Nov. 17, 1959 W. M. LEEDS 2,913,556

CIRCUIT INTERRUPTERS

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Fig. 1.

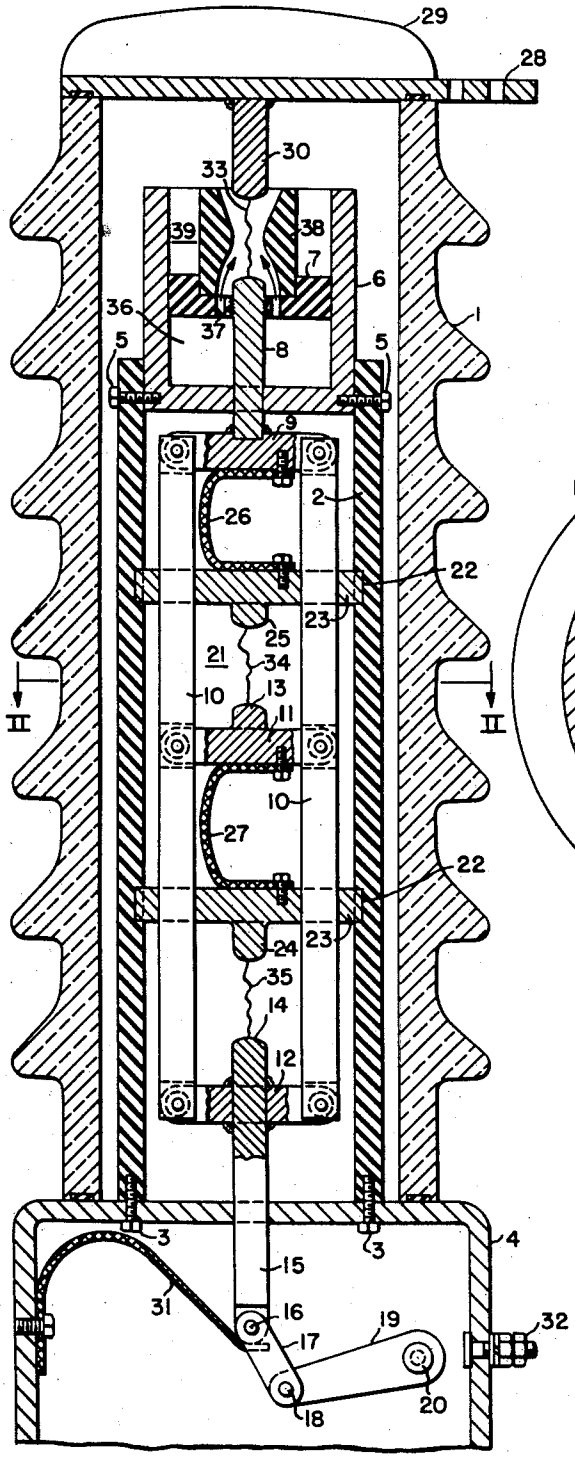

Fig. 2.

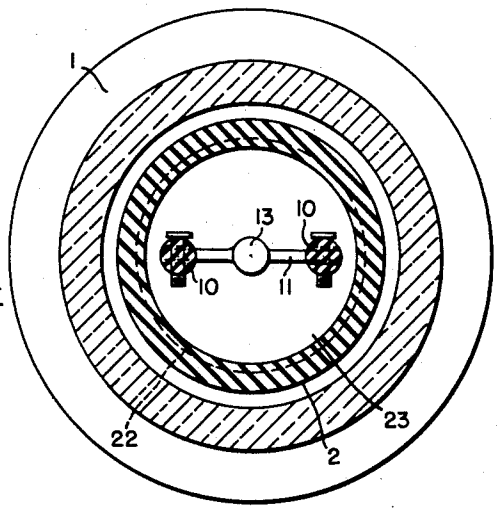

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Fig.3.

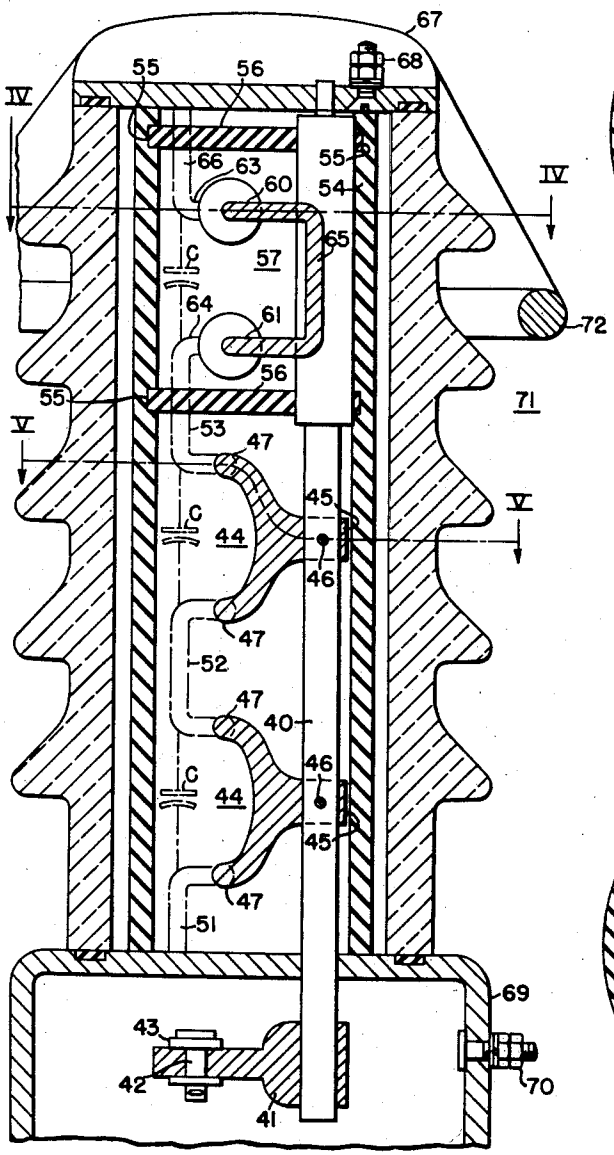


Fig.5.

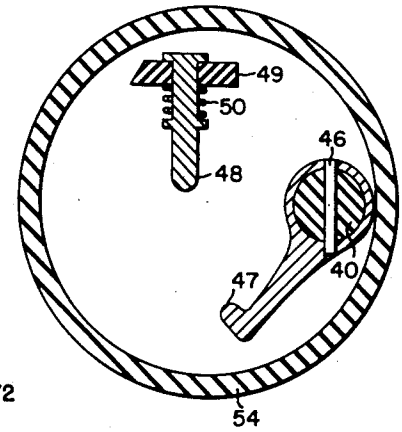
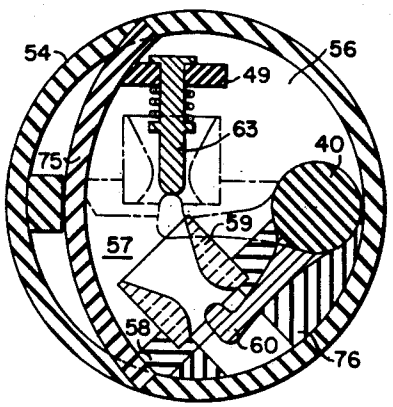


Fig.4.



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CIRCUIT INTERRUPTERS

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13 Claims. (Cl. 200—145)

This invention relates to circuit interrupters, in general, and, more particularly, to interrupting structures and arc-extinguishing arrangements therefor. In the United States patent application filed April 15, 1955 by Benjamin P. Baker, Charles F. Cromer and Joseph Sucha, Serial No. 501,535, now United States Patent 2,809,259 issued October 8, 1957, there is disclosed an improved multi-break circuit interrupting structure particularly adaptable for interrupting leading currents associated with the switching of capacitor banks. This application also teaches the use of a rotatable vane, or piston wing, which forces fluid toward a plurality of established breaks.

It is a general object of my invention to improve upon the interrupting structures set out in this application and to provide a more effective and simple arc-extinguishing structure.

High-voltage circuit interrupter designs for minimum mechanical effort seem to require conflicting arrangements according to the type of interrupting duty. This is especially true for gas-filled breakers, such as those using SF_6, in which short multi-breaks opened at high speed make a restrike-free interrupter of capacitance charging current, but the plain breaks are not very effective on fault-interrupting duty. On the other hand, a strong forced flow of gas through a nozzle in which an arc is drawn will interrupt considerable voltage and current under fault conditions in a single break, but even with the flow, charging currents are not cleared without some restriking.

One solution would be to provide a multi-break arrangement with strong forced flow in each gap. However, this requires an excessive amount of driving energy. The present invention describes two arrangements involving one or more pump-type interrupter units in series with one or more plain breaks. Thus, the pumping effort is reduced to the minimum required for adequate fault interruption, while the added plain breaks in series provide restrike-free charging current interruption. The additional gaps also make possible adequate insulating strength in the open position with shorter stroke, than if fewer series breaks were used.

It is, therefore, a further object of my invention to provide an improved all-purpose circuit interrupter which will have adequate ability to interrupt capacitance currents, and in addition will have the ability to interrupt considerable power on inductive circuits.

Still, a further object of my invention is to provide an improved multi-break structure which will be compact and require little space, preferably being of such configuration as to enable it to be positioned within a generally cylindrical elongated casing.

Still, a further object of my invention is to provide a simplified mechanical arrangement for quickly establishing a plurality of breaks in series, and in which forced fluid flow is provided adjacent one or more of the breaks to render the structure, as a whole, adequate

for interrupting considerable voltage and current under fault conditions.

Further objects and advantages will readily become apparent upon reading the following specification, taken in conjunction with the drawings, in which:

Figure 1 is a vertical longitudinal sectional view through one embodiment of my invention, the contact structure being indicated in the partially open-circuit position;

Fig. 2 is a sectional view taken substantially along the line II—II of Fig. 1;

Fig. 3 is a vertical sectional view taken through another embodiment of my invention;

Fig. 4 is a sectional view taken substantially along the line IV—IV of Fig. 3; and,

Fig. 5 is another sectional view taken substantially along the line V—V of Fig. 3.

Referring to the drawings, and more particularly to Fig. 1 thereof, the reference numeral **1** designates a casing composed of a suitable weatherproof material, preferably porcelain. Disposed interiorly within the elongated cylindrical casing **1** is an insulating tube **2** secured by bolts **3** to a lower casting support **4**. The insulating tube **2** supports at its upper end by additional bolts **5** a relatively stationary operating cylinder **6**, within which moves a piston **7**. The piston **7** is secured by a threaded connection to an upper movable contact **8** carried by a bridging member **9**, the outer ends of which are secured to a pair of longitudinally extending insulating operating rods **10**. The operating cylinder **6** and the piston **7** define, at times, a pressure chamber, adjacent which is established a contact gap, as hereinafter described.

The operating rods **10**, in addition to carrying the upper movable contact **8**, have further bridging members **11**, **12**, each of which carries an associated movable contact **13** or **14**.

As viewed in Fig. 1, the movable contact **14** has a lower extension **15**, which is pivoted, as at **16**, to a link **17**. The link **17** is pivoted, as at **18**, to a crank arm **19** rotatable about a fixed axis **20**. Any suitable means may be provided for effecting rotation of the crank arm **19** and hence through the linkage **17**, longitudinal opening and closing motion of the framework **21**, comprising the two insulating operating rods **10** and their associated movable contact structure.

The insulating tube **2** has a plurality of annular recesses **22** provided therein, within which is seated a plurality of metallic discs **23** which carry relatively stationary contacts **24**, **25**. Flexible connectors **26** and **27** connect the movable and stationary contacts **9**, **25** and **13**, **24** electrically in series, so that in the closed position of the interrupter the circuit therethrough extends from a terminal plate portion **28** of an upper cover casting **29** to the upper stationary contact **30**. The circuit then extends through the upper movable contact **8**, through the conducting bridging portion **9** and through the flexible conector **26** to the conducting disc **23**. The circuit then extends through the relatively stationary contact **25** to the second movable contact **13** of the movable framework **21**.

The circuit then extends through the conducting bridging member **11** and through the flexible connector **27** to the lowermost conducting disc **23**, and hence through the lowermost stationary contact **24** to the lower movable contact **14**. From here the circuit extends through a flexible connector **31** to the conducting lower casting support **4** to a lower terminal stud **32**.

The fluid disposed interiorly within the casing **1** may be any suitable gas, liquid, vapor or spray for some applications, but preferably, it is most desirable to use sulphur hexafluoride gas, the remarkable arc-extinguishing

properties of which are set out in United States patent application, filed July 19, 1951, Serial No. 237,502, now United States Patent 2,757,261 issued July 31, 1956 to Harry J. Lingal, Thomas E. Browne, Jr., and Albert P. Strom, and assigned to the assignee of the instant application. However, the gas could be selenium hexafluoride, the arc-extinguishing characteristics of which are set out in United States patent application filed September 14, 1954, Serial No. 455,976, now United States Patent 2,733,316, issued January 31, 1956 to Thomas E. Browne, Jr., Albert P. Strom and Harvey E. Spindle, assigned to the assignee of the instant application, or the gas could be a mixture of SF_6 with SeF_6, or mixtures of either or both of said gases with such gases as helium, nitrogen, carbon dioxide, argon or air. Although I have suggested certain gases to be used in the improved circuit interrupter, it is not to be inferred that I exclude thereby a suitable arc-extinguishing liquid, such as oil for example, for certain features of my invention are readily adaptable in an oil-filled circuit interrupter.

Regardless of the type of fluid utilized within the casing 1, the operation thereof will be readily apparent from the foregoing description, namely a downward opening movement of the framework 21, as effected by rotation of the crank arm 19 will effect the simultaneous establishment of a plurality of serially related arcs 33—35 between the several cooperating pairs of contacts 30, 8; 25, 13; and 24, 14. Since the piston, or gas-pressure producing means 7 is secured to, and movable with, the upper movable contact 8, it will force fluid against the arc 33 from the region 36 within the operating cylinder or pressure chamber 6 and below the piston 7 upwardly through a plurality of apertures 37 and through a nozzle 38, which moves with the piston 7, and through which the arc 33 is drawn.

It will be noted that two of the breaks, that is the two lowermost of the three breaks, are "plain" breaks, that is they are established in a surrounding ambient relatively free of fluid-flow conditions, and are particularly effective in establishing adequate dielectric strength, particularly suitable for the interruption of leading currents associated with the switching of capacitor banks.

The upper break, on the other hand, established between the contacts 8, 30 is established within a region of relatively strong fluid flow, as provided by the piston means 39. Thus, the upper break is particularly effective in interrupting considerable current and voltage under fault conditions in a single break.

Thus, the interrupter disclosed in Figs. 1 and 2 is an all-purpose interrupter, in which a plurality of plain breaks are utilized in conjunction with a further break in which intensive deionizing action is obtained. By providing forced fluid flow at only one break, instead of all three breaks, the mechanical effort required to effect opening of the interrupter is considerably reduced; and when the interrupter is used during the interruption of leading currents associated with capacitor switching, it is not necessary to have forced fluid flow at all the breaks, but during this period, the plain breaks are sufficiently adequate to hold the voltage to obtain practically restrike-free performance.

Referring to Figs. 3–5 of the drawings, it will be noted that in this embodiment of the invention a rotatable insulating operating shaft 40 is employed, being rotated by a crank arm 41 which may be linked, as at 42, to a drive shaft 43 having a bifurcated end, as shown. The rotatable operating shaft 40 carries therewith a plurality of U-shaped movable contacts 44, each having a collar portion 45 which is pinned by pins 46 to the shaft 40 so as not to slip upon the shaft 40. The U-shaped movable contacts 44 have tip portions 47 which cooperate with relatively stationary contacts 48, the latter being supported upon a vertical insulating strip 49 and biased by springs 50 to the position shown in Fig. 5. The several contacts are electrically connected in series by strap portions 51—53 so that a plurality of series simultaneous breaks are provided.

Within an insulating tube 54 and supported within annular recesses 55 therein, is a pair of insulating discs 56, which assist in providing a piston or pressure chamber 57, within which moves a rotatable vane, or piston wing 58 (Fig. 4). The piston chamber 57 is also defined by an insulating curved wall 75 and a stationary insulating filler block 76. The piston wing 58 is secured to and rotatable with the rotatable operating shaft 40.

Associated with the insulating piston wing 58 is a pair of nozzles 59 having a construction similar to the nozzle 38, hereinabove referred to in connection with Fig. 1. Also, the upper end of the rotatable operating shaft 40 carries a pair of rotatable movable contacts 60, 61 which cooperate with a pair of relatively stationary contacts 63, 64. The movable contacts 60, 61 are electrically interconnected by a strap portion 65 so that the contact breaks are all in series electrically.

The upper stationary contact 63 is electrically connected by a strap connector 66 to an upper cover casting 67 having a terminal stud 68. A shield 72 for grading the stress axially along the interrupter 71 may be provided and may be integrally formed with the cover casting 67. The lower support casting 69 has a terminal stud 70 associated therewith.

The electrical circuit extending through the modified interrupter 71 proceeds in an obvious manner, namely from terminal stud 68, through the conducting cover casting 67 and through the conducting strap 66 to the upper stationary contact 63. The circuit then extends through the movable contact 60 and strap connection 65 to the movable contact 61. The circuit then extends through the stationary contact 64 and through the strap connection 53 to the movable contact 47 of the upper U-shaped contact member 44. The circuit then extends in an obvious zigzag manner, referring to Fig. 3, to the lower strap 51 and hence through the conducting casting support 69 to the lower terminal stud 70. For grading the voltage substantially equally between the several series breaks a plurality of shunting capacitors "C" may be employed.

During the opening operation, the bifurcated drive shaft 43 effects through the pin connection 42 rotation of the crank arm 41 and hence rotatable motion of the operating shaft 40. This results in simultaneous separation of all of the movable contacts from their associated stationary contacts establishing thereby a plurality of serially related arcs. The upper two arcs are drawn through the two nozzles 59 associated with the piston wing or gas-pressure producing means 58. This forces fluid from the pressure chamber through the nozzles 59 to direct a strong blast of fluid against the upper two arcs. The lower four arcs are not subjected to any fluid flow, and are particularly effective during capacitor switching. The upper two breaks, which are affected by the piston action, provide deionizing conditions necessary for enabling the interrupter to interrupt high power during fault conditions. Thus, again there is provided an all-purpose interrupter in which four of the breaks are plain breaks and are drawn in a surrounding ambient relatively free of fluid-flow conditions, whereas the upper two breaks are both established in a surrounding ambient in which relatively strong fluid-flow conditions exist.

As mentioned, the upper two breaks in the interrupter 71 are particularly effective during fault-current interruption, whereas the lower four breaks, being plain breaks, are particularly effective for establishing adequate dielectric strength during capacitor switching.

From the foregoing description of two embodiments of the invention, it will be observed that there is provided an improved circuit interrupter, of the multi-break type, in which one or more plain breaks are established in series with one or more additional breaks, the latter being subjected to relatively intensive fluid-flow conditions. The

result is an all-purpose interrupter suitable for interrupting either currents associated with inductive circuits or the leading currents associated with capacitor switching.

Although I have shown and described specific structures, it is to be clearly understood that the same were merely for the purpose of illustration, and that changes and modifications may readily be made therein by those skilled in the art without departing from the spirit and scope of the invention.

I claim as my invention:

1. A circuit interrupter including an operating rod positively carrying a plurality of movable contacts, a plurality of relatively stationary contacts, means electrically connecting the several contacts in series, movement of the operating rod effecting simultaneous separation of the movable contacts away from the relatively stationary contacts to draw a plurality of arcs in series, a relatively stationary operating cylinder, a piston movable with the operating rod and operable within said operating cylinder to force fluid toward one of the established arcs, and one or more other contact gaps establishing arcing in a surrounding ambient relatively free of fluid-flow conditions.

2. The combination in a circuit interrupter of an elongated casing, an operating rod movable longitudinally of the casing and positively carrying a plurality of movable contacts, a plurality of relatively stationary contacts, means electrically connecting the several contacts in series, movement of the operating rod effecting simultaneous separation of the movable contacts away from the relatively stationary contacts to draw a plurality of arcs in series, piston means responsive to the opening movement of the operating rod to force fluid toward one of the arcs, and one or more of the established arcs being drawn in a surrounding ambient which is relatively free of fluid-flow conditions.

3. The combination in a circuit interrupter of an elongated casing, a pair of operating rods movable longitudinally of the casing and positively carrying a plurality of movable contacts, a plurality of relatively stationary contacts, movement of the operating rods effecting simultaneous separation of the movable contacts away from the relatively stationary contacts to draw a plurality of arcs in series, a relatively stationary operating cylinder, a piston disposed adjacent one of the movable contacts and secured thereto, said piston being movable within the operating cylinder during the opening operation to force fluid toward one of the established arcs, and one or more other arcs being established in a region of undisturbed fluid-flow conditions.

4. A circuit interrupter including a rotatable operating shaft carrying a plurality of movable contacts, a plurality of relatively stationary contacts, means electrically connecting the several contacts in series, the several pairs of contacts separating simultaneously, piston means responsive to the rotation of the rotatable operating shaft to force fluid toward one or more of the established arcs, and one or more of the established arcs being drawn in an ambient relatively free of fluid-flow conditions.

5. The combination in a circuit interrupter of an elongated casing, a piston chamber disposed interiorly of the casing, a rotatable operating shaft, a piston wing rotatable with the operating shaft and movable within the piston chamber, said rotatable operating shaft carrying a plurality of movable contacts, a plurality of relatively stationary contacts, the several pairs of contacts separating simultaneously said piston wing forcing fluid toward one or more of the established arcs, and one or more other of the established arcs being drawn in an ambient relatively free of fluid-flow conditions.

6. The combination in a circuit interrupter of means defining a plurality of contact gaps in series, means for establishing said plurality of contact gaps substantially simultaneously, piston means for forcing fluid flow toward arcing at one or more of the contact gaps for effective arc-extinguishing action, and one or more other of the contact gaps establishing arcing in a surrounding ambient which is relatively free of fluid-flow conditions.

7. A circuit interrupter including an elongated insulating cylinder, a rotatable operating shaft closely disposed to one wall of said insulating cylinder and extending axially thereof, an insulating piston wing and an orifice carried by said rotatable operating shaft, means defining a plurality of relatively stationary contacts spaced axially along said elongated insulating cylinder, a plurality of movable contacts carried by said rotatable operating shaft, one of said movable contacts disposed in close proximity to said movable orifice, one of said relatively stationary contacts and another of said movable contacts separating in a surrounding ambient which is relatively free of fluid-flow conditions, and rotation of said rotatable operating shaft causing said movable piston wing to force fluid through said orifice to effect extinction of the arc established at said one movable contact.

8. A circuit interrupter including an elongated insulating cylinder, a rotatable operating shaft closely disposed to one wall of said insulating cylinder and extending axially thereof, an insulating piston wing and an orifice carried by said rotatable operating shaft, a curved wall member extending axially of said elongated insulating cylinder and disposed therein, said rotatable piston wing rotating closely to said curved wall member, means defining a plurality of relatively stationary contacts spaced axially along said elongated insulating cylinder, a plurality of movable contacts carried by said rotatable operating shaft, one of said movable contacts disposed in close proximity to said movable orifice, one of said relatively stationary contacts and another of said movable contacts separating in a surrounding ambient which is relatively free of fluid-flow conditions, and rotation of said rotatable operating shaft causing said movable piston wing to force fluid through said orifice to effect extinction of the arc established at said one movable contact.

9. A circuit interrupter including an elongated insulating cylinder, a rotatable operating shaft closely disposed to one wall of said insulating cylinder and extending axially thereof, an insulating piston wing and an orifice carried by said rotatable operating shaft, a curved wall member extending axially of said elongated insulating cylinder and disposed therein, said rotatable piston wing rotating closely to said curved wall member, a stationary insulating filler block disposed along said elongated insulating cylinder in the region of said curved wall member and conforming to the curved wall of said elongated insulating cylinder, means defining a plurality of relatively stationary contacts spaced axially along said elongated insulating cylinder, a plurality of movable contacts carried by said rotatable operating shaft, one of said movable contacts disposed in close proximity to said movable orifice, one of said relatively stationary contacts and another of said movable contacts separating in a surrounding ambient which is relatively free of fluid-flow conditions, and rotation of said rotatable operating shaft causing said movable piston wing to force fluid through said orifice to effect extinction of the arc established at said one movable contact.

10. A circuit interrupter of the gas-blast type having separable contact-gap forming means including a movable operating rod carrying a plurality of movable contacts, means connecting the movable contacts in series, means arranging the separable contact-gap forming means such that all of the serially related contact gaps are drawn simultaneously, one or more of the serially related contact gaps being established in an arc-extinguishing gas which is free of gas-flow conditions, means defining a pressure chamber relatively remote from said one or more contact gaps which are established in gas free of gas-flow conditions, at least another contact gap being established immediately adjacent said pressure chamber,

and gas-pressure producing means responsive to opening movement of said operating rod for raising the gas pressure within said pressure chamber to effect deionizing gas flow at said other contact gap for effective fault-current interruption.

11. A circuit interrupter of the gas-blast type including a casing containing sulfur hexafluoride gas, separable contact-gap forming means disposed within said casing including a movable operating rod carrying a plurality of movable contacts, means connecting the movable contacts in series, means arranging the separable contact-gap forming means such that all of the serially related contact gaps are drawn simultaneously, one or more of the serially related contact gaps being established in an arc-extinguishing gas which is free of gas-flow conditions, means defining a pressure chamber relatively remote from said one or more contact gaps which are established in gas free of gas-flow conditions, at least another contact gap being established immediately adjacent said pressure chamber, and gas-pressure producing means responsive to opening movement of said operating rod for raising the gas pressure within said pressure chamber to effect deionizing gas flow at said other contact gap for effective fault-current interruption.

12. A circuit interrupter of the gas-blast type including an elongated cylindrical casing, separable contact-gap forming means including a rotatable insulating operating rod carrying hook-shaped movable bridging contacts, said rotatable operating rod extending longitudinally of said casing, means supporting a plurality of relatively stationary contacts spaced axially along said casing and cooperable with said movable contacts, means connecting the movable contacts in series, means arranging the separable contact-gap forming means such that all of the serially related contact gaps are drawn simultaneously, one or more of the serially related contact gaps being established in an arc-extinguishing gas which is free of gas-flow conditions, means defining a pressure chamber relatively remote from said one or more contact gaps which are established in gas free of gas-flow conditions, at least another contact gap being established immediately adjacent said pressure chamber, and gas-pressure producing means responsive to opening movement of said operating rod for raising the gas pressure within said pressure chamber to effect deionizing gas flow at said other contact gap for effective fault-current interruption.

13. A circuit interrupter of the gas-blast type including an elongated cylindrical casing containing sulfur hexafluoride gas, separable contact-gap forming means including a rotatable insulating operating rod carrying hook-shaped movable bridging contacts, said rotatable operating rod extending longitudinally of said casing, means supporting a plurality of relatively stationary contacts spaced axially along said casing and cooperable with said movable contacts, means connecting the movable contacts in series, means arranging the separable contact-gap forming means such that all of the serially related contact gaps are drawn simultaneously, one or more of the serially related contact gaps being established in an arc-extinguishing gas which is free of gas-flow conditions, means defining a pressure chamber relatively remote from said one or more contact gaps which are established in gas free of gas-flow conditions, at least another contact gap being established immediately adjacent said pressure chamber, and gas-pressure producing means responsive to opening movement of said operating rod for raising the gas pressure within said pressure chamber to effect deionizing gas flow at said other contact gap for effective fault-current interruption.

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