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HIGH VOLTAGE SWITCHING ARRANGEMENT

Filed June 25, 1954

2 Sheets-Sheet 1

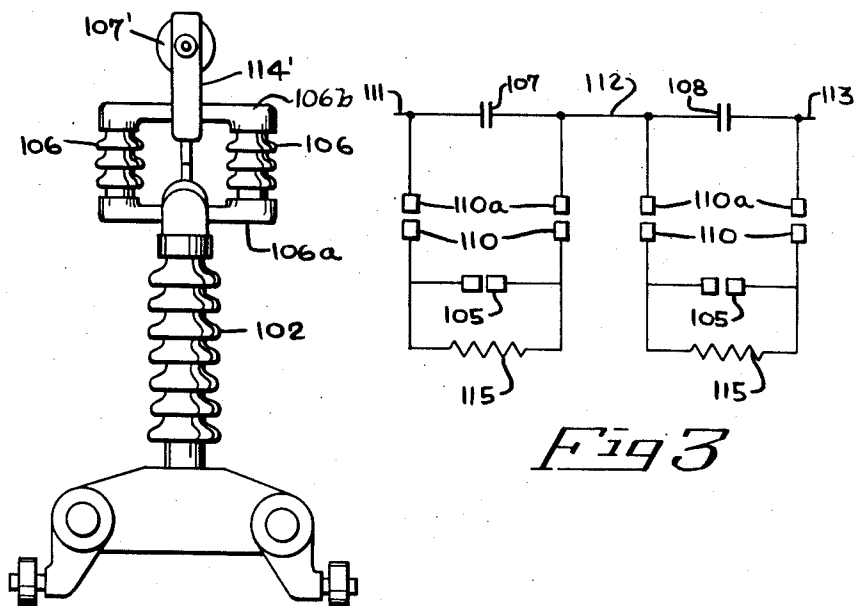
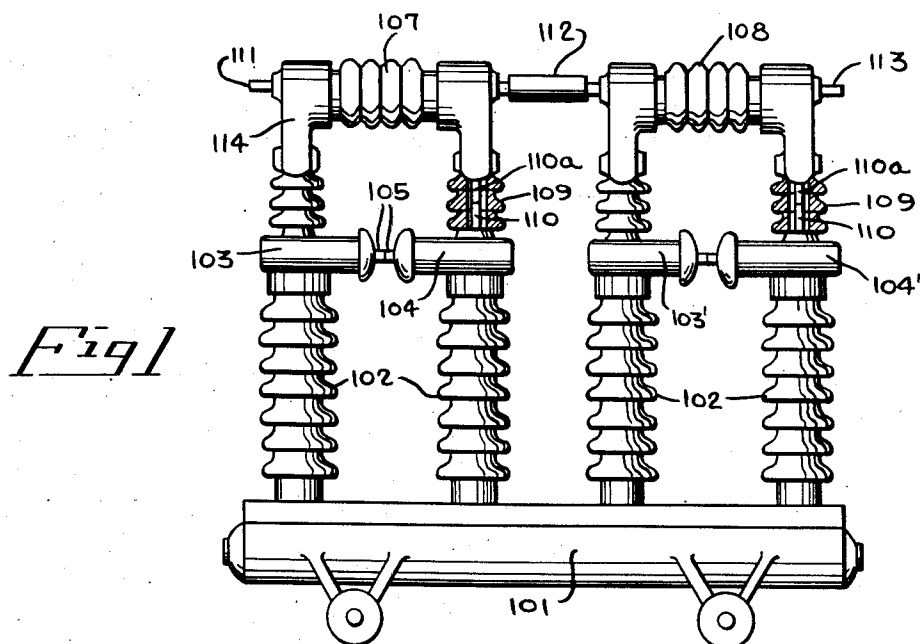


Fig 2

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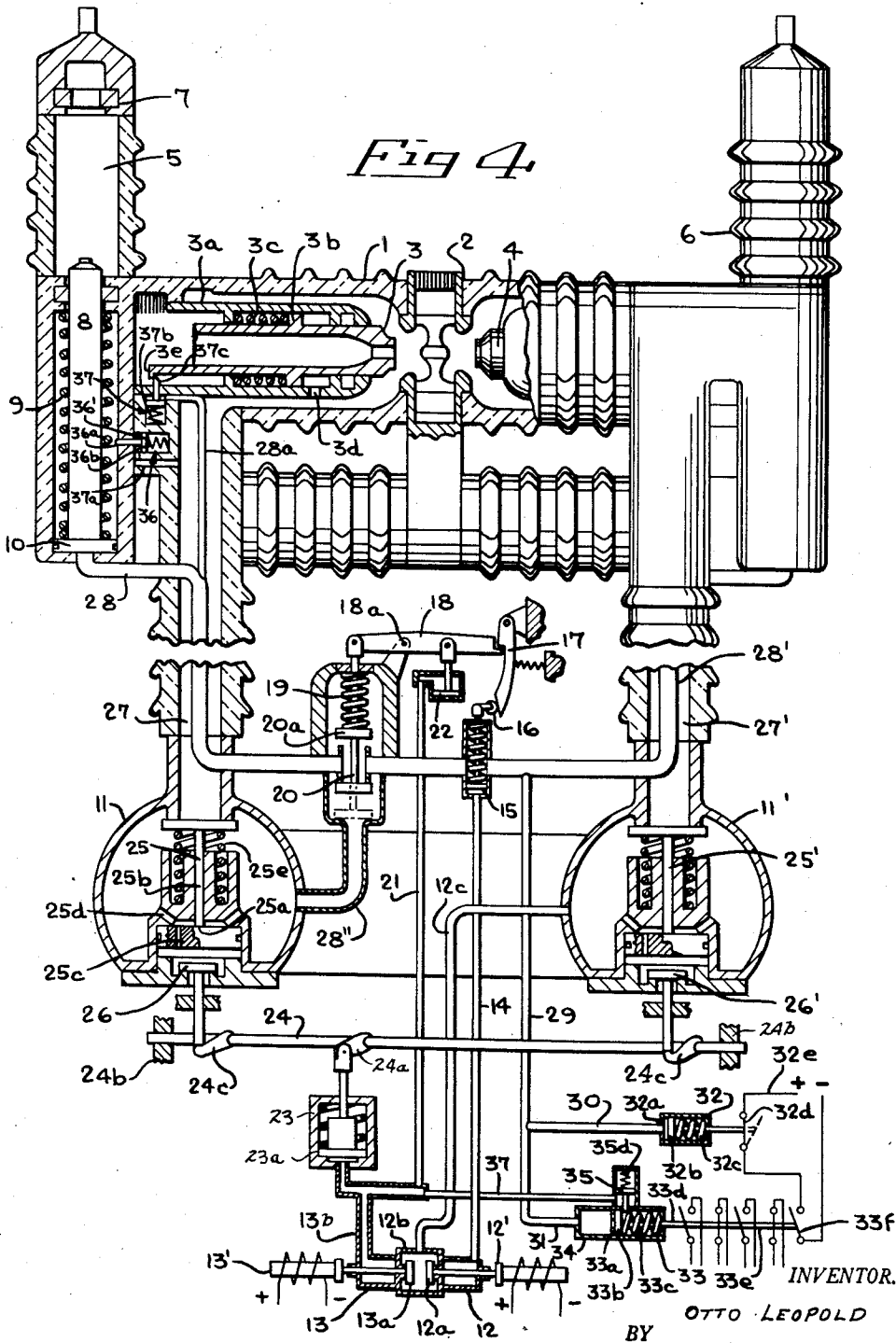
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2 Sheets-Sheet 2



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HIGH VOLTAGE SWITCHING ARRANGEMENT

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Claims priority, application Germany February 11, 1953

18 Claims. (Cl. 200—148)

The present application is a continuation-in-part application of my co-pending application Serial No. 409,634, filed on February 11, 1954, and now abandoned.

The present invention relates to a high voltage switching arrangement, and more particularly to a fluid-pressure operated high voltage switching arrangement.

In the arrangements of the prior art, high voltage switches having multiple power break gaps are provided with an open air switch independently of the current breaking switch. The switching arrangements according to the prior art have the disadvantage that they require comparatively much space for the current breaking switches and the open air switch.

It is one object of the present invention to provide a high voltage switching arrangement which overcomes the disadvantages of the known construction and includes at least one current breaking switch and at least one voltage breaking switch connected in series and being operated by fluid-pressure operating means.

It is another object of the present invention to provide a plurality of groups of voltage breaking switches and current breaking switches combined in a compact space-saving and rigid construction.

It is a further object of the present invention to provide two vertical insulating supports bridged by a horizontal current breaking switch and supporting two vertical voltage breaking switches, which are bridged by a horizontal carrier member supporting a condenser connected in parallel with the voltage breaking switches and the current breaking switch.

It is a still further object of the present invention to provide resilient means permanently tending to maintain the voltage breaking switch or switches in open position, and pressure-fluid operated means for moving the voltage breaking switches to closed position.

It is another object of the present invention to lock the voltage breaking switch or switches in closed position, and to release the same by fluid-pressure operating means.

It is an important object of the present invention to provide a switching arrangement in which the voltage breaking switches can be opened and closed in rapid succession so that they open and close simultaneously with the current breaking switch when the same is operated in rapid succession when a short circuit occurs.

It is yet an object of the present invention to provide a high voltage switching arrangement in which the voltage breaking switches are held in closed position by fluid pressure controlled by a spring-loaded valve which tends to assume an open position.

It is yet another object of the present invention to provide locking means for holding the spring-loaded valve in closed position and to provide control means for releasing such locking means.

It is a further object of the present invention to provide fluid-pressure operated indicating means actuated

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by the fluid pressure in the switching arrangement to indicate the position of the voltage breaking and current breaking switches.

It is also an object of the present invention to provide a fluid operated safety device which actuates the control means of the switching arrangement to open the current breaking switch, when the fluid-pressure operating the voltage breaking switches drops below a predetermined level.

With these objects in view, the present invention mainly consists in a high voltage switching arrangement comprising, in combination, at least one fluid-pressure operable current breaking switch, at least one pressure fluid operable voltage breaking switch arranged in series with the current breaking switch, and fluid-pressure operating means for operating the switches.

Preferably at least one pair of voltage breaking switches are arranged in series with the current breaking switch, and are supported on vertical insulating extensions of upright insulating supports between whose upper ends the current breaking switch extends.

Preferably a plurality of power break gaps are provided in a plurality of current breaking switches, each of the current breaking switches being connected in series to a pair of voltage breaking switches which are connected in series to the next pair of voltage breaking switches.

The present invention also consists in a fluid-pressure operable high voltage switching arrangement, preferably of the "free jet" gas pressure operated type which is provided with at least one or a plurality of independent voltage break gaps advantageously with switch elements which may be locked in the "off" position.

In a multiple arrangement of voltage break gaps of this type, the voltage breaking switches may be arranged extremely close to each other.

In a preferred embodiment of the present invention the voltage breaking switches are arranged in hollow insulating chambers permitting the use of compressed gas whereby the flash-over resistance of the voltage breaking gap is considerably increased. The advantages of an open visible voltage breaking switch may be maintained if the hollow insulator is made of transparent material such as plexigum.

In order to increase the mechanical stability of the arrangement, the two extensions of the insulators housing the voltage breaking switches are preferably bridged by insulators which serve as carriers for impedances, such as condensers which are provided for uniform distribution of the voltage.

According to a preferred embodiment, the present invention consists in a high voltage switching arrangement which comprises, in combination, at least one fluid-pressure operable current breaking switch movable between an open position and a closed position, at least one pressure-fluid operable voltage breaking switch arranged in series with the current breaking switch and being movable between an open position and a closed position, resilient means permanently tending to maintain the voltage breaking switch in the open position, a locking device for locking the voltage breaking switch in the closed position, and fluid pressure operating means for operating the switches and the locking device.

This arrangement has the advantage that if repeated closing of the switching arrangement is desired after short circuits, the voltage breaking switch can follow the switching operation of the current breaking switch, while according to the prior art corresponding switches remain closed during short circuit breaking operations. In known arrangements, shifting of pressure-fluid operated voltage breaking switches to open position causes the

difficulty that the returning piston of the movable voltage breaking contact has to overcome the resistance of a volume of fluid which is still under high pressure so that the movement of the voltage breaking switch into closed position is considerably dampened. The reason therefor is that the cross section of the outlet valve must be so dimensioned that during movement of the switch to closed position in normal operation, a gas volume is available which dampens the return movement of the switch so that a recoil of the movable contact is prevented. During rapid operation of the voltage breaking switch required when a short circuit occurs, the dampening effect is too great in the constructions of the prior art.

In accordance with the present invention the voltage breaking switch is operated by a pressure fluid only for movement to its closed position, but is urged to its open position by resilient spring means. The movable contact of the voltage breaking switch is preferably locked in closed position by suitable locking means which are pressure-fluid operated and are released by pressure-fluid operated releasing means.

The arrangement of the present invention obtains the advantageous result that the movable contact of the voltage breaking switch does not have to overcome the dampening resistance of a fluid volume under high pressure, but only the resistance of uncompressed fluid, such as air under atmospheric pressure, and of course, in addition thereto the resistance of the spring means urging the contact into open position. However, pressure fluid can easily overcome such small resistances so that the voltage breaking switch can be moved into its closed position substantially without any delay.

The locking device is provided for preventing automatic disconnection of the voltage breaking switch. The locking device is either a spring-loaded catch, or may be constituted by the piston of the movable switch contact if the same is according to the present invention constantly under pressure while being in closed position.

Since the voltage breaking switch of the present invention is under pressure while being in closed position, it is possible to provide simple and reliable indicating means by arranging in the pressure conduit of the voltage breaking switch a pressure fluid operated indicating device, which is actuated when the fluid pressure drops below a predetermined level so that it can be ascertained whether the existing fluid pressure is sufficient for the operation of the switching arrangement. In order to prevent in such cases movement of the voltage breaking switch to its open position, preferably additional mechanical locking means are provided on the fixed contact of the voltage breaking switch. In this event, the pressure fluid acting on the piston of the movable contact serves mainly the purpose of actuating the indicating means so that the condition of the voltage breaking switch can be determined.

According to a preferred embodiment of the present invention the high voltage switching arrangement comprises, in combination, at least one fluid-pressure operable current breaking switch movable between a circuit breaking position and a circuit closing position, at least one fluid-pressure operable voltage breaking switch connected in series with the current breaking switch and being movable between an open position and a closed position, resilient means urging the current breaking switch into the circuit closing position, and the voltage breaking switch into the open position, a source of fluid pressure, conduit means connecting the source of fluid pressure with the switches, a first main valve arranged in the conduit means and being associated with the voltage breaking switch, the first main valve tending to assume an open position in which pressure fluid is supplied to the voltage breaking switch for moving and holding the same in the closed position, a second main valve arranged in the conduit means and being associated with the current

breaking switch, the second main valve tending to assume an open position in which pressure fluid is supplied to the current breaking switch for moving the same to the circuit breaking position, first and second locking means for holding the first and second main valves, respectively, in closed positions, control means for selectively releasing the first and second locking means, and means for returning the first and second main valves to the closed positions of the same.

The above described arrangement is preferably provided with a safety device including a fluid-pressure operable member communicating with the conduit means so as to be actuated when the fluid pressure drops below a predetermined level. The safety device is preferably operatively connected to the control means, for instance by electromagnetic relay means, so as to effect movement of the current breaking switch to circuit breaking position when the fluid pressure drops below a predetermined level.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

Fig. 1 is a front elevation illustrating a multiple switching arrangement according to the present invention;

Fig. 2 is a side view of a modified embodiment of the present invention;

Fig. 3 is a diagram illustrating a circuit according to the present invention; and

Fig. 4 is a front view of a modified embodiment of the present invention shown on an enlarged scale, and partly in section.

Referring now to the drawings, and more particularly to Fig. 1, four upright insulating supports 102 are mounted on a movable container 101 for pressure fluid, such as compressed air. The insulating supports 102 carry at their upper end two switch chambers 103, 104 supporting and partly housing the contact arms of the current breaking switches 105. The switch contacts 105 project from the switch chambers 103, 104 in circuit closing position of the current breaking switch, and are retracted into the interior of the switch chambers 103, 104 in the circuit breaking position of the current breaking switch 105. In the embodiment shown in Fig. 4, however, entirely closed switch chambers are provided. The voltage breaking switches comprising a movable contact 110 and a fixed contact 110a are arranged in the interior of hollow vertical extensions 109 of the upright insulators 102. The modified construction shown in Fig. 2 differs from the construction shown in Fig. 1 only by the fact that the voltage breaking switches 110' are not completely enveloped by insulators. In the embodiment of Fig. 2 horizontal members 106a and 106b extend in transverse direction with respect to the current breaking switch 105 and are spaced by vertical insulators 106. In the embodiment of Fig. 1, the members 114 are secured to the extensions 109, and in the embodiment of Fig. 2 the members 114' are supported on the upper transverse member 106b. In the embodiment of Fig. 1, carrier members 107, 108 for impedances, such as condensers, are supported under members 114. Similarly a condenser 107' is supported on the members 114' in the embodiment of Fig. 2. In order to increase the power, the current breaking switches 105 may be shunted by switch resistances 115, see Fig. 3, which are preferably arranged in the insulating members 106. The residual current of the switch resistances 115, 115' is disconnected by the voltage breaking switches 110, 110a after the main arc is extinguished between the contacts 105. The circuit diagram is shown in Fig. 3 from which it will also become apparent that the conductor 112 connects in series two groups of switch-

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es. The current enters at 111, passes through the voltage breaking switches 110, 110a, the current breaking switches 105 and the conductor 112 and leaves at 113.

Referring now to the modified embodiment of the present invention shown in Fig. 4, the current breaking switch comprises two movable fluid-pressure operated contacts 3 and 4 which cooperate with a fixed contact 2. The current breaking switch 3, 4 is arranged in a hollow insulator 1. The contact 3 is slidably mounted in a cylinder means 3a and includes a piston portion 3b which is engaged by a resilient means 3c. The construction of the contact 4 is the same, so that resilient means urge the current breaking switch 3, 4 to move into a circuit closing position. When pressure fluid, such as compressed air, enters the cylinder means 3a through the opening 3b, the switch 3, 4 is urged into its circuit breaking position. Pressure fluid is supplied to the current breaking switch 3, 4 from a source of pressure fluid such as containers 11, 11' which are associated with the contacts 3 and 4, respectively, and communicate with the same through pressure conduit 27, 27' respectively.

Locking means are provided for locking each of the contacts 3 and 4 in the circuit breaking position of the current breaking switch 3, 4. As illustrated for the contact 3, a hooked portion 3e is provided on the rear end of contact 3 and cooperates with a catch 37a which is fixedly connected to a piston 37. The piston 37 is slidably arranged in a cylinder means and can be urged by pressure fluid passing through conduit 28a into a position releasing the contact 3 for movement into circuit closing position under the action of resilient means 3c. A spring 37b urges the catch 37a into locking position and the hooked end 3e of the contact 3 passes over the oblique end face of the catch 37a when pressure fluid passing through opening 3d urges contact 3 into its circuit breaking position, and is then locked by catch 37a.

Two voltage breaking switches are connected in series with the current breaking switch 3, 4 and include fixed contacts 7 mounted in vertical hollow insulating members 5, 6, respectively, and movable contacts 8. The movable contact 8 has a piston portion 10 which is engaged by a resilient means 9 which urges the movable contact 8 away from the fixed contact 7, and consequently urges the voltage breaking switch into an open position. When pressure fluid is supplied through the supply conduits 28, 28', respectively, the respective movable contacts 8 are urged into a circuit closing position against the action of the springs 9. A locking device 36 is provided for locking the voltage breaking contacts in closed position. Each locking device includes a spring 36b urging a piston 36' and a catch 36a into a locking position so that the movable contact 8 of the voltage breaking switch is locked in closed position. A conduit 37a communicates with the pressure conduit 37 and with the cylinder of the locking device so that pressure fluid acting on a piston 36 releases the catch 36a permitting the voltage breaking switch to return to its open position under the action of the resilient means 9.

According to the present invention, the two voltage breaking switches are released to return to open position directly after the arc has been extinguished between the current breaking contacts 3 and 4. After the current breaking switch has been returned to circuit closing position by releasing the locking means 37, the voltage breaking switches are moved to closed positions. The voltage breaking switches are held in closed position by the pressure of the pressure fluid supplied through conduits 28, 28' and acting on the piston portions 10. In addition thereto the locking device 36 holds the associated contact 8 in circuit closing position.

According to the present invention fluid-pressure operating means are provided for actuating the current breaking switch and the voltage breaking switches. As explained above, two containers 11, 11' contain a fluid under pressure such as compressed air and communicate with

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the pressure conduits 27 and 27'. A supply conduit 28, 28', 28'' connects the source of fluid pressure 11 with the cylinder means of the voltage breaking switches. A first main valve 20 is arranged in the supply conduit, and includes a movable valve member 20a which is urged by resilient means 19 into a conduit opening position shown in broken lines. A lever 18 is pivotally supported at 18a and is connected to the valve member 20a. The other end of lever 18 is provided with a recess cooperating with a spring-loaded locking means 17, which in the illustrated conduit closing position of the first main valve 20 locks the lever 18 and thereby the valve member 20a. In this position, the pressure fluid may escape from conduits 28, 28'.

First fluid-pressure operating means 22 composed of a cylinder and piston are connected to the lever 18 for urging the valve member 20a into its conduit opening position against the action of the resilient means 19.

Second fluid-pressure operating means 15 comprising a cylinder and a spring-loaded piston act through a releasing member 16 on the locking means 17 for moving the same into a releasing position releasing lever 18 and thereby valve member 20a.

First control means 13 and second control means 12 are provided for starting the operations which result in movement of the voltage breaking switches and of the current breaking switch between the circuit closing and circuit breaking positions of the same. The control means 12 and 13 include piston valve portions 13a and 12a which are arranged in a cylinder means 12b. A conduit 12c connects the cylinder means 12b with the source of pressure fluid 11'. A conduit 14 connects the second control means 12 with the cylinder of the second fluid-pressure operated means 15, and a conduit 21 connects the first control means 13 with the first fluid-pressure operating means 22. The piston valve portions 12a and 13a control the flow of pressure fluid into the conduits 14 and 21, respectively. The first and second control means are operated by electromagnetic relay means 12' and 13'.

A conduit 13b connects the first control means 13 with the cylinder of a third fluid-pressure operating means 23 whose piston 23a is connected to an arm 24a of a cam shaft 24 which is turnably mounted in stationary supports 24b. Cams 24c of the cam shaft 24 act on relief valves 26, 26' which are associated with second main valves 25, 25' which serve for actuating the current breaking switch 3, 4. Each second main valve 25 includes a movable valve member 25a which has an upper valve portion 25b for closing and opening a pressure conduit 27, and a lower portion 25c on which the fluid pressure acts through openings 25d in the valve body. Since the area of the portion 25c is greater than the area of the valve portion 25b, the second main valve tends to move into a conduit opening position against the action of the spring 25e which urges the valve member 25a into its conduit closing position. However, such opening movement is prevented when the relief valve 26 is closed.

When the relief valve 26 is opened by the action of the third fluid-pressure operating means 23 through cam shaft 24, the pressure on the valve portion 25c opens the second main valve 25 so that pressure fluid passes through conduits 27, and 27', respectively, and simultaneously acts on the locking device 36 and on the current breaking switch 3, 4.

The switching arrangement operates in the following manner:

When the circuit closing second control means 12 is mechanically or electrically operated, which is only necessary for a short time, pressure fluid passes through conduit 14 into the second fluid-pressure operating means 15, which constitutes releasing means for the first main valve 20, and the locking means 17 is pushed into a releasing position releasing the lever 18 so that the first main valve opens and pressure fluid passes through con-

duits 28, 28', 28'' to the voltage breaking switches and moves the movable contacts 8 into a closing position in which the locking device 36 locks the contact 8 due to the action of the spring 36b. The pressure in the conduits 28, 28' is maintained although the control means 12 returns to its initial position.

At the same time the pressure fluid passing through conduit 28a releases the locking means 37 so that the contacts 3, 4 of the current breaking switch are returned to circuit closing position by the springs 3c.

When the "circuit opening" first control means 13 are operated, which is only necessary for a short time, pressure fluid passes through conduit 13b into conduit 21 so that the first fluid-pressure operating means 22 return the lever 18 to its initial position in which it is locked by the locking member 17 while the first main valve 20 assumes its conduit closing position in which pressure fluid escapes from conduits 28, 28'.

Shortly before that operation, the third fluid-pressure operating means 23 opens the relief valves 26, 26' so that the valves 25, 25' move to their conduit opening positions and the pressure fluid passes through the conduits 27, 27'. The pressure fluid passes through the openings 3d and urges the contacts 3 and 4 of the current breaking switch into a circuit breaking position in which they are locked by the locking devices 37. At the same time the arc is extinguished by pressure fluid passing between the contacts 3 and 4 and through the openings at the front ends of the same.

Pressure fluid also passes through the conduits 37a so that the locking means 36 are released, and the voltage breaking contacts move to their open positions due to the action of the springs 9.

The switching apparatus according to the present invention is preferably provided with a safety device and with indicating means.

An auxiliary conduit 29 communicates with the supply conduit 28' and branches into two conduits 30 and 31. A safety device 32 including a cylinder 32a, a piston 32b and a spring 32c communicates with the conduit 30. A switch 32d located in a circuit 32e is operated by the piston 32b.

An indicating device 33 including a cylinder 33a, a piston 33b, a spring 33c and a switch member 33d is supplied with pressure fluid from the conduit 31. The switch 33d operates a plurality of indicating switches 33e for indicating the position of the voltage and circuit breaking switches. The piston 33b can be locked by a spring-loaded fluid operated locking means 35 which is urged into a locking position by the spring 35a, and may be relieved by pressure fluid passing through conduit 37, which communicates with conduit 13a.

When the voltage breaking switches and the current breaking switch are closed by operating the "on" control means 12, the supply conduit 28' is under pressure so that pressure fluid passes through conduit 29 and conduit 31 into the delay chamber 34 of the indicating device 33 so that the indicating switches 33e indicate the closed position of the switching arrangement. The locking means 35 locks the indicating device in indicating position. At the same time the fluid pressure in conduit 30 actuates the safety device 32 so that the switch 32d is opened.

When the "off" control means 13 is operated, the first main valve 20 is closed so that pressure fluid escapes from the conduits 28, 28' as described above. Consequently the conduit 30 and 31 are relieved of pressure, and the safety device 32 returns to its initial position due to the action of the spring 32c, closing the contact 32d. The operation of the control means 13 causes pressure fluid to enter the conduit 13b, and consequently the conduit 37 so that the locking means 35 is released, and the switching member 33e returns to its initial position due to the action of the spring 32c. The switch 33f in the circuit 32e is simultaneously opened.

The arrangement is such that the operation of the indi-

cating device 32 is delayed with respect to the operation of the safety device 32.

In the event that the fluid pressure drops in the conduits 28 to 31 below a predetermined value, for instance if a line breaks, the safety device 32 is urged by the spring 32c into a position in which the switch 32d is closed. The circuit 32e is connected to the electromagnetic relay means 13' of the "off" control means 13 so that closing of the switch 32e effects operation of the piston valve member 13a and the current breaking switch 3, 4 is moved to its circuit breaking position. The action of the indicating device 33 is delayed so that the switch 33f is still closed when the electromagnetic relay means 13' is energized by closing of the switch 33d.

In the event that the switching arrangement is switched off during normal operation, the fluid pressure in the conduit 31 drops, and the "off" position is indicated since the spring 33c urges the switching member 33d to the left. At the same time the circuit 32e is interrupted at 33f so that the electromagnetic relay 13' is not energized although contact 32d is closed.

In arrangements including a main switch and an additional switch it is sometimes desirable to maintain the voltage breaking switch of a branch line in circuit closing position although no pressure acts thereon. In this event the movable contact 3 of the voltage breaking switch is provided with a locking means which can only be opened by fluid pressure produced during the disconnecting operation. In this arrangement, the indicating device 33 is provided with a locking means which is operated by the fluid pressure produced during the circuit breaking operation.

The switching arrangement according to the embodiment illustrated in Fig. 4, has the considerable advantage that the control means 12 and 13 are only actuated for a short time to start the switching operations. After the operation has been started, the control means 12 and 13 return to their initial position and are ready for the next operator while the switching operations are automatically completed. This construction permits a very rapid succession of circuit breaking operations and it is consequently very suitable for short circuit operations.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of high voltage switching arrangements differing from the types described above.

While the invention has been illustrated and described as embodied in a high voltage switching arrangement including fluid-pressure operated voltage breaking switches arranged in series with a fluid-pressure operated current breaking switch and urged by resilient means to move to an open position, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. A high voltage switching arrangement comprising, in combination, a pair of spaced upright insulating supports; at least one fluid-pressure operable current breaking switch supported in horizontal position on said insulating supports; at least one pair of vertical pressure-fluid operable voltage breaking switches arranged in series with said current breaking switch, each of said voltage breaking switches being supported on one of said supports and projecting upwardly from the same so that

said current breaking switch is arranged intermediate said voltage breaking switches; and fluid-pressure operating means for operating said switches.

2. A high voltage switching arrangement comprising, in combination, a pair of spaced upright insulated supports; at least one fluid-pressure operable current breaking switch supported in horizontal position on said insulated supports; a first horizontal member supported on each of said insulating supports and extending transverse to said current breaking switch; two vertical insulators supported at the ends of each of said first horizontal members; two second transverse horizontal members bridging the upper ends of said vertical insulators; a pair of vertical voltage breaking switches connected in series with said current breaking switch, each voltage breaking switch extending between one first and one second horizontal member; and hollow insulating extensions of said upright supports enveloping said voltage breaking switches.

3. A switching arrangement as claimed in claim 2 and including horizontal carrier means extending between said extensions and adapted to support an impedance connected in parallel with said pair of voltage breaking switches and said current breaking switch.

4. A switching arrangement as claimed in claim 2 and including a condenser means extending between said extensions and being supported by the same, said condenser being connected in parallel with said pair of voltage breaking switches and with said current breaking switch.

5. A switching arrangement as claimed in claim 2 wherein said insulating supports and said extensions are formed with conduits communicating with said fluid-pressure operating means and with the interior of said hollow extensions so that said voltage breaking switches are surrounded by pressure fluid.

6. A high voltage switching arrangement comprising, in combination, a pair of spaced upright insulating supports; at least one fluid-pressure operable current breaking switch supported in horizontal position on said insulating supports; at least one pair of vertical pressure-fluid operable voltage breaking switches arranged in series with said current breaking switch, each of said voltage breaking switches being supported on one of said supports and projecting upwardly from the same so that said current breaking switch is arranged intermediate said voltage breaking switches; fluid-pressure operating means for operating said switches; locking means for locking said current breaking switch in a circuit breaking position; fluid-pressure operated releasing means for releasing said locking means; a pair of hollow vertical extensions of said insulating supports projecting upwardly from the same on both sides of said current breaking switch and enveloping said voltage breaking switches; and impedance means extending between said extensions and being supported by the same, said impedance means being connected in parallel with said pair of voltage breaking switches and with said current breaking switch.

7. A high voltage switching arrangement comprising, in combination, at least one fluid-pressure operable current breaking switch movable between an open position and a closed position; at least one pressure-fluid operable voltage breaking switch arranged in series with said current breaking switch and being movable between an open position and a closed position; resilient means permanently tending to maintain said voltage breaking switch in said open position; other resilient means permanently tending to maintain said current breaking switch in closed position; a first spring-loaded locking device for locking said voltage breaking switch in said closed position; a second spring-loaded locking device for locking said current breaking switch in said open position; fluid-pressure operating means for operating

said switches, said fluid-pressure operating means selectively urging said voltage breaking switch into said closed position and releasing said second locking device so that said current breaking switch moves to said closed position, or releasing said first locking device so that said voltage breaking switch moves to said open position and moving said current breaking switch to said open position.

8. A switching arrangement as claimed in claim 7 wherein said fluid-pressure operating means first moves said current breaking switch to said open position, and then releases said first locking device so that said voltage breaking switch moves to said open position after said current breaking switch has arrived in said open position of the same.

9. A high voltage switching arrangement comprising, in combination, at least one fluid-pressure operable current breaking switch movable between a circuit breaking position and a circuit opening position; at least one fluid-pressure operable voltage breaking switch arranged in series with said current breaking switch and being movable between an open position and a closed position; resilient means permanently tending to maintain said voltage breaking switch in said open position; a source of pressure fluid; supply conduit means including a supply conduit connecting said source of pressure fluid with said voltage breaking switch; and a main valve arranged in said supply conduit and including a valve member movable between a conduit opening position and a conduit closing position, said main valve including resilient means urging said valve member into said conduit opening position; and operating means for moving said valve member into said conduit closing position.

10. A high voltage switching arrangement comprising, in combination, at least one fluid-pressure operable current breaking switch movable between a circuit breaking position and a circuit opening position; at least one fluid-pressure operable voltage breaking switch arranged in series with said current breaking switch and being movable between an open position and a closed position; resilient means permanently tending to maintain said voltage breaking switch in said open position; a source of pressure fluid; supply conduit means including a supply conduit connecting said source of pressure fluid with said voltage breaking switch; and a main valve arranged in said supply conduit and including a valve member movable between a conduit opening position and a conduit closing position, said main valve including resilient means urging said valve member into said conduit opening position; first fluid-pressure operating means for moving said valve member into said conduit closing position; a spring-loaded locking member tending to engage and lock said valve member in said conduit closing position; and second fluid-pressure operating means for moving said spring-loaded locking member into a position releasing said valve member so that the same moves to said conduit opening position due to the action of said resilient means when said second fluid-pressure operating means are actuated.

11. A high voltage switching arrangement comprising, in combination, at least one fluid-pressure operable current breaking switch movable between a circuit breaking position and a circuit opening position; at least one fluid-pressure operable voltage breaking switch arranged in series with said current breaking switch and being movable between an open position and a closed position; resilient means permanently tending to maintain said voltage breaking switch in said open position; a source of pressure fluid; supply conduit means including a supply conduit connecting said source of pressure fluid with said voltage breaking switch; a first main valve associated with said voltage breaking switch and being arranged in said supply conduit, said first main valve including a movable valve member movable between a conduit opening position and a conduit closing position, and re-

resilient means urging said movable valve member into said conduit opening position; a pressure conduit means including a pressure conduit connecting said source of pressure fluid with said current breaking switch; a second main valve arranged in said pressure conduit and including a valve member movable between a conduit opening position and a conduit closing position, and resilient means urging said movable valve member into said conduit closing position, said second main valve being adapted to be urged by the fluid pressure of pressure fluid in said pressure conduit into said conduit opening position; a relief valve associated with said second main valve and being movable between an open position and a closed position, said relief valve in open position relieving said movable valve member of said second main valve so that the same moves under the action of the pressure fluid into said conduit opening position; first fluid-pressure operating means for moving said valve member of said first main valve into said conduit closing position; a spring-loaded locking member tending to engage and lock said movable valve member of said first main valve in said conduit closing position; second fluid-pressure operating means for moving said spring-loaded locking member into a releasing position releasing said valve member of said first main valve for movement to said conduit opening position; third fluid-pressure operating means connected to said relief valve for moving the same to said open position; first control means for actuating said first and third fluid-pressure operating means whereby said first main valve moves to said conduit closing position so that said voltage breaking switch moves to said open position, and whereby said second main valve moves to said conduit opening position and said current breaking switch moves to said circuit breaking position; and second control means for actuating said second fluid operating means whereby said spring-loaded locking member releases said movable valve member of said first main valve so that said voltage breaking switch moves to said closed position while said second main valve closes said pressure conduit so that said current breaking switch moves to said circuit closing position thereof.

12. A switching arrangement as claimed in claim 11 wherein said current breaking switch includes two movable contacts, and comprising two second main valves, each second main valve being associated with one of said contacts; two pressure conduit means; two relief valves; and cam shaft means including cam means engaging said two relief valves; and means connecting said cam shaft with said third fluid-pressure operating means for simultaneous actuation of the said two relief valves.

13. A high voltage switching arrangement comprising, in combination, at least one fluid-pressure operable current breaking switch movable between a circuit breaking position and a circuit closing position; a pair of fluid-pressure operable voltage breaking switches connected to the ends of the current breaking switch and being movable between open and closed positions; resilient means urging said current breaking switch into said circuit closing position, and said voltage breaking switches into said open position; a source of fluid pressure; conduit means connecting said source of fluid pressure with said switches, the arrangement being such that pressure fluid passing through said conduit means urges said voltage breaking switches into said closed positions, and said current breaking switch into said circuit breaking position; control valve means associated with said conduit means for controlling flow of pressure fluid therethrough; and a safety device including a fluid-pressure operated member communicating with said conduit means so as to be actuated when the fluid pressure in the same drops below a predetermined level, said safety device being operatively connected to said control valve means so as to effect movement of said current breaking switch to said circuit breaking position when the fluid pressure in said conduit means drops.

14. A switching arrangement as claimed in claim 13 and including electromagnetic relay means for operating said control valve means; a circuit including a safety switch operated by said safety device, and being connected to said electromagnetic relay means, the arrangement being such that said safety switch is closed when the fluid-pressure in said conduit means drops whereby said electromagnetic relay means is energized for moving said control valve means into a position effecting movement of said current breaking switch to said circuit breaking position.

15. A high voltage switching arrangement comprising, in combination, at least one fluid-pressure operable current breaking switch movable between a circuit breaking position and a circuit closing position; a pair of fluid-pressure operable voltage breaking switches connected to the ends of the current breaking switch and being movable between open and closed positions; resilient means urging said current breaking switch into said circuit closing position, and said voltage breaking switches into said open position; a source of fluid pressure; conduit means connecting said source of fluid pressure with said switches, the arrangement being such that pressure fluid passing through said conduit means urges said voltage breaking switches into said closed positions, and said current breaking switch into said circuit breaking position; and control valve means associated with said conduit means for controlling flow of pressure fluid therethrough.

16. A high voltage switching arrangement comprising, in combination, at least one fluid-pressure operable current breaking switch movable between a circuit breaking position and a circuit closing position; a pair of fluid-pressure operable voltage breaking switches connected to the ends of the current breaking switch and being movable between open and closed positions; resilient means urging said current breaking switch into said circuit closing position, and said voltage breaking switches into said open position; a source of fluid pressure; conduit means connecting said source of fluid pressure with said switches, the arrangement being such that pressure fluid passing through said conduit means urges said voltage breaking switches into said closed positions, and said current breaking switch into said circuit breaking position; locking means for locking said switches in said last-mentioned positions; fluid-pressure operated releasing means for said locking means; and control valve means associated with said conduit means for controlling flow of pressure fluid therethrough.

17. A high voltage switching arrangement comprising, in combination, at least one fluid-pressure operable current breaking switch movable between a circuit breaking position and a circuit closing position; at least one fluid-pressure operable voltage breaking switch connected in series with said current breaking switch and being movable between an open position and a closed position; resilient means urging said current breaking switch into said circuit closing position, and said voltage breaking switch into said open position; a source of fluid pressure; conduit means connecting said source of fluid pressure with said switches; a first main valve arranged in said conduit means and being associated with said voltage breaking switch, said first main valve tending to assume an open position in which pressure fluid is supplied to said voltage breaking switch for moving and holding the same in said closed position; a second main valve arranged in said conduit means and being associated with said current breaking switch, said second main valve tending to assume an open position in which pressure fluid is supplied to said current breaking switch for moving the same to said circuit breaking position; first and second locking means for holding said first and second main valves, respectively, in closed positions; control means for selectively releasing said first and second locking

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means; and means for returning said first and second main valves to said closed positions of the same.

18. A high voltage switching arrangement comprising, in combination, at least two pairs of spaced upright insulating supports; at least one fluid-pressure operable current breaking switch supported in horizontal position respectively between each pair of insulating supports; a plurality of vertical fluid-pressure operable voltage breaking switches, at least two of said voltage breaking switches being connected in series with one of said current breaking switches, respectively, each of said voltage breaking switches being supported on one of said supports respectively and projecting outwardly from the same so

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that said current breaking switch is arranged intermediate the two voltage breaking switches connected in series therewith; and fluid-pressure operating means for operating said switches.

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