Jan. 13, 1953 F. Y. GREPE 2,625,627

HIGH-VOLTAGE CONTACTOR SYSTEM

Filed March 19, 1947 4 Sheets-Sheet 1

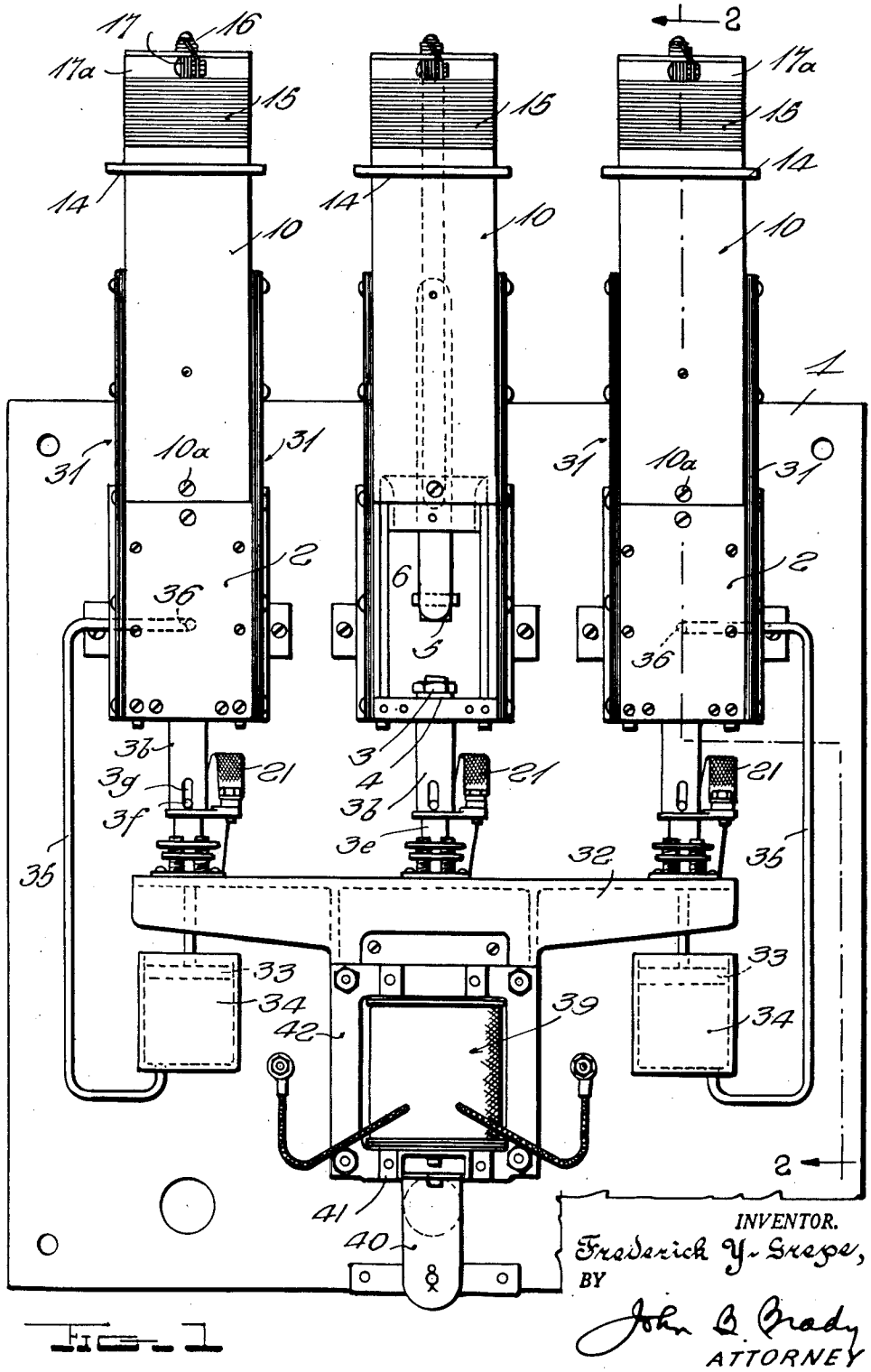

FIG. 1

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Filed March 19, 1947 4 Sheets-Sheet 2

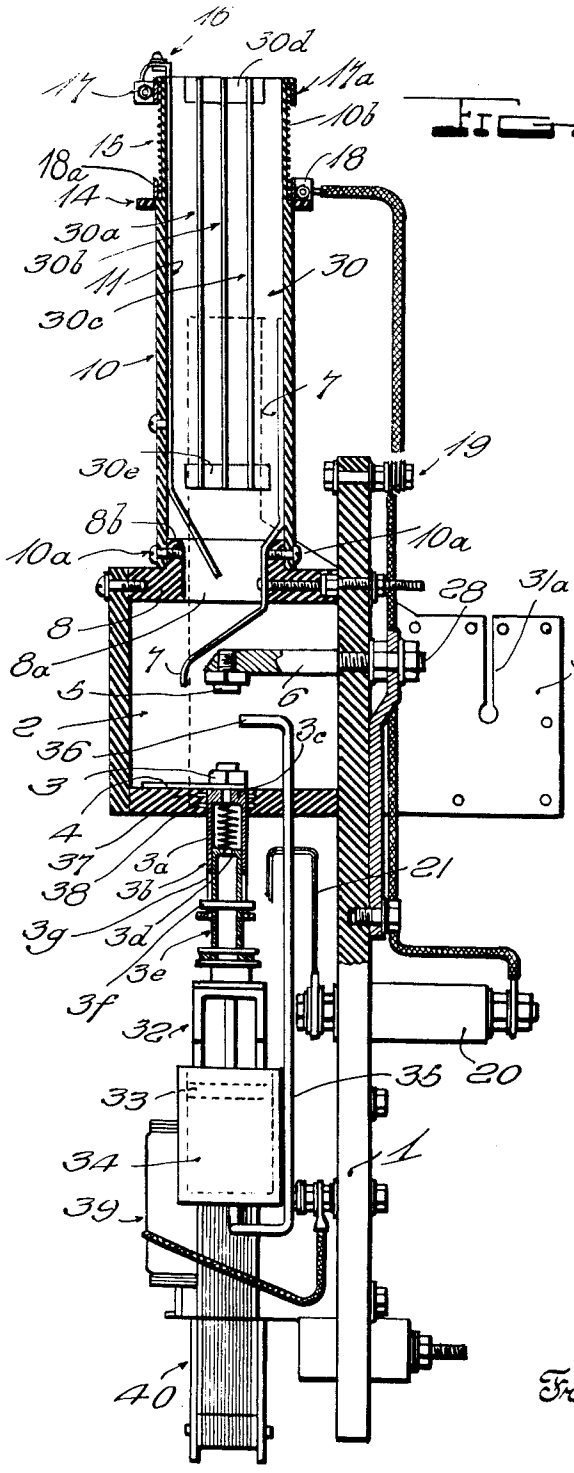

FIG. 2

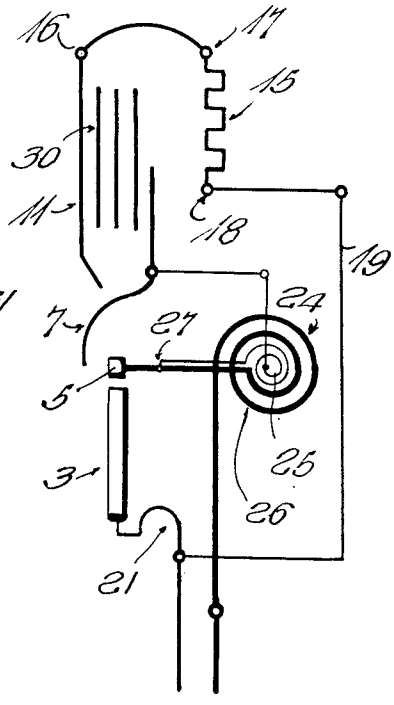

FIG. 5

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HIGH-VOLTAGE CONTACTOR SYSTEM

Filed March 19, 1947 4 Sheets-Sheet 3

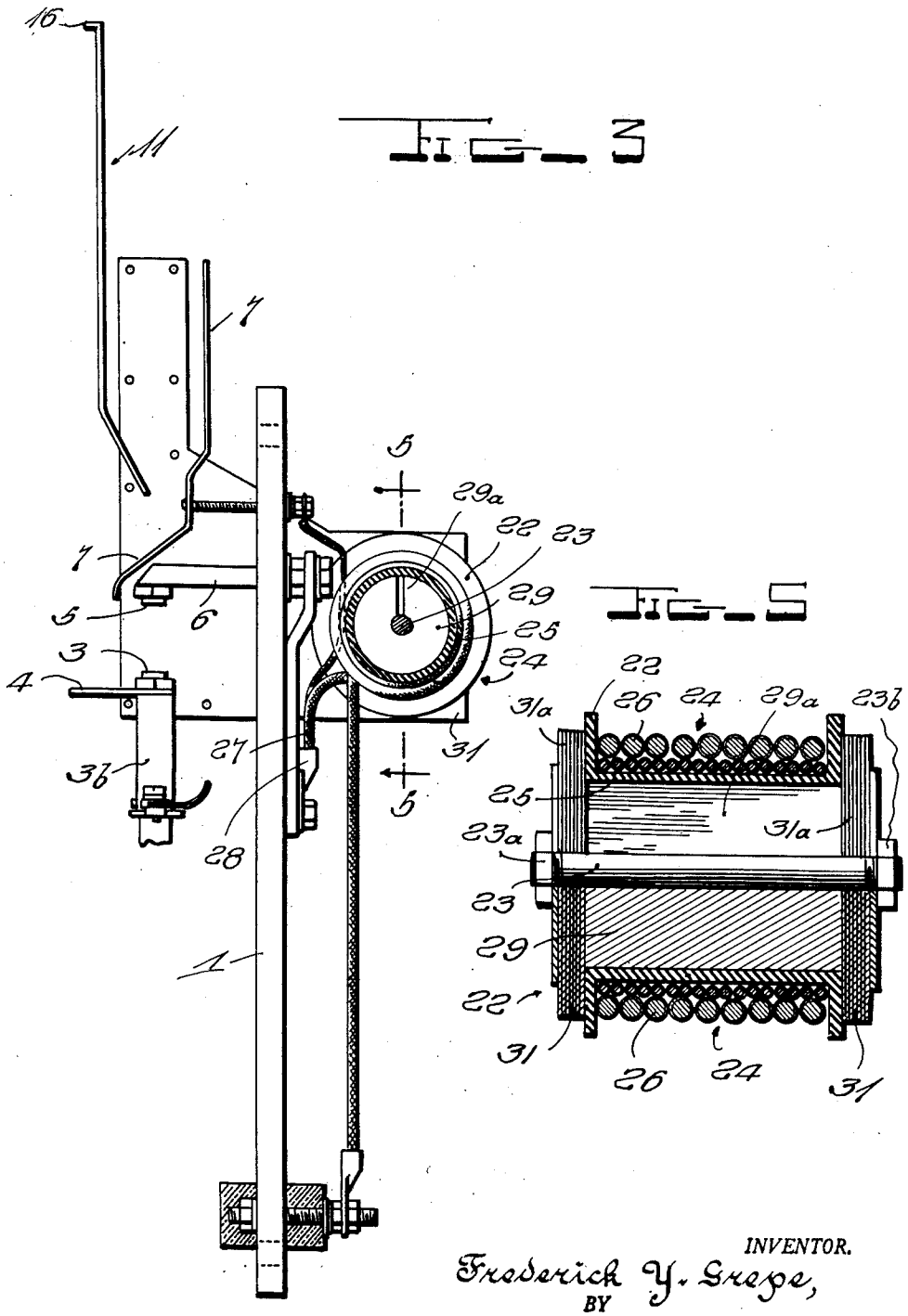

FIG. 3

FIG. 5

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HIGH-VOLTAGE CONTACTOR SYSTEM

Filed March 19, 1947 4 Sheets-Sheet 4

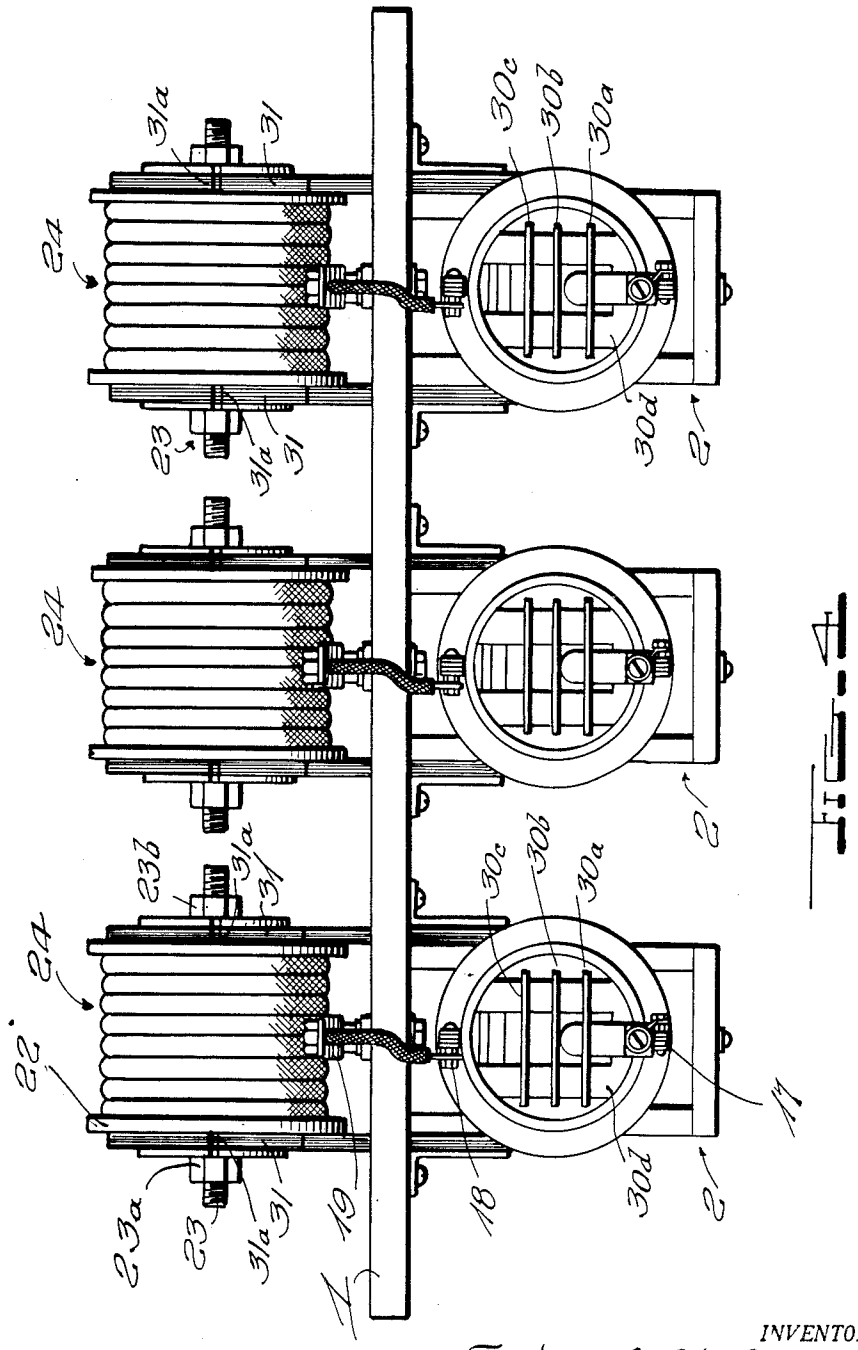

FIG. 4

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UNITED STATES PATENT OFFICE

2,625,627

HIGH-VOLTAGE CONTACTOR SYSTEM

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Application March 19, 1947, Serial No. 735,634
In Canada February 27, 1947

15 Claims. (Cl. 200—147)

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My invention relates broadly to high voltage contactors and more particularly to a construction of high voltage contactor having means for magnetically blowing out arcs at the contacts.

One of the objects of my invention is to provide a construction of high voltage contactor having means associated with the contactor for utilizing the gases formed at the contacts in assisting in the extinguishing of the arc.

Another object of my invention is to provide a construction of high voltage contactor system including an effective arrangement of arc runners associated with the contacts for assisting in the extinguishing of the arc and the splitting of the arc into a multiplicity of parts for subsequent dissipation.

Still another object of my invention is to provide an improved method and construction of apparatus for effectively damping the arc formed at high voltage contactors.

Another object of my invention is to provide an improved construction of magnetic circuit for facilitating the blowing out of arcs formed at high voltage contacts and displacing the arc through an arc splitter.

A further object of my invention is to provide an arrangement of stack or chimney associated with high voltage contacts with runners extending upwardly through the stack or chimney from the contacts for removing the arc from the contacts and rapidly dissipating the arc through the stack or chimney.

Still another object of my invention is to provide a high voltage contactor system in which the opening of the contacts is automatically accompanied by the release of a jet of compressed gas directed transversely to the formed arc which assists in removing the arc from the contacts for dissipation through associated arc runners.

Still another object of my invention is to provide a construction of chimney or stack associated with the magnetic blowout system adjacent high voltage contacts where the chimney or stack provides a support for the resistive element of a damping circuit which becomes effective as the arc moves towards the top of the stack or chimney.

Other and further objects of my invention reside in the improved construction of arc splitter, magnetic blowout system and associated runners in a stack or chimney as set forth more fully in the specification hereinafter following by reference to the accompanying drawings in which:

Figure 1 is a front elevational view of the improved high voltage contactor of my invention;

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Fig. 2 is a vertical sectional view taken substantially on line 2—2 of Fig. 1, with certain of the parts illustrated in side elevation; Fig. 3 is a vertical view through the magnetic blowout system, illustrating in side elevation the relative arrangement of contacts, arc runners, and the magnetic pole pieces of the magnetic blowout system; Fig. 4 is a top plan view of the magnetic blowout system of my invention; Fig. 5 is a vertical sectional view of the magnetic blowout control winding taken substantially on line 5—5 of Fig. 3; and, Fig. 6 is a schematic and diagrammatic circuit outlay illustrating the principles of the arc dissipating system of my invention.

Referring to the drawings in detail reference character 1 designates a main panel of insulation material arranged to support the high voltage contactors, the operator for the high voltage contactors and the associated magnetic blowout system. An arc chamber 2 formed from insulation material is supported by the rear face of the main panel 1. The arc chamber 2 is apertured at the bottom thereof for the passage of a vertically movable contactor 3 which operates from a vertically movable actuator controlled from the magnetic operator 39 supported from the rear of the panel 1 as will be hereinafter described in more detail.

The vertically movable contact 3 has associated therewith the transversely extending lower arcing tip or runner 4 which extends toward the front wall of the arc chamber 2. A stationary contact 5 is supported with respect to the rear of panel 1 on a standard 6 in alignment with the movable contact 3. Terminating adjacent the stationary contact 5, but disposed in spacial relation thereto, I provide a rear arc runner 7 which extends vertically through the annular opening 8a in the insulated top section 8 of the arc chamber 2 and substantially half way up the insulated stack or chimney formed from cylindrical or tubular insulating material shown at 10. The stack or chimney 10 is secured to the upwardly extending annular portion 8b of the top section 8 by suitable means such as screws 10a.

The stack or chimney 10 extends vertically from the arc chamber 2 for a substantial distance above the arc chamber 2 and supports on the inner wall thereof in a position diametrically opposite the position of the rear arc runner 7, a front arc runner 11. The front arc runner 11 extends interiorly of the entire height of the stack 10 and terminates at its upper end in a terminal 16. The tubular stack 10 serves as a housing for a vertically extending arc splitter

30. The arc splitter 30 comprises a multiplicity of spacially related parallel electrically conductive plates 30a, 30b and 30c disposed in the stack or chimney 10 intermediate the rear arc runner 7 and the front arc runner 11. The electrically conductive plates 30a, 30b and 30c are electrically insulated from each other by insulators 30d and 30e located adjacent opposite ends of the plates so that the plates serve as spaced electrodes capable of splitting or dividing the arc.

The exterior of the stack or chimney 10 carries adjacent the upper end thereof a flange or ring member 14 formed from insulation material which is forced and cemented upon the outside of the stack or chimney 10. This flange 14 serves as a support for the commencement of the winding 15 consisting of high resistance wire such as Nichrome wire which connects at its lower end to a terminal 18 carried by a band 18a which encircles the winding of resistance wire 15. The upper end of the winding of resistance wire 15 is connected to a terminal 17 carried by band 17a which encircles the upper end of the winding 15. In order to accommodate the winding 15 of the stack or chimney 10 is suitably grooved at 10b which allows the high resistance wire to be retained on the exterior thereof and provides a sufficient shoulder at each end to form abutment means for the bands 17a and 18a for thereby insuring a sturdy permanent construction. The terminal 16 of the front arc runner 11 connects to the terminal 17 of the high resistance winding 15. Terminal 18 at the lower end of the high resistance winding 15 connects to the terminal 19 supported by the insulated panel 1. Terminal 19 connects through an insulated conductor with the terminal 20 carried by insulated panel 1. Terminal 20 extends through panel 1 and provides a connection for flexible lead 21 which connects to the vertically movable contact 3.

The magnetic blowout system includes a spool of insulation material which I have designated generally at 22 which supports the multiple winding 24 of the magnetic blowout system. The insulated spool 22 includes the magnetic core 29 which is secured by means of bolt 23 between the laminated pole pieces 31 forming the magnetic blowout cheeks or ears. The securing bolt 23 is supported at opposite ends in the laminated pole pieces by means of nut members 23a and 23b which engage the bolts and fasten the spool 22 in position between the magnetic pole pieces 31. The magnetic core 29 is slotted at 29a and the pole pieces 31 are slotted at 31a for reducing eddy current losses in the magnetic system.

The multiple winding 24 consists of two series connected windings 25 and 26, the two windings being connected intermediate the terminals thereof at 27 and connected to terminal 28 which connects to the stationary contact 5. The first winding 26 on the blowout is of a heavy gauge wire of a few turns to be consistent with the load which the breaker will carry and to keep normal temperatures. Winding 26 has a relatively small number of ampere turns. The second winding 25 on the blowout system consists of as many turns as desired and of a smaller size wire to create a strong field for the moment of interruption. Winding 25 has a relatively large number of ampere turns. As the second winding is not in series with the load itself a light wire can be used and a proportionately larger number of turns in keeping with space and cost. The blowout windings 25 and 26 are connected in a manner that the heavy winding 26 of a few turns remains in series with the load when breaker is in the closed position and the second winding 25, through the medium of the arc as a connecting link, energizes the second winding 25 for the period when the breaker opens so that the windings 25 and 26 of the blowout system 24 are in series with each other during the period when the breaker opens, and so create a strong field when it is most needed.

The movable contacts 3 are each supported by an insulated bridge 32. The individual movable contacts 3 are resiliently supported with respect to the bridge 32 by means of coil springs 3a disposed within the sleeve 3b which supports the contact 3 and between the end of the internal socket 3c in sleeve 3b and the head 3d of the member 3e, which is mounted on the bridge arm 32. The relative movement of the sleeve 3b with respect to the member 3e is limited by pin 3f carried by member 3e projecting through slots 3g in sleeve member 3b. The flexible connection 21 connects to the sleeve member 3b as shown for carrying the high voltage to the contact 3. The lower arcing tip or runner 4 moves up and down with the contact 3.

The arm 32 has connected therewith two or more air pistons 33 which operate in air cylinders 34 which are connected through air blast tubes 35 with nozzles 36 directed at the gap between contacts 3 and 5 for delivering a blast of air between the contacts 3 and 5 as they separate. This action is automatic due to the drop gravity action of the bridge 32. A puff of air is delivered precisely at the junction of contacts 3 and 5 where the arc is initiated tending to displace the arc to the runners 4 and 7.

The operator which operates the bridge 32 is represented schematically in the form of a solenoid winding 39 operating armature 40 with respect to the pole pieces 41 of the magnetic core structure 42 with which the solenoid winding 39 is associated.

The operation of the control system is rapid for upon energization of solenoid winding 39 armature 40 is attracted by magnetic pole pieces 41 of the magnetic system 42 and air pistons 33 move upwardly in air cylinders 34 without appreciable drag or inertia as air is free to move backwardly through nozzles 36 and pipes 35 to the air cylinders 34 thereby preventing the setting up of a vacuum. Nevertheless a strong puff of air is delivered at the contacts when the bridge 32 gravitates upon deenergization of solenoid winding 39.

The stack or chimney constituted by tubular member 10 connected with the top of the arc chamber 2 serves as an expansion chamber for the gases rising from the arc chamber 2.

I also provide expansion chambers 37 and 38 in the form of annular recesses provided in arc chamber 2 at the position of entry of sleeve member 3b into arc chamber 2 so that movable contact 3 is free to move vertically while gases may expand into the annular expansion chambers 37 and 38.

The magnetic blowout system which includes the laminated magnetic pole pieces, cheeks or ears 31 is shaped to extend a substantial distance upwardly on diametrically opposite sides of the stack or chimney 10 for maintaining magnetic flux for directing the arc upwardly through the arc splitter 30 and facilitating the blowing out of the arc. The arc is drawn between contacts 3 and 5 as contact 3 retracts. The field produced by heavy gauge winding 26 lifts the arc from

contact 5 to runner 7 and from contact 3 to runner 4 assisted by the puff of compressed air from nozzle 36. The arc then persists between runners 4 and 7. The arc having reached runner 7 immediately switches in the multi-turn fine wire winding 25 of the blowout system in series so producing an intense concentration of flux. This causes the arc to advance very rapidly on up runner 7 and eventually spills over across to runner 11. This then produces two arcs, one between runners 4 and 7, the main arc, and another smaller arc between runners 7 and 11. The two arcs are effectively in parallel.

The smaller arc acts as a discharge resistor across the main arc and so damps out the high peak voltages which appear across the contacts. The main arc will also build up a pressure in the arcing chamber 2 which will tend to blast the arc up the chimney-like tube 10. At an appropriate moment the main arc is extinguished leaving the small arc to be blown vertically upwardly through the tube through the arc splitter 30, and eventually extinguished.

The current in the small arc is kept down to a predetermined value by virtue of the resistor 15 in series. Resistor 15 and the arc which is itself a resistor constitutes a damper across the main arc.

I have shown the high voltage contactor system of my invention applied to a polyphase system in which contacts are interposed in each phase of a three-phase system. It will be understood that the number of contactor units in the system may be varied without departing from my invention. Moreover, I realize that changes may be made in the details of construction of the contact system and associated arc chamber, the stack connected therewith and the arc splitter arranged in the stack, and while I have described my invention in one of its preferred embodiments I desire that it be understood and modifications may be made and that I intend no limitations upon my inventon except as may be imposed by the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. In a high voltage contactor system, a set of relatively movable circuit closing and opening contacts, a walled arc pressure chamber enclosing said contacts, and having a restricted outlet in a chamber wall, arc runners adjacent said contacts, a free vent open at the top constituting a chimney projecting upwardly from said pressure chamber, in communication with the chamber through the outlet, one of said arc runners extending vertically upward from the arc pressure chamber through said vent and a coacting arc runner in said vent in a position interiorly thereof diametrically opposite said last mentioned arc runner, whereby the arc is forced to follow a predetermined path upwardly through said vent under the action of a blast resulting from an arc formed in said arc pressure chamber.

2. In a high voltage contactor system, a set of relatively movable circuit closing and opening contacts, a walled arc pressure chamber enclosing said contacts, and having a restricted outlet in a chamber wall, arc runners adjacent said contacts, a free vent open at the top constituting a chimney projecting upwardly from said arc pressure chamber, in communication with the chamber through the outlet, one of said arc runners extending vertically upward through said vent, a coacting arc runner in said vent in a position interiorly thereof diametrically opposite

said last mentioned arc runner and a magnetic blowout system having pole pieces extending on diametrically opposite sides of said vent and for a distance substantially above said arc pressure chamber and adjacent said arc runners, whereby the arc is forced into and upwardly through the vent by the action of a blast resulting from an arc in said pressure chamber and by the action of magnetic flux between the pole pieces.

3. In a high voltage contactor system, a set of relatively movable circuit closing and opening contacts, a walled arc pressure chamber enclosing said contacts, and having a restricted outlet in the top thereof, arc runners adjacent said contacts, a chimney extending upwardly from the chamber in communication therewith through the outlet, said chimney being open at the top and forming a free vent, one of said arc runners extending from the chamber through the outlet and upwardly through the chimney, a coacting arc runner in said chimney in a position interiorly thereof diametrically opposite said last mentioned arc runner and an arc splitter disposed in said chimney intermediate the arc runners therein, whereby the arc is forced to follow a predetermined path upwardly through said chimney under the action of a blast resulting from an arc formed in said arc pressure chamber, and through said arc splitter and through the open top of said chimney.

4. In a high voltage contactor system, a set of relatively movable circuit closing and opening contacts, a walled arc pressure chamber enclosing said contacts, and having a restricted outlet in the top thereof, arc runners adjacent said contacts, a walled chimney extending upwardly from the chamber in communication therewith through the outlet, said chimney being open at the top and forming a free vent, one of said arc runners extending from the chamber through the outlet and upwardly through the chimney, a coacting arc runner in said chimney in a position interiorly thereof diametrically opposite said last mentioned arc runner, a magnet having pole pieces extending on opposite sides of said arc pressure chamber and opposite sides of said chimney and extending upwardly to a position adjacent said arc runners and an arc splitter disposed within said chimney between said arc runners, whereby the arc is forced into and upwardly through the chimney and through the arc splitter and through the free vent formed by said chimney by the action of a blast resulting from an arc in the pressure chamber and by the action of magnetic flux between the pole pieces.

5. In a high voltage contactor system, a set of relatively movable circuit closing and opening contacts, an arc pressure chamber enclosing said contacts, a restricted orifice at the top thereof, arc runners adjacent said contacts, a stack formed from insulation material and extending upwardly from the restricted orifice of said arc pressure chamber, and terminating at the top thereof in a free vent, one of said arc runners extending vertically upwardly from said chamber through said stack and a coacting arc runner disposed within said stack in a position diametrically opposite said last mentioned arc runner and a magnetic blowout system comprising pole pieces externally of said arc chamber and said stack disposed so that magnetic flux thereof within the chamber moves the arc from the contacts to the arc runners and so that flux within the stack moves the arc along the arc runners and through said free vent.

6. In a high voltage contactor system, a set of relatively movable circuit closing and opening contacts, an arc pressure chamber enclosing said contacts, arc runners adjacent said contacts, a stack formed from insulation material and extending upwardly from said arc pressure chamber and open at the top for forming a free vent, one of said arc runners being disposed adjacent one of said contacts in arc gap relation thereto and extending vertically upwardly from said chamber through said stack and a coacting arc runner disposed within said stack in a position diametrically opposite said last mentioned arc runner, a magnetic blowout system comprising pole pieces externally of said arc chamber and said stack, disposed so that the magnetic flux from said pole pieces moves the arc from the contacts in the chamber to the runners and through the stack on the runners, and through said free vent and a resistive damping circuit extending between one of said arc runners and one of said contacts.

7. In a high voltage contactor system, a set of relatively movable circuit closing and opening contacts, an arc pressure chamber closed at the bottom and the sides thereof enclosing said contacts, arc runners adjacent said contacts, said chamber having a restricted opening in the top thereof, a chimney of insulation material extending upwardly from the restricted opening in the top of said arc chamber, one of said arc runners extending vertically upward from said chamber through the opening and through said chimney, a coacting arc runner in said chimney in a position interiorly thereof diametrically opposite said last mentioned arc runner and an arc splitter disposed within said chimney and intermediate the arc runners therein, said arc splitter comprising a multiplicity of electrically conductive plates extending longitudinally of the chimney and insulated one from another.

8. In a high voltage contactor system, a set of relatively movable circuit closing and opening contacts, an arc pressure chamber enclosing said contacts and having a restricted outlet, arc runners adjacent said contacts, one of said arc runners being disposed in arc gap relation with one of said contacts, a chimney of insulation material extending upwardly from said arc chamber, said last mentioned arc runner extending vertically upward from said chamber through the outlet and through said chimney, a coacting arc runner in said chimney in a position interiorly thereof diametrically opposite said last mentioned arc runner and in air gap relation thereto, an arc splitter disposed within said chimney and intermediate the arc runners therein, said arc splitter comprising a multiplicity of electrically conductive plates insulated one from another and an arc damping circuit connected between one of said runners and one of said contacts.

9. In a high voltage contactor system, a set of relatively movable circuit closing and opening contacts disposed in substantially vertical alignment, an arc pressure chamber enclosing said contacts, a chimney of insulation material extending upwardly from said arc pressure chamber and open at the top to provide a free vent, arc runners adjacent said contacts, one of said runners being conductively connnected with one of said contacts and the other of said runners being disposed in arc gap relation to the other of said contacts in the chimney, said last mentioned arc runner extending vertically upward from said chamber through said chimney, and a coacting arc runner in said chimney in a position interiorly thereof diametrically opposite said last mentioned arc runner.

10. In a high voltage contactor system, a load circuit, a set of relatively movable circuit closing and opening contacts, an arc pressure chamber enclosing said contacts, a free vent open at the top constituting a chimney projecting upwardly from said arc pressure chamber, an arc runner extending vertically upward from within the chamber through said chimney, a coacting arc runner in said chimney in a position interiorly thereof diametrically opposite said last mentioned arc runner, and a magnetic blowout system including a pair of magnetic pole pieces extending on opposite sides of said arc chamber, said chimney, and the arc runners therein, and an electromagnetic exciting winding associated with said magnetic pole pieces, said winding including a pair of sections, one of said sections being in series with the load circuit and with said contacts and the pair of said sections being in series with each other and with the load circuit and with the arc runners.

11. In a high voltage contactor system, a set of relatively movable circuit closing and opening contacts, an arc pressure chamber enclosing said contacts, a free vent open at the top constituting a chimney projecting upwardly from said arc pressure chamber, a first arc runner extending vertically upward from said chamber through said vent, a second arc runner in said vent in a position interiorly thereof diametrically opposite said first arc runner, a third arc runner connected to one of said contacts in the chamber, and a resistance unit connected between the second arc runner and the third arc runner.

12. In a high voltage contactor system, a set of relatively movable circuit closing and opening contacts, an arc pressure chamber enclosing said contacts, a free vent open at the top constituting a chimney projecting upwardly from said arc pressure chamber, an arc runner extending vertically upward from said chamber through said vent, a coacting arc runner in said vent in a position interiorly thereof diametrically opposite said last mentioned arc runner and a resistance unit supported adjacent to the upper end of said vent, said unit having one end thereof connected between said last mentioned arc runner and one of said contacts.

13. In a high voltage contactor system, a panel of insulation material, an arc pressure chamber mounted on said panel, a fixed contact extending through said panel and projecting into said arc pressure chamber, a movable contact disposed in the bottom of said arc pressure chamber and movable into circuit closing and opening position with respect to said fixed contact, a load circuit, a free vent chimney open at the top constituting a chimney projecting upwardly from said arc pressure chamber, an arc runner extending vertically upward from said chamber through said vent, a coacting arc runner in said vent disposed in a position interiorly thereof diametrically opposite said last mentioned arc runner, a magnetic blowout system comprising a pair of magnetic pole pieces extending on opposite sides of said arc chamber and extending upwardly for a substantial distance along said vent and on opposite sides of the arc runners therein, an electromagnetic system coupled with said magnetic pole pieces, said electromagnetic system including a pair of windings, one of said windings connected in the load circuit in series with the contacts, the

pair of windings connected in the load circuit in series with each other and in series with said arc runners.

14. In a high voltage contactor system, a load circuit, a set of relatively movable circuit closing and opening contacts, an arc pressure chamber enclosing said contacts, arc runners adjacent said contacts, a free vent open at the top constituting a chimney projecting upwardly from said arc pressure chamber, one of said arc runners extending vertically upwardly from said arc pressure chamber and into said vent, the other of said arc runners being disposed in said vent and extending vertically upward through said vent beyond the upper end of the aforesaid arc runner, a magnetic blowout system comprising a pair of magnetic pole pieces extending on opposite sides of said arc pressure chamber, said contacts, said vent and the arc runners in said vent, and an electromagnetic exciting system comprising a pair of windings one of said windings having a greater number of turns than the other, the one containing the smaller number of turns being connnected in series with the load circuit and with the contacts, and the winding having a greater number of turns being connected in series with the load circuit, the other winding and the arc runners.

15. In a high voltage circuit breaker, a walled arc-chamber; a stationary contact in the chamber; a movable contact operable to engage and disengage the stationary contact by operating means passing through a chamber wall; an upright chimney extending above the chamber; a restricted outlet through a wall of the chamber communicating with the chimney; a blowout magnet comprising pole pieces at opposite sides of the chamber exteriorly thereof; a winding in two parts for energizing the pole pieces; a first arc runner having a lower end portion in the chamber and adjacent the stationary contact, and extending through the outlet and upwardly along the inside of the chimney; a second arc runner connected to the movable contact, extending laterally therefrom and under the lower end portion of the first arc runner; a third arc runner having a lower end portion adjacent the lower end portion of the first arc runner and extending upwardly along the inside of the chimney and spaced transversely of the chimney from the first arc runner; the magnet pole pieces having upright extensions adjacent opposite sides of the chimney and exteriorly thereof; a resistance unit connected to an upper portion of the third arc runner; arc splitting barriers supported in the chimney between the first and third arc runners therein; the said parts arranged so that when an arc is drawn between the contacts in the chamber magnetic flux between the pole pieces will propel it to transfer it to the first and second arc runner, and gas pressure in the chamber caused by the arc and exhausting at substantial velocity through the restricted outlet and upwardly through the chimney combined with propulsion by the magnetic flux, will elevate the arc and cause it to transfer to the first and third arc runners and move upwardly through the chimney and be cooled by the arc splitting barrier, and extinguished; and circuit connections for causing current in the circuit-to-be-broken to flow in series through one part of the magnet winding and through the arc drawn at the contacts; and for causing current in the circuit-to-be-broken to flow in series through both parts of the winding and to the first arc runner and through the arc to the third arc runner and through the resistance unit when the arc has transferred to the first and third runners.

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