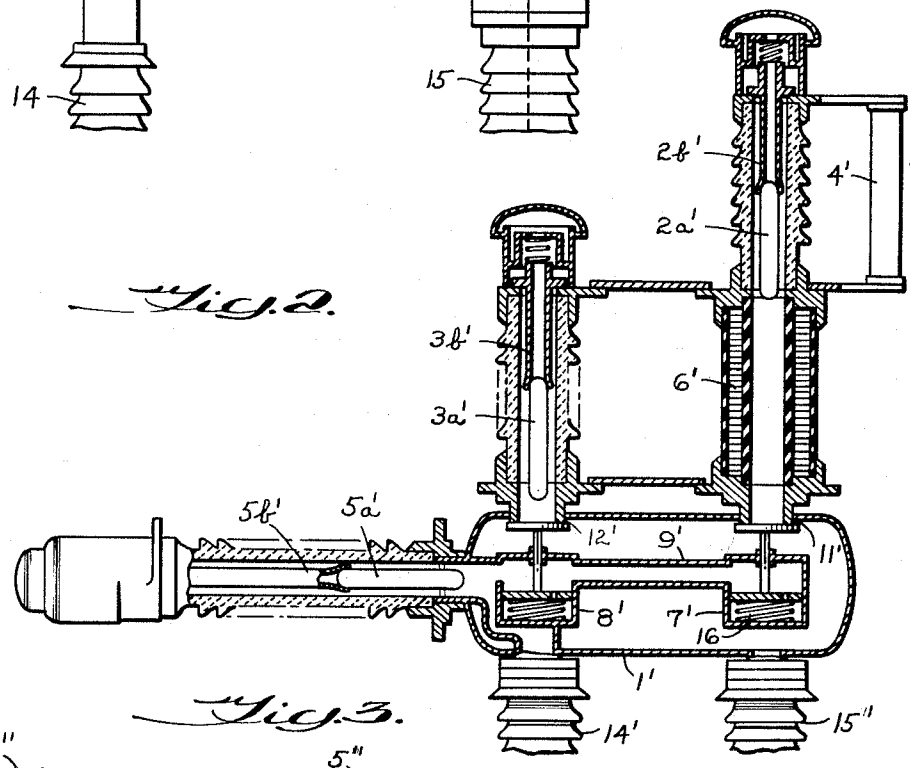
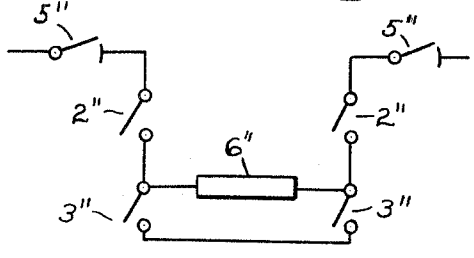


Fig. 3.



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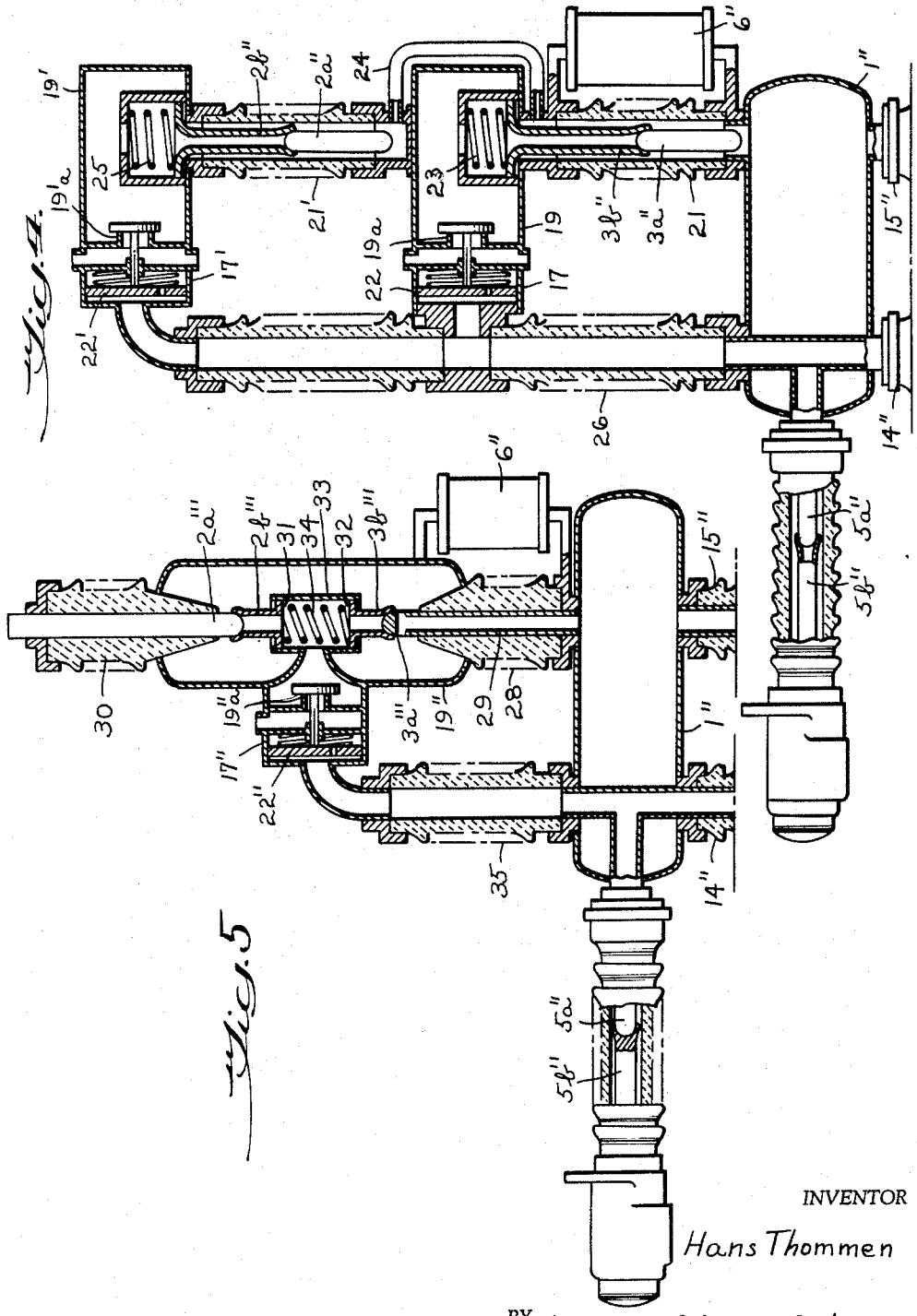


Fig. 4

Fig. 5

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COMPRESSED AIR SWITCH WITH MULTIPLE INTERRUPTION

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Claims priority, application Switzerland, June 13, 1959, 74,399

2 Claims. (Cl. 200—148)

This invention relates in general to compressed air actuated electrical switching apparatus wherein the contacts which define the switching points are blasted with compressed air, and in particular to switches of the general type described which include a plurality of power interrupting switching points and a voltage disconnecting or isolating switching point, all of which are connected electrically in series, and one of the power switching points being paralleled with a low-ohmic resistance. Another of the power interrupting switching points can also, if desired, be paralleled by a high-ohmic resistance for voltage control. The function of the power interrupting switching points is to satisfactorily disconnect the load current through the switching apparatus up to the highest circuit-breaking rating for which the apparatus is designed. The function of the voltage disconnecting switching point is to ensure voltage isolation between the input and output terminals of the switching apparatus during the entire period that the latter is in its disconnected state.

It is known to design air blast switches with a plurality of power interrupting switching points wherein such points are associated together in various numbers depending upon the magnitude of the operating voltage of the system to which the switching apparatus is applied, and also the magnitude of the load current which must be interrupted, each of these elements being designed in the same manner.

In newer developments of air blast switching apparatus, it has become necessary to further increase their circuit-breaking capacity. To this end, it has been known to provide two power interrupting switching points in series and to connect a low-ohmic resistance in parallel with one of the power interrupting switching points. A voltage disconnecting switching point is also connected in series with the two power interrupting switching points. In operation, the power interrupting switching point which is paralleled by the low-ohmic resistance is opened first thereby to divert the current flow through the resistance, and then the other power interrupting switching point opens in order to interrupt the current flowing through the resistance. The voltage disconnecting switching point is then opened and maintained in an open state so long as the open circuit condition is desired. The two power interrupting switching points can be allowed to re-close as soon as the voltage disconnecting switching point has been opened so that the circuit can be re-closed through the switching apparatus simply by re-closing the contacts at the voltage disconnecting switching point.

The compressed air required for actuating the power interrupting and voltage disconnecting switching points and for blasting the same with the compressed air in order to facilitate arc extinction across the switch contacts, is usually obtained from a common supply tank in which the air is maintained under the desired pressure. Where the switching apparatus is composed of a plurality of similar circuit breaking groups, it has already been proposed to sub-divide the pressure tank corresponding to the number circuit breaking groups, i.e. to associate each tank with one, or more, groups of power interrupting switching points of both types, and with one voltage disconnecting switching point. The whole switch assembly thus becomes quite complicated, since each group requires separate air control valves for the switching. The supply of compressed air and the arrangement of the air control valves becomes even more complicated if the switching motion is different in the various switching points and if the high-ohmic resistances when used, also have separate auxiliary switching points to control their parallel connection with their associated power interrupting switching points, i.e. when the power interrupting switching points for example, close immediately after extinction of the arc, while the voltage disconnecting switching point remains open, and the auxiliary switching point for the high-ohmic resistances first closes at the instant the entire switching apparatus begins an opening function and then re-opens.

The object of the present invention is to provide an improved structural arrangement for switching apparatus of the general type described which is more simple and economical to manufacture and which permits one to more easily assemble and adapt the various components to different power and voltage requirements. In accordance with the invention, the improved structural assembly is characterized by two series connected power interrupting switching points of the air blast type, one of which is paralleled by a low-ohmic resistance, a voltage disconnecting switching point also of the air blast type in series with the power interrupting switching points, an auxiliary compressed air tank having built-in main valves for controlling admission of compressed air to the power interrupting switching points, at least one such switching point being electrically isolated from the auxiliary compressed air tank by a tubular insulator located on the tank.

The invention will become more apparent from the following detailed description of several practical embodiments and from the accompanying drawings wherein:

FIG. 1 is a fragmentary view of one embodiment of the invention, the switching structure essential to an understanding of the invention being shown partly in vertical central section and partly in elevation;

FIG. 2 is a view similar to FIG. 1 illustrating a modified embodiment of the invention;

FIG. 3 is a schematic circuit diagram showing only the arrangement of the power interrupting switching points and the voltage disconnecting or isolating switching points in an organization which comprises two similar switching units connected in series, each such unit being constituted by a series connected arrangement of two power switching points and a voltage disconnecting switching point, and a low ohmic resistance connected in parallel with a series arrangement of one power interrupting switching point of one switch unit and one power interrupting switching point of the other switch unit;

FIG. 4 is a view similar to FIG. 1 but showing a somewhat different embodiment; and

FIG. 5 is a view similar to FIG. 4 but showing a modification of the latter.

With reference now to the embodiment illustrated in FIG. 1 it will be seen that the switch structure comprises an auxiliary compressed air tank 1, a laterally extending hollow insulator 2' supported by tank 1 and containing a pair of normally closed, power interrupting, switch contacts 2*a*, 2*b*, and a vertically upward extending hollow insulator 3' also supported by tank 1 and containing a pair of normally closed, power interrupting, switch contacts 3*a*, 3*b*. A pair of normally closed, voltage disconnecting, switching contacts 5*a*, 5*b* is contained within an inclined hollow insulator 5' which is connected at its upper end with the upper end of insulator 3'. The two power interrupting switching points 2*a*, 2*b* and 3*a*, 3*b* and the voltage disconnecting point 5*a*, 5*b* are connected

electrically in series. A low-ohmic resistance 6 is connected in parallel with the power interrupting switching point 3*a*, 3*b* and a high-ohmic resistance 4 can, if desired, be connected in parallel with the power interrupting switching point 2*a*, 2*b*.

Within the auxiliary compressed air tank 1 is arranged the main control valve structure for the two power interrupting switching points. This comprises a casing 9 containing two compressed air operated piston-cylinder type valve units 7 and 8 disposed at right angles to each other. Unit 7 functions to control admission of compressed air from tank 1 into the hollow insulator 2' so as to effect separation of the contacts 2*a*, 2*b*. Unit 8 functions in a similar manner to control admission of compressed air from tank 1 into the hollow insulator 3' so as to effect separation of the contacts 3*a*, 3*b*.

The auxiliary compressed air tank 1 is supported atop a vertical hollow insulator column 15 through which compressed air from a suitable primary source of supply such as a tank (not shown) is introduced into the auxiliary tank 1, and a valve 10 serves to control admission of compressed air into casing 9 so as to effect operation of the piston-cylinder units 7, 8 which, in turn, control admission of compressed air to the switch contacts 2*a*, 2*b* and 3*a*, 3*b*.

The inclined insulator 5' which contains the voltage disconnecting contacts 5*a*, 5*b* is supported by a vertical hollow insulator column 14 through which compressed air is fed to the hollow insulator 5' from the same source which supplies compressed air to the column 15.

The switching apparatus of FIG. 1 operates in the following manner. When it is desired to open the circuit, valve 10 is opened to admit compressed air from tank 1 to the interior of casing 9. Piston-cylinder valve unit 8 functions first to admit compressed air from casing 9 into insulator 3' at inlet 12 and effect disconnection of contacts 3*a*, 3*b*. This forces the current which had been passing through these contacts when closed to take a parallel path through the low-ohmic resistance 6. Piston-cylinder valve unit 7 then functions to admit compressed air from casing 9 into insulator 2' at inlet 11 and effect disconnection of contacts 2*a*, 2*b* which serves to interrupt the current flowing through resistance 6. After contacts 2*a*, 2*b* have been opened, compressed air is admitted through insulator column 14 into insulator 5' to effect separation of the voltage disconnecting contacts 5*a*, 5*b*. These latter contacts are maintained in their open state by maintaining the air pressure within the column 14 and insulator 5' for so long as it is desired to hold the circuit open at the switching apparatus. However, as soon as the contacts 5*a*, 5*b* have been separated, the power interrupting switching points at contact sets 2*a*, 2*b* and 3*a*, 3*b* are reclosed. This is effected by means of the leakage of compressed air through small ports in the piston elements of the piston-cylinder type valve units 7 and 8 so as to ultimately equalize the air pressures on opposite faces of these piston elements whereupon the restoring forces in springs 16 which are located in the cylinders serve to gradually reclose the entrances 11 and 12 to the insulators 2' and 3' and shut off the supply of compressed air thereto. A spring loaded blow-off valve structure 13 is located at the outer end of insulator 2' and a similar valve structure is associated with the upper end of insulator 3'. These valves which are structurally united with the movable contacts 2*b*, 3*b* are loaded by their springs in such manner as to close off the ends of their respectively associated insulators 2', 3' and also move the contacts 2*b*, 3*b* into engagement with their respective stationary contacts 2*a*, 3*a*. When the valves 7, 8 open to admit compressed air into insulators 2', 3', the contacts 2*b*, 3*b* are separated from their respective contacts 2*a*, 3*a* and the valves 13 open against the counter action of their loading springs to discharge the compressed air from the insulators. When valves 7, 8 re-close, the blow-off valves 13 also re-close to close off the ends of the insulators and re-close the contact sets 2*a*, 2*b* and 3*a*, 3*b*.

The necessary electrical series connection between the stationary contacts 2*a* and 3*a* can be made through the wall of the auxiliary tank 1 which can be made from electrically conductive material. The connection from contact 3*b* to contact 5*b* is made by suitable means, not shown in detail.

The embodiment which has been described can constitute one structural switch unit of the entire switch assembly. Another such structural switch unit containing two power interrupting switching points and a voltage disconnecting point can be arranged to the left of the one shown in FIG. 1, i.e. as a mirror image of the first one, in which event the voltage disconnecting point could be branched off from the same supporting insulator column 14. Alternately a second such structural switch unit could be arranged in the same direction as the one depicted in FIG. 1.

FIG. 2 illustrates a somewhat different embodiment wherein the power interrupting switching point (contact set 2*a*' and 2*b*' within its hollow insulator structure) is located atop the low-ohmic resistance unit which, in this embodiment takes the form of a tubular member 6' supported vertically upon the auxiliary tank 1' and which may be surrounded by an auxiliary hollow insulator. The other power interrupting switching point (contact set 3*a*' and 3*b*' within its hollow insulator structure) is mounted vertically and directly upon the auxiliary tank 1' parallel with tubular member 6'. The voltage disconnecting switching point (contact set 5*a*' and 5*b*' within its hollow insulator structure is likewise mounted directly upon tank 1' and is disposed in a horizontal attitude laterally of the tank.

In this embodiment, the casing 9' located within tank 1' houses the main control valves 7' and 8'. These are similar in structure to the valves 7, 8 of the FIG. 1 embodiment but are actuated, not by compressed air admitted from tank 1' as in FIG. 1, but rather by compressed air supplied to the casing 9' from a vertical, hollow supporting insulator 14' which serves as one support for the tank 1'. Air from casing 9' is also fed through the horizontal insulator of the voltage disconnecting switching point (contact set 5*a*', 5*b*') to separate these contacts after the power interrupting switching points (contact sets 2*a*', 2*b*' and 3*a*') have been opened.

A second hollow supporting insulator 15' is disposed parallel with insulator 14' and serves as the other support for tank 1'. Compressed air which feeds upwardly through insulator 15' is admitted to the interior of tank 1' and the latter serves as the supply source of compressed air which feeds through inlets 11' and 12' when the control valves 7' and 8' are opened to thus effect disengagement between the power interrupting switching points 2*a*', 2*b*' and 3*a*', 3*b*'. It will be noted that the compressed air which is used to open the contacts 2*a*', 2*b*' must first pass upwardly through the tubular low-ohmic resistance unit 6' to thus cool the same. Moreover, the longer air path established by this resistance unit 6' provides the necessary delay in switching sequence so that the contacts 2*a*', 2*b*' open subsequently to the opening of contacts 3*a*', 3*b*'. As with the FIG. 1 embodiment, a high-ohmic resistance unit 4' can be connected in parallel with the contacts 2*a*', 2*b*' for potential control.

The manner in which the embodiment of FIG. 2 operates is the same as that of FIG. 1. The advantages of the FIGS. 1 and 2 embodiments are that the two power interrupting switching points can be supplied with compressed air together from a common auxiliary tank, and that the assembly can be effected in a space-saving manner. Moreover, it is possible to combine any desired number of switch units, depending upon the voltage to which the switching apparatus is applied and the circuit breaking capacity desired. Several switch units can be omitted if the circuit breaking capacity is to be lower. It is even

possible to eliminate one power interrupting switching point completely without changing the construction of the individual elements.

The switching for multiple break switches in accordance with the invention can be effected in any desired order and direction. For example, as shown in the circuit diagram of FIG. 3, the number of necessary resistances can be reduced and power interrupting switching points of different switch units can be connected together in such manner as to be paralleled by a common low-ohmic resistance unit. Thus the complete switching assembly is comprised of two series connected switching units, each such unit comprising a series arrangement of two power interrupting switching points 2'', 3'' and a voltage disconnecting switching point 5''. However, only one low-ohmic resistance unit 6'' is used and this is connected in parallel with the two series connected switching points 3''.

FIGS. 4 and 5 illustrate embodiments wherein the main control valves 17 are arranged on the exhaust side of the power interrupting switching points and separation of the contacts at the power interrupting switching points is effected not by introducing compressed air from an auxiliary tank to the interior of the insulators containing these switching points but rather by permitting compressed air which has been stored in these insulators and auxiliary tank to be discharged therefrom.

With reference now to FIG. 4 it will be seen that the auxiliary tank 1'' is carried on the top of two, parallel spaced hollow insulator columns 14'' and 15''. Upstanding upon the tank 1'' is a tubular insulator 21 which contains a set of power interrupting switching contacts 3*a*'', 3*b*'', and mounted at the top of insulator 21 is a housing 19 provided with an exhaust outlet 19*a* which is controlled by a valve 17. The lower end of insulator 21 communicates with the interior of tank 1'' and the upper end of insulator 21 communicates with the interior of housing 19. The movable contacts 3*b*'' is loaded by a spring 23 into engagement with the stationary contacts 3*a*'', and the low-ohmic resistance 6'' is connected in parallel with the contacts 3*a*'', 3*b*''.

Upstanding upon the housing 19 is another tubular insulator 21' which contains the other set of power interrupting switching contacts 2*a*'', 2*b*'', and mounted upon the top of insulator 21' is a second housing 19' provided with an exhaust outlet 19*a*' which is controlled by valve 17'. The lower end of insulator 21' is placed in communication with the upper end of insulator 21 by means of a duct 24, and the upper end of insulator 21' communicates with housing 19'. The movable contacts 2*b*'' is loaded by a spring 25 into engagement with the stationary contact 2*a*''.

Also upstanding upon the tank 1'' and spaced parallel with the insulators 21, 21' is another tubular insulator 26 which serves as a support for the piston elements 22, 22' of the control valves 17, 17' and their cylinders and also as a duct for the passage of compressed air from the upper end of support insulator 14'' to actuate those piston elements. It will also be noted that compressed air from insulator 14'' passes into the tubular insulator element which contains the contacts 5*a*'', 5*b*'' of the voltage disconnecting switching point. As with the other arrangements, the two power interrupting switching points represented by contact sets 2*a*'', 2*b*'' and 3*a*'', 3*b*'', and the contact set 5*a*'', 5*b*'' are all connected electrically in series.

The arrangement shown in FIG. 4 operates in the following manner.

When all of the switch contacts are closed, compressed air fills the insulators 21, 21' and the housings 19, 19'. To effect an opening of the switch, compressed air is admitted through insulator 14'' into the tubular insulator 26. When this air reaches the first piston 22 it shifts the latter to the right thus opening the outlet 19*a* and permitting the compressed air stored in housing 19 to flow outward to atmosphere which results in an upward movement of contact 3*b*'' so as to disengage it from contact 3*a*''. The current which had then been flowing through these contacts is thus shunted over to flow through the low-ohmic resistance 6''. By this time, the compressed air flowing upward through insulator 26 past the branch off point to piston 22 will reach the other piston 22' to thus shift it to the right and thus open outlet 19*a*' which permits the compressed air stored in housing 19' to flow outward to atmosphere and effect an upward movement of contact 2*b*'' so as to disengage it from contact 2*a*''. As these latter two contacts separate, the current which had been flowing through resistance 6'' is interrupted. The flow of compressed air into the insulator containing the voltage disconnecting switching point (contacts 5*a*'', 5*b*'') then causes these latter contacts to separate, and they remain separated so as to effect the desired voltage isolation so long as the switch is in its disconnected state. However, the pistons 22, 22' are provided with small orifices which ultimately serve to equalize the fluid pressure on opposite faces of the pistons so that the latter are moved back to the left by the action of their respective biasing springs 27, 27' and re-close the housing outlets 19*a* and 19*a*' thereby resulting in a re-closing of the switch contacts 2*a*'', 2*b*'' and 3*a*'', 3*b*'', and reestablishing the air pressure within the housings 19, 19' and insulators 21, 21'. When it is desired to reclose the switch, air is vented from insulator 14'' to atmosphere which results in a re-closing action of the contacts 5*a*'', 5*b*'' and a venting of air from the tubular insulator 26.

The series electrical connections between the power interrupting switching points and the voltage disconnecting switching point can be effected by making the housing 19, 19' and auxiliary tank 1'' from an electrically conductive material. Thus the circuit through the switch can be traced from housing 19' to contact 2*b*'' to contact 2*a*'' to housing 19 to contact 3*b*'' to contact 3*a*'' to tank 1'' to contact 5*b*'' to contact 5*a*''.

The arrangement illustrated in FIG. 5 is similar to that of FIG. 4 in that operation of the switch is effected by exhausting compressed air from the chamber containing the power interrupting switching contacts and hence similar parts have been given the same reference numerals. However, instead of separate valves for controlling the exhaust from the respective power interrupting switching points, only one control valve structure is used. With reference now to FIG. 5 it will be seen that a tubular insulator 28 upstands upon the auxiliary compressed air tank 1'' which is supported by the two, parallel spaced tubular insulators 14'' and 15''. The insulator 28 is lined with a sleeve 29 of conductive material which terminates in the stationary contact 3*a*''' located within one end portion of housing 19'' which is supported by the insulator 28. The opposite end of the vertically disposed housing 19'' supports an insulator 30 through which extends the stationary contact structure 2*a*''' that is co-axial with the contact 3*a*'''.

The movable contacts 2*b*''' and 3*b*''' are carried by pistons 31, 32 respectively which operate vertically in a common cylinder 33 located within housing 19'', these pistons being biased in opposite vertical directions by a loading spring 34 disposed between the pistons so as to normally cause the sets of contacts controlled respectively thereby to be engaged.

Also upstanding upon tank 1'' parallel with insulator 28 is another tubular insulator 35 through which air is conducted from insulator 14'' up to the piston 22'' of control valve 17'' which controls the opening and closing of the compressed air exhaust outlet 19*a*'' from housing 19''. Operation of the switch of this embodiment is essentially the same as in the embodiment of FIG. 4. Compressed air introduced through insulator 35 causes piston 22'' to move to the right thus opening the outlet 19*a*'' and venting the compressed air stored in housing 19'' to atmosphere. This also effects a venting of compressed air from the interior of cylinder 33 which establishes a temporary pressure differential on pistons 31, 32 causing them to move towards each other in succession so as to

disengage contacts 3b''' and 2b''' from their respective stationary contacts in that order. The voltage disconnecting switching contacts 5a'' and 5b'' then open. Valve piston 22'' then shifts to the left to re-close the outlet 19a'' whereupon the contact sets 2a''', 2b''' and 3a''', 3b''' re-close as the pressure of the air rebuilds within housing 19'' and interior of cylinder 33.

The series connection of the various switching elements in FIG. 5 can be traced from contact 2a''' to contact 2b''' to piston 31 and cylinder 33 which are made of electrically conductive material to conductive piston 32 to contact 3b''' to contact 3a''' to electrically conductive sleeve 29, to electrically conductive tank 1'' to contact 5b'' to contact 5a''.

I claim:

1. A compressed air actuated switch unit comprising a main tank containing compressed air, first and second hollow insulator columns upstanding upon said main tank, an auxiliary compressed air tank supported atop said first hollow insulator for receiving compressed air from said main tank, a first hollow insulator extending laterally from said auxiliary compressed air tank and containing a pair of compressed air actuated power interrupting switching contacts, a second hollow insulator extending upwardly from said auxiliary compressed air tank and containing a second pair of compressed air actuated power interrupting switching contacts, valve means within said auxiliary compressed air tank for controlling flow of compressed air to said first and second hollow insulators for actuating said first and second pairs of switching contacts, a third hollow insulator mounted on said second insulator column and containing a pair of compressed air actuated voltage disconnecting switching contacts, one of said voltage disconnecting contacts being connected to one of the power interrupting contacts of said second pair of such contacts, said first and second pairs of power interrupting switching contacts being connected in series, a low ohmic resistance connected in parallel with said second pair of power interrupting switching contacts, and a high ohmic resistance connected in parallel with said first pair of power interrupting switching contacts.

2. A compressed air actuated switch unit comprising a main tank containing compressed air, a pair of hollow insulator columns upstanding on said main tank, an auxiliary compressed air tank supported at the top of said insulator columns, the interior of said auxiliary tank being in communication with said main tank through one of said insulator columns, a low ohmic resistance embodied in a first hollow insulator upstanding upon said auxiliary tank, a second hollow insulator upstanding upon said first hollow insulator and containing a first pair of compressed air actuated power interrupting switching contacts paralleled by a high ohmic resistance, a third hollow insulator upstanding upon said auxiliary tank and containing a second pair of compressed air actuated power interrupting switching contacts and which are connected in parallel with said low ohmic resistance, a fourth hollow insulator extending laterally from said auxiliary tank and containing a pair of compressed air actuated voltage disconnecting contacts, all of said pairs of contacts being connected together in series, and compressed air actuated valve means included within said auxiliary tank controlling flow of compressed air into said first, second and third hollow insulators, compressed air to said control valves and to said fourth hollow insulator being delivered thereto from said main tank through the other of said insulator columns.

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