

Oct. 26, 1965

C. F. CROMER
FLUID-BLAST CIRCUIT INTERRUPTERS WITH
PRESSURE-ACTUATED FLUID DIRECTORS

3,214,545

Filed April 11, 1961

5 Sheets-Sheet 1

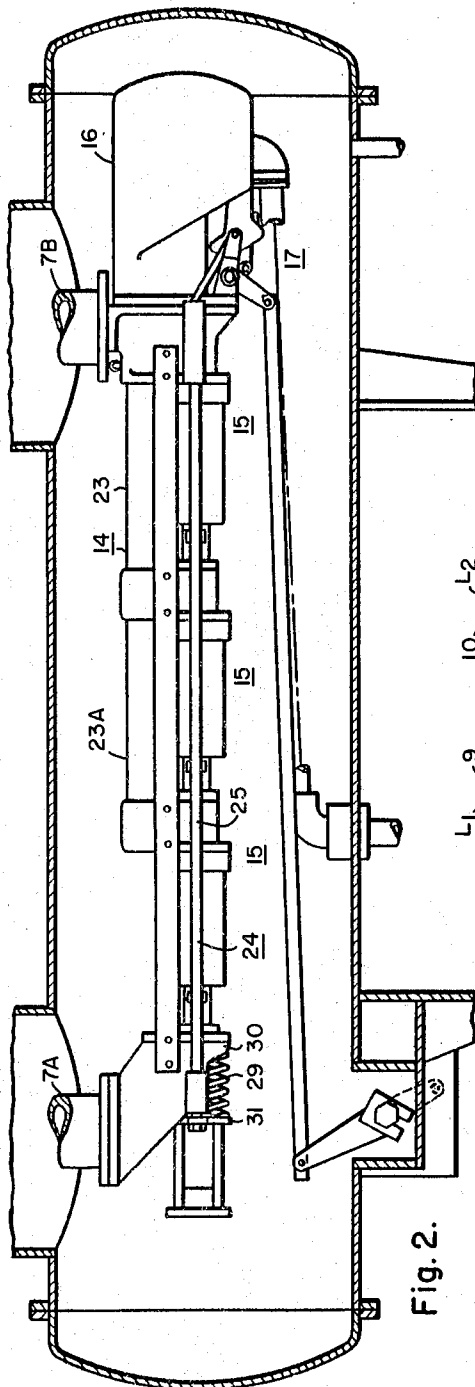


Fig. 2:

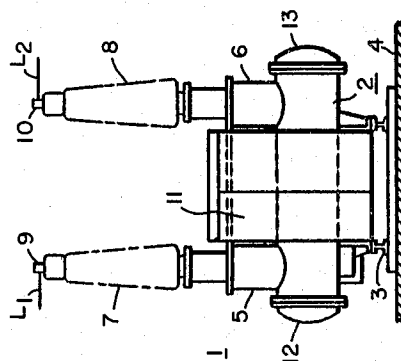


Fig. 1.

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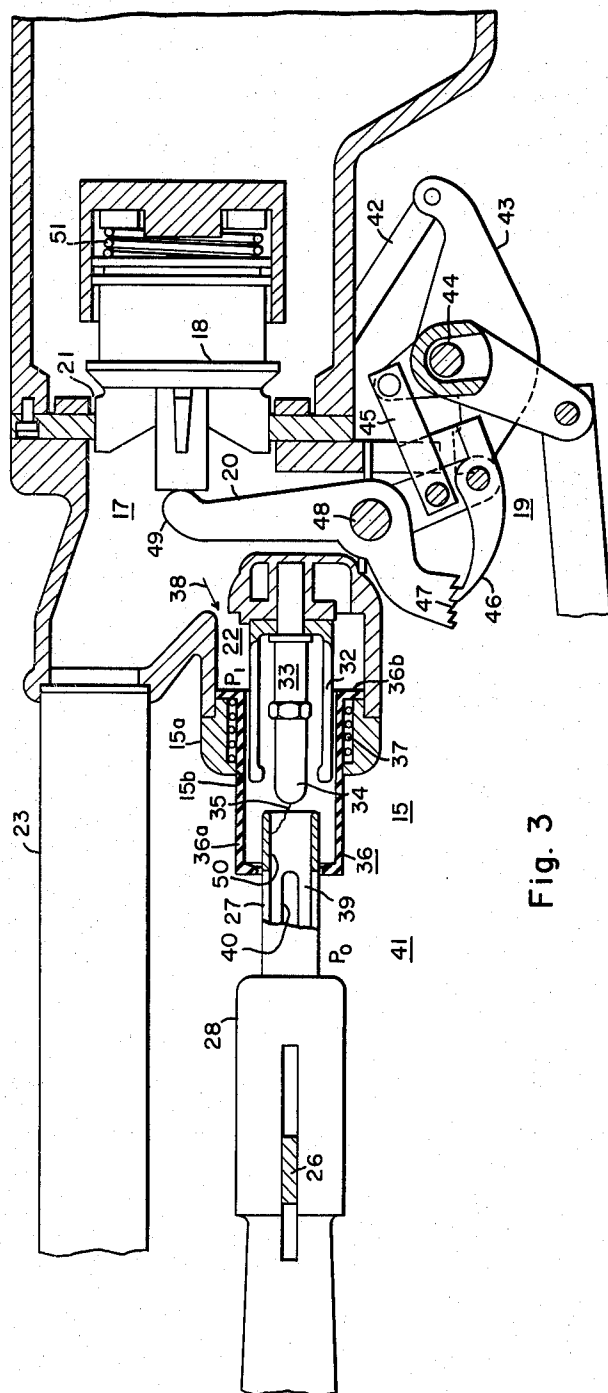


Fig. 3

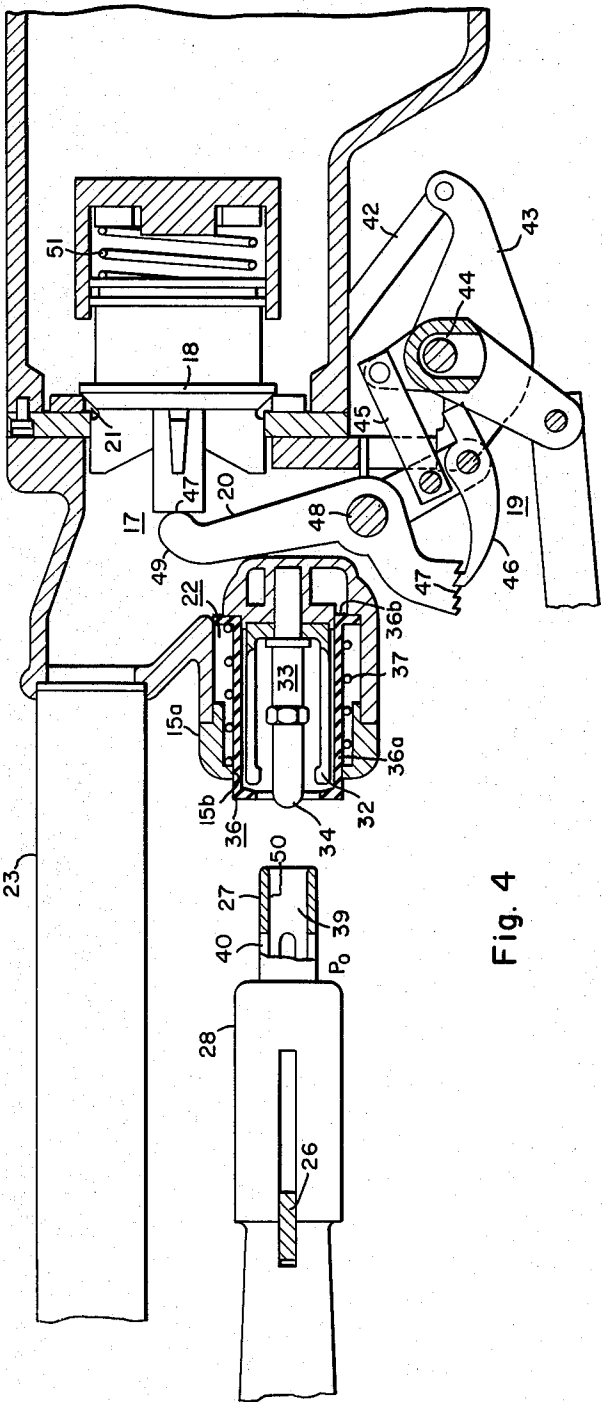
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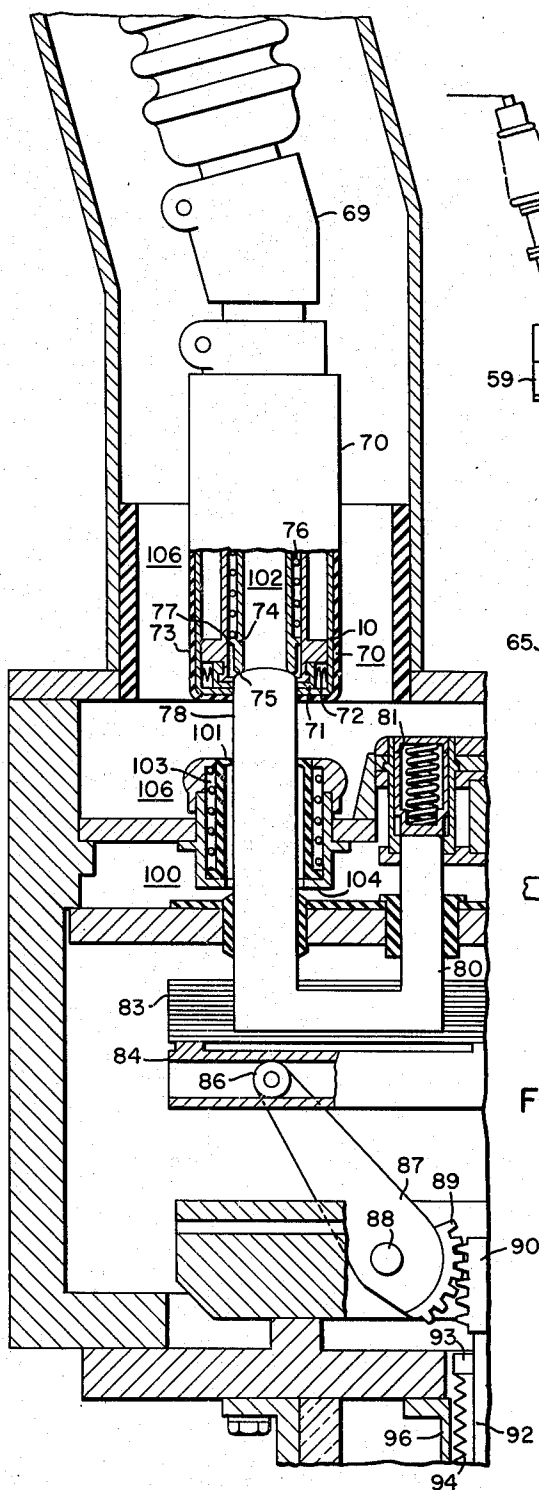
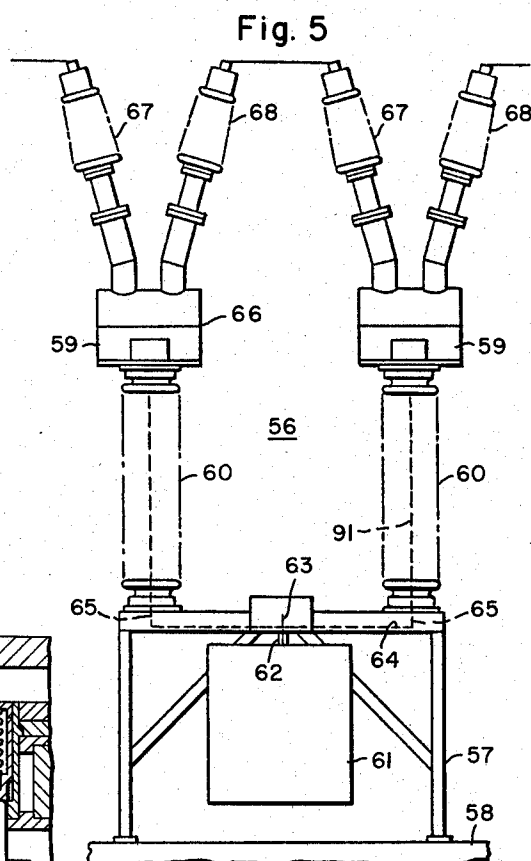


Fig. 7



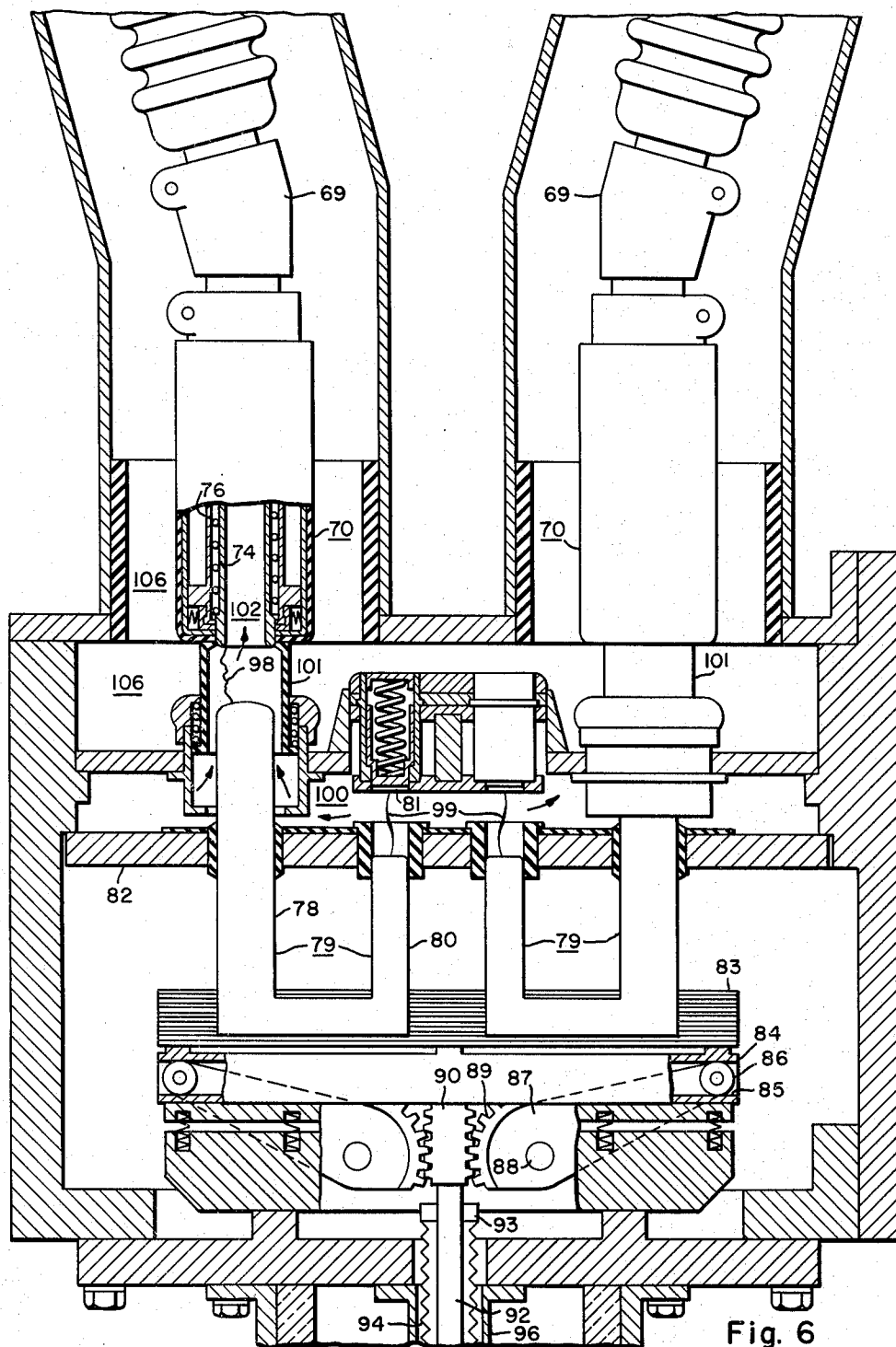
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FLUID-BLAST CIRCUIT INTERRUPTERS WITH PRESSURE-ACTUATED FLUID DIRECTORS

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7 Claims. (Cl. 200-148)

This invention relates to fluid-blast circuit interrupters in general and, more particularly, to fluid-blast circuit interrupters which direct a blast of arc-extinguishing fluid into the arc stream to effect the interruption thereof.

A general object of the present invention is to provide a highly effective arc-extinguishing structure in which the presence of insulating material between the separated contacts in the fully open-circuit position of the interrupter is avoided.

A more specific object of the present invention is to provide an improved fluid-blast circuit interrupter in which a retractable flow-director is employed, which is responsive to the differential pressure existing during the opening operation of the interrupter.

Another object of the present invention is to provide an improved fluid-blast circuit interrupter in which the fluid blast is exhausted through a relatively stationary contact structure, and the control of the fluid blast is obtained by the employment of a retractable flow-director responsive to the differential pressure existing thereacross.

Still a further object of the present invention is the provision of an improved fluid-blast circuit interrupter in which the fluid blast is exhausted through the movable tubular contact, and a retractable flow-director is associated with the relatively stationary contact to more effectively direct the fluid blast during the opening operation. Preferably the retractable flow-director is retracted in the fully open-circuit position of the interrupter, to prevent the presence of insulating surfaces in the isolating gap in the fully open-circuit position of the interrupter.

Another object of the present invention is the provision of an improved fluid-blast interrupter in which a retractable flow-director is utilized, which is responsive to the differential pressure existing thereacross. As a result, the retraction of the flow-director increases the gap spacing in the fully open-circuit position of the interrupter, and during a subsequent closing operation, insulating surfaces are not present along the path of closing movement of the movable contact prior to re-ignition during the closing stroke.

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

FIGURE 1 is an end elevational view of a three-pole multi-phase fluid-blast circuit interrupter embodying features of the present invention;

FIG. 2 is an enlarged longitudinal sectional view taken through one of the three tank structures of the multi-phase circuit interrupter of FIG. 1, the contact structure being illustrated in the closed-circuit position;

FIG. 3 is an enlarged fragmentary view of one of the arc-extinguishing units of the arc-extinguishing assemblage illustrated in FIG. 2, with the contact structure being illustrated in the partially open-circuit position;

FIG. 4 is a fragmentary view, similar to that of FIG. 3, but illustrating the position of the several parts in the fully open-circuit position of the interrupter;

FIG. 5 is an end elevational view of a modified type of fluid-blast circuit interrupting structure;

FIG. 6 is a considerably enlarged longitudinal sectional view taken through one of the live metallic tanks of the arc-extinguishing structure of FIG. 5, the contact

structure being illustrated in the fully open-circuit position; and,

FIG. 7 is a fragmentary view, similar to that of FIG. 6, but illustrating the contact structure in the fully closed-circuit position.

Referring to the drawings, and more particularly to FIG. 1 thereof, the reference numeral 1 generally designates a dual-pressure high-voltage multi-phase fluid-blast circuit interrupter for controlling the three phases of a transmission system. FIG. 1 shows only the end tank of the three-tank structure. It will be noted that the tank structure 2 comprises an elongated metallic grounded tank extending in a generally horizontally position, being supported by steel beams 3 and mounted upon a concrete base 4.

Extending upwardly from the upper side of the generally horizontally-extending metallic tank structure 2 are a pair of bushing supports 5, 6, which fixedly support into operative position terminal bushings 7, 8. The line connections L_1 , L_2 are secured to the upper terminals 9, 10, respectively, of the terminal bushings 7, 8.

As illustrated in FIG. 1, a mechanism compartment 11, enclosing a suitable operating mechanism, not shown, is disposed adjacent the end tank structure 2. End covers 12, 13 are provided to permit entrance into the interior of the tank structure 2 for maintenance purposes.

With reference to FIG. 2, which shows the arc-extinguishing assemblage 14 supported from the lower ends 7A, 7B of the terminal bushings 7, 8, it will be noted that there are provided a plurality of serially-related arc-extinguishing units, generally designated by the reference numeral 15. Disposed at the right-hand end of the arc-extinguishing assemblage 14 is a high-pressure reservoir tank 16 containing gas at a relatively high pressure, say 250 p.s.i. A blast-valve structure 17, more clearly shown in FIG. 3, is provided to control the blasting of gas past a blast valve 18 in accordance with opening and closing movements of a linkage 19, set forth in detail in United States patent application filed October 17, 1960, Serial No. 63,201, now U.S. Patent No. 3,164,704, issued January 5, 1965, to Russell N. Yeckley, Joseph Sucha and Roswell C. Van Sickle, and assigned to the assignee of the instant application.

Opening of the blast valve 18 in response to rotative movement of a pivotally-mounted blast-valve lever 20 permits the blasting of gas past the valve seat 21, and into an inlet portion 22 associated with the first arc-extinguishing unit 15 of the arc-extinguishing assemblage 14. Additional blasting of gas takes place through a blast tube 23 (FIG. 2) to the middle arc-extinguishing unit 15, and through an additional blast tube 23A (FIG. 2) to the left-hand arc-extinguishing unit 15 of the arc-extinguishing assemblage 14.

Generally, the movable contact assemblage 24 of the arc-extinguishing assemblage 14 comprises a pair of parallel-disposed spaced insulating operating rods 25, bridged by conducting cross-members 26, the latter carrying, adjacent the middle portions thereof, movable tubular contacts 27. The movable tubular contacts 27 are guided within a metallic guide structure 28 more fully set forth and claimed in United States patent application filed January 23, 1959, Serial No. 788,668, now U.S. Patent No. 3,057,983, issued October 9, 1962, to Russell N. Yeckley, Joseph Sucha and Benjamin P. Baker, and assigned to the assignee of the instant application.

As viewed in FIG. 2, the movable contact assemblage 24, comprising the several movable tubular contacts 27, is biased in a leftward opening direction by a battery of accelerating compression springs 29, interposed between a bracket support 30 and a movable spring seat 31, constituting the left-hand extremity of the movable contact assemblage 24. As a result, the battery of compression

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springs 29 biases the entire movable contact assemblage 24 in a leftward opening direction, as viewed in FIGS. 2 and 3, tending thereby to cause the separation between the several movable contacts 27 from the relatively stationary finger contacts 32, collectively forming a relatively stationary contact structure, generally designated by the reference numeral 33. In addition, an arcing horn 34 stationarily positioned, provides a terminal for one end of the arc 35, which is drawn between the movable contact 27 and the relatively stationary contact structure 33.

As shown more in detail in FIG. 3, a retractable flow-director 36, formed of a suitable insulating material, is provided, being spring-biased by a spring 37 to a retracted position, as illustrated in FIG. 4 of the drawings. As will be brought out more clearly hereinafter, opening of the blast valve 18 by operation of the linkage 19 will cause a differential pressure (P_1 minus P_0) to exist across the flow-director 36, effecting advance movement thereof, as illustrated in FIG. 3 of the drawings. The orifice chamber 15a has an orifice opening 15b, within which slidably moves the fluid-flow insulating director 36. More specifically, the retractable flow-director 36 comprises an insulating flow-directing portion 36a and a piston portion 36b, the latter being acted upon by the gas blast issuing from the inlet portion 22, in the manner illustrated by the arrows designated by the reference numeral 38. Following cessation of the gas blast, as brought about by the closing of the gas-blast valve 18, the spring 37 will effect retraction of the flow-director 36.

As set forth more in detail in United States patent application filed October 7, 1960, Serial No. 61,284, now U.S. patent No. 3,154,658, issued October 27, 1964 to Robert Colclaser and Russell N. Yeckley, and assigned to the assignee of the instant application, it has been found highly desirable to direct the gas blast into the interior 39 of the movable tubular contact 27. Venting slots 40 are provided to permit exhausting of this gas into the general region 41, interiorly of the tank structure 2. To more effectively direct the gas blast into the interior 39 of the movable tubular contact 27, the flow-director 36 is provided.

During the closing operation, however, it is desirable to avoid the presence of insulating surfaces along the path of closing motion of the movable contact 27 prior to the point at which re-ignition occurs during the closing stroke. By having the flow-director 36 spring-biased to a retracted position as shown in FIG. 4, the presence of insulating surfaces along the path of closing travel of the movable contact 27 is avoided.

The opening operation of the circuit interrupter 1 will now be described. During the opening operation, the mechanism, not shown, disposed within the mechanism compartment 11 is unlatched, thereby permitting the accelerating compression spring 29 to effect leftward opening movement of the movable contact structure 24, and consequent opening movement of the several movable contacts 27. Since the movable contact structure 24 has its right-hand end linked, by a connecting link 42, to a crank-arm 43 pivotally mounted about a stationary axis 44, a link 45 will force the pawl 46 against the serrated portion 47 of the pivotally mounted blast-valve thrust lever 20. As shown more in detail in FIG. 3, the blast-valve thrust lever 20 is pivoted about a stationary axis 48. Consequently, clockwise rotation of the blast-valve thrust lever 20 will, through the nose portion 49 thereof, force the blast valve 18 to the right, thereby permitting a blast of gas to enter into the inlet region 22 of the first arc-extinguishing unit 15. In addition, the gas blast passes through the blast tubes 23, 23A to the adjacently-disposed arc-extinguishing units 15. The presence of considerable gas pressure within the inlet region 22 causes a differential pressure to exist across the flow director 36 to effect thereby the leftward advancing movement thereof. This condition is illustrated in FIG. 3 of the drawings.

The leftward opening movement of the movable con-

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tacts 27 will effect the separation thereof away from the relatively stationary finger contacts 32, drawing arcs 35 therebetween. Because of the gas blast, the arc will quickly transfer to the arcing horns 34, and, near a current zero, the left-hand end of the arcs 35 will move along the inner surfaces 50 of the movable tubular contacts 27. During this time it is desirable to direct substantially all of the gas blast through the movable tubular contacts 27. The flow-director 36 achieves this end.

Following extinction of the arcs 35, the pawl 46 is disengaged from the ratchet portion 47 of rotatable blast valve thrust lever 20 to permit the gas pressure, within the reservoir 16, plus the spring pressure 51 to effect reclosure of the blast valve 18. Upon equalization of pressure conditions across the flow-director 36, the spring 37 will effect retraction of the flow director 36 to the position illustrated in FIG. 4 of the drawings. As mentioned previously, this will have the advantage that during a subsequent reclosure of the contacts, there will not be present insulating surfaces along the closing path of the movable contacts 27.

Reference may be made to the aforesaid patent application Serial No. 788,668 for a more detailed explanation of the matter of general operation of the circuit interrupter 1. For the purpose of fully understanding the present invention, however, it is only necessary to know that opening of the blast valve 18 effects arc-extinction in the manner hereinbefore described, and cessation of the gas blast permits retraction of the movable flow-director 36 in the manner described.

FIG. 5 illustrates a modified type of fluid-blast circuit interrupter 56 mounted upon a frame-work 57, the latter being supported upon a suitable base 58. As shown, two arc-extinguishing units 59 are arranged in series. This is particularly desirable for the higher voltages. For details of the operation of the circuit interrupter 56, reference is directed to United States patent application filed August 27, 1959, Serial No. 836,405, now U.S. Patent No. 3,110,791, issued November 12, 1963, to Wayne Aspey and Benjamin P. Baker and assigned to the assignee of the instant application.

Generally, it will be observed that upstanding insulator columns 60 are provided, which support the arc-extinguishing units 59 an adequate distance above ground potential. A mechanism compartment 61 is provided, enclosing a suitable operating mechanism, not shown. The mechanism, not shown, disposed within the mechanism compartment 61 is operable to effect downward movement of an operating rod 62, which is pivotally connected to a bell-crank 63. The bell-crank 63 actuates a horizontally-extending operating shaft 64, which has a pair of crank-arms 65 disposed at the opposite ends thereof. The crank-arms 65, in turn, are linked with horizontally-extending operating rods extending lengthwise of the frame work 57 and beneath the several insulator columns 60, comprising the several pole-units associated with the circuit interrupter 56. Actually, FIG. 5 only illustrates the end pole-unit, the other two pole-units being in alignment and, therefore, not shown.

Disposed at the upper ends of the insulator columns 60 are pressure-resistant metallic live tanks 66 at line potential in the closed-circuit position of the interrupter. Extending downwardly into the interior of the pressure tanks 66 are a pair of terminal bushings, 67, 68, to the lower interior ends 69 of which, as viewed in FIG. 6, are secured relatively stationary contact structures, generally designated by the reference numeral 70. As shown more in detail in FIG. 6 of the drawings, the relatively stationary contact structures 70 comprise a plurality of circumferentially-positioned segmental contacts 71 biased radially inwardly by compression springs 72. The segmental contacts 71 are disposed within a static shield 73, which serves to suppress the formation of corona in the open-circuit position of the interrupter.

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Movable longitudinally within the relatively stationary contact structure 70 is a relatively stationary exhaust tube 74, having an arc-resistant tip portion 75 associated therewith. The exhaust tube 74 is biased downwardly by a compression spring 76. A suitable stop 77 limits the downward following movement of the exhaust tube 74 with a movable interrupting contact 78.

As more clearly shown in FIG. 6, the movable interrupting contact 78 is associated with a U-shaped movable contact structure 79, having a movable pressure-generating contact 80 carried therewith. The movable pressure-generating contact 80 is cooperable with the relatively stationary pressure-generating contact 81 secured to a metallic interrupting tube 82. As shown in FIG. 6, there are two U-shaped movable contact structures 79, carried by an insulating cross-head 83, in turn, secured to a movable channel member 84 forming a raceway 85 for the accommodation of driving rollers 86 disposed at the free ends of crank-arms 87. The crank-arms 87 are rotatable about fixed axes 88, and have gear segments 89, which mesh with a double-sided rack 90. The rack 90 is carried at the upper end of an insulating operating rod 91, indicated in FIG. 5 of the drawings.

Interposed between the double-sided rack 90 and the insulating operating rod 91 is a metallic coupling member 92, which has a sleeve 93 soldered to a metallic bellows 94. The lower end of the metallic bellows 94 is soldered to a ring secured to the lower end of a guide tube 96.

It will be apparent that during the opening operation, the insulating operating rod 91 moves upwardly to move the rack 90 upwardly, and consequently rotates the driving-cranks 87 to opposite directions about their axes 88. This will effect separation of the driving rollers 86 to forcibly cause the cross-head 83 to move downwardly establishing thereby a pair of interrupting arcs 98, and a pair of serially related pressure-generating arcs 99. This condition is illustrated in FIG. 6 of the drawings, even though said figure illustrates the fully open-circuit position of the interrupter.

The establishment of the two pressure-generating arcs 99 generates pressure within the region 100 within metallic tube 82, and thereby causes the advancement of the insulating flow director 101, as illustrated in FIG. 6 of the drawings.

The advancement of the flow-director 101 against the static shield 73 by the differential pressure existing thereacross, causes the blasting of fluid from the pressure-generating arc to flow through the flow director 101, and into the interior 102 of the exhaust tube 74 in a manner illustrated by the arrows in FIG. 6 of the drawings.

Preferably the arc extinguishing fluid disposed within the pressurized live tank 59 is liquefied sulfur-hexafluoride (SF_6) gas. (Other liquefied gases, such as set forth in United States patent application filed September 13, 1957, Serial No. 683,760, now U.S. Patent No. 3,150,240 issued September 22, 1964, to Winthrop M. Leeds and Benjamin P. Baker, and assigned to the assignee of the instant application may be employed.

As illustrated in FIG. 6, the retractable insulating flow-director is biased by a spring 103 to a lower retracted position against a stop 104. It is only during the existence of relatively high-pressure conditions within the region 100 that the flow director 101 assumes its advanced position, as illustrated in FIG. 6.

In order to obtain highly-efficient interrupting action, it is desirable to confine, or to direct the flow of the interrupting medium and furthermore to provide a disconnecting gap after circuit interruption has been accomplished, preferably one not bridged by solid insulation. When a relatively stationary gas-flow director is employed, there results the disadvantage that upon closing the contacts there is inserted solid insulation into the circuit long before the dielectric gaseous medium between the contacts has reached a breakdown or prestrike value.

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This can and may result in damage to solid insulation. Such action can be avoided by employing a retractable gas flow director, which is withdrawn after the differential actuating pressure between the interrupting chamber and the low-pressure chamber has been reduced to a predetermined value.

The present invention discloses contact arrangements and a method of obtaining an interrupter construction which minimizes such mentioned disadvantages.

In the closed circuit position, the main moving contacts 78 mate with the cluster of current collecting fingers 71 and the pressure-generating contacts 80 make engagement with the relatively stationary pressure-generating contact 81. Since in the closed-circuit position, no differential pressure exists between the regions 100, 106, no differential pressure causes the gas-inflow director 101 to be in the extended position.

As the contacts are opened, the spring-biased metallic orifice 74 follows the main moving contact 78 until it reaches its fully open position in contact with the fingers 71. Simultaneously, the pressure-generating contact 80 has been opening, and simultaneously arcs are drawn at the interrupting breaks and the pressure-generating breaks. The differential pressure produced between the regions 100, 106 results in an upward force exerted upon the flow-director 101, positioning it as shown in FIG. 6, being held tightly against the static shield 73.

As the current approaches current zero, the arc 98 is swept into the metallic orifice 74 and interruption is accomplished. With the interruption of the current, the two regions 100, 106 return to the same pressure, and when this force is removed, the flow-director 101 again returns to its static position, as shown in FIG. 7 of the drawings.

The immediate recovery of voltage will appear across the insulating gas flow director 101, as it does with interrupter construction utilizing a stationary flow-director. However, with proper terminating electrode design, no breakdown difficulties will occur. Also, since the flow director 101 is retracted, no prestriking voltage will appear across the insulation upon closing of the contacts 78, 71.

From the foregoing description of the invention, it will be apparent that there is provided an improved circuit interrupter, in which a retractable flow-director 36, 101 is employed, being responsive to the differential pressure existing thereacross. This feature of the invention has been described in connection with two different forms of circuit interrupters. There results the distinct advantage that during the closing stroke, insulating surfaces along the path of closing travel of the movable contact is avoided. On the other hand, the invention has the advantage of positively directing the gas flow into relatively stationary, or movable contact structures as desired, to create effective gas flow conditions.

Although there has been illustrated 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 fluid-blast circuit interrupter including a stationary orifice chamber having an orifice opening through which a slidable tubular retractable insulating fluid-flow director moves, contact structure through which fluid is not exhausted disposed within said stationary orifice chamber, a tubular contact disposed externally of said orifice chamber and cooperable with said first contact to establish an arc, means for supplying fluid pressure to said stationary orifice chamber, said fluid-flow director being pressure-responsive so as to project from said orifice chamber upon application of fluid pressure, the extension of said insulating fluid-flow director forcing all the fluid to flow through said externally-situated tubular con-

tact for effective arc-extinguishing conditions, and means biasing said director to a retracted position to minimize the presence of insulating material between the separated contacts in the fully open position of the interrupter.

2. A fluid-blast circuit interrupter including a stationary orifice chamber having an orifice opening through which a slidable tubular retractable insulating fluid-flow director moves, a movable solid contact disposed within said stationary orifice chamber, a relatively stationary tubular contact disposed externally of said orifice chamber and cooperable with said first movable contact to establish an arc, means for supplying fluid pressure to said stationary orifice chamber, said fluid-flow director being pressure-responsive so as to project from said orifice chamber upon application of fluid pressure, the extension of said insulating fluid-flow director forcing all the fluid to flow through said externally-situated relatively stationary tubular contact for effective arc-extinguishing conditions, and means biasing said director to a retracted position to minimize the presence of insulating material between the separated contacts in the fully open position of the interrupter.

3. A fluid-blast circuit interrupter including a stationary orifice chamber having an orifice opening through which a slidable tubular retractable insulating fluid-flow director moves, relatively stationary contact structure through which fluid is not exhausted disposed within said stationary orifice chamber, a movable tubular contact disposed externally of said orifice chamber and cooperable with said first relatively stationary contact structure to establish an arc, means for supplying fluid pressure to said stationary orifice chamber, said fluid-flow director being pressure-responsive so as to project from said orifice chamber upon application of fluid pressure, the extension of said insulating fluid-flow director forcing all the fluid to flow through said externally-situated movable tubular contact for effective arc-extinguishing conditions, and means biasing said director to a retracted position to minimize the presence of insulating material between the separated contacts in the fully open position of the interrupter.

4. A fluid-blast circuit interrupter including a stationary orifice chamber having an orifice opening through which a slidable tubular retractable insulating fluid-flow director moves, relatively stationary contact structure through which fluid is not exhausted disposed within said stationary orifice chamber, a movable tubular contact disposed externally of said orifice chamber and cooperable with said contact structure to establish an arc, said relatively stationary contact structure including an annular cluster of finger contacts and a generally centrally-located arc horn projecting within said movable tubular contact in the closed-circuit position of the interrupter, means for supplying fluid pressure to said stationary orifice chamber, said fluid-flow director being pressure-responsive so as to project from said orifice chamber upon application of fluid pressure, the extension of said insulating fluid-flow director forcing all the fluid to flow through said externally-situated movable tubular contact for effective arc-extinguishing conditions, and means biasing said director to a retracted position to minimize the presence of insulating material between the separated contacts in the fully open position of the interrupter.

5. A fluid-blast circuit interrupter including a stationary orifice chamber having an orifice opening through which a slidable tubular retractable insulating fluid-flow director moves, a movable solid contact disposed within said stationary orifice chamber, a relatively stationary tubular contact disposed externally of said orifice cham-

ber and cooperable with said first contact to establish an arc, means including a pair of pressure-generating contacts for supplying fluid pressure to said stationary orifice chamber, said fluid-flow director being pressure-responsive so as to project from said orifice chamber upon application of fluid pressure, the extension of said insulating fluid-flow director forcing all the fluid to flow through said externally-situated relatively stationary tubular contact for effective arc-extinguishing conditions, and means biasing said director to a retracted position to minimize the presence of insulating material between the separated contacts in the fully open position of the interrupter.

6. A fluid-blast circuit interrupter including a stationary orifice chamber having an orifice opening through which a slidable tubular retractable insulating fluid-flow director moves, a movable solid contact disposed within said stationary orifice chamber, a relatively stationary tubular contact disposed externally of said orifice chamber and cooperable with said first movable contact to establish an arc, an annular cluster of relatively stationary finger contacts surrounding said tubular contact and making contacting engagement with said movable solid contact in the closed-circuit position, means for supplying fluid pressure to said stationary orifice chamber, said fluid-flow director being pressure-responsive so as to project from said orifice chamber upon application of fluid pressure, the extension of said insulating fluid-flow director forcing all the fluid to flow through said externally-situated relatively stationary tubular contact for effective arc-extinguishing conditions, and means biasing said director to a retracted position to minimize the presence of insulating material between the separated contacts in the fully open position of the interrupter.

7. A fluid-blast circuit interrupter including an arc-extinguishing assemblage comprising a plurality of stationary orifice chambers each having an orifice opening through which a slidable tubular retractable insulating fluid-flow director moves, relatively stationary contact structure through which fluid is not exhausted disposed within each stationary orifice chamber, a plurality of movable tubular contacts disposed externally of said orifice chambers and simultaneously cooperable with said first contact structures to establish a plurality of serially-related arcs, means including a high-pressure reservoir and blast-valve means for supplying fluid pressure to each stationary orifice chamber, each fluid-flow director being pressure-responsive so as to project from the respective orifice chamber upon application of fluid pressure, the extension of said insulating fluid-flow director forcing all the fluid to flow through the respective externally-situated movable tubular contact for effective arc-extinguishing conditions, and means biasing each director to a retracted position to minimize the presence of insulating material between the respective separated contacts in the fully open position of the interrupter.

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