Dec. 13, 1966 C. F. CROMER 3,291,949

FLUID-BLAST CIRCUIT INTERRUPTERS HAVING IMPROVED ARC SPLITTER STRUCTURE

Filed Sept. 18, 1964 4 Sheets-Sheet 1

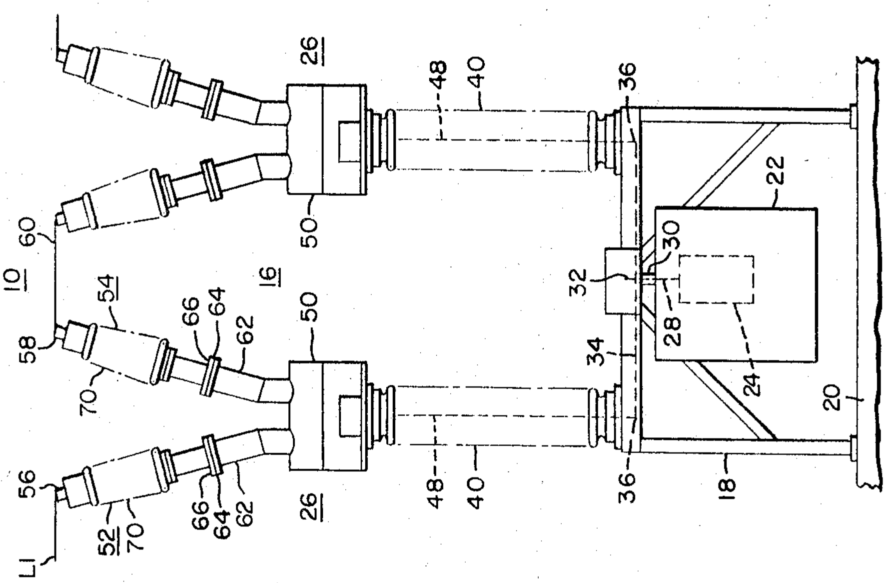


FIG. 2.

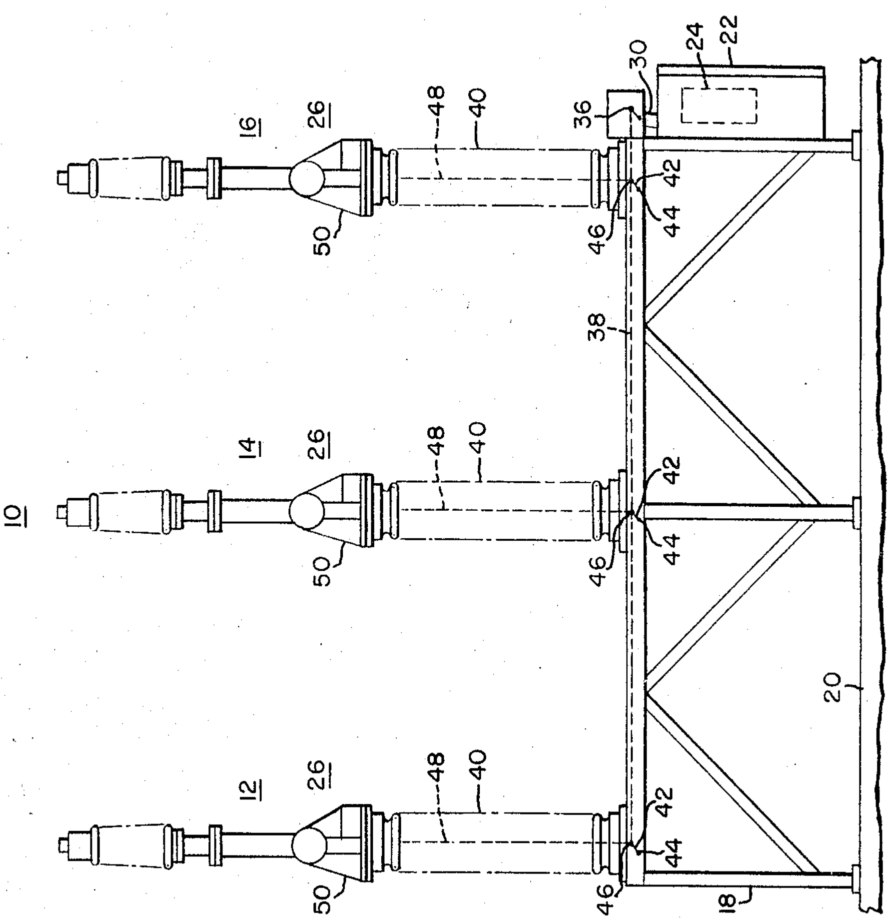
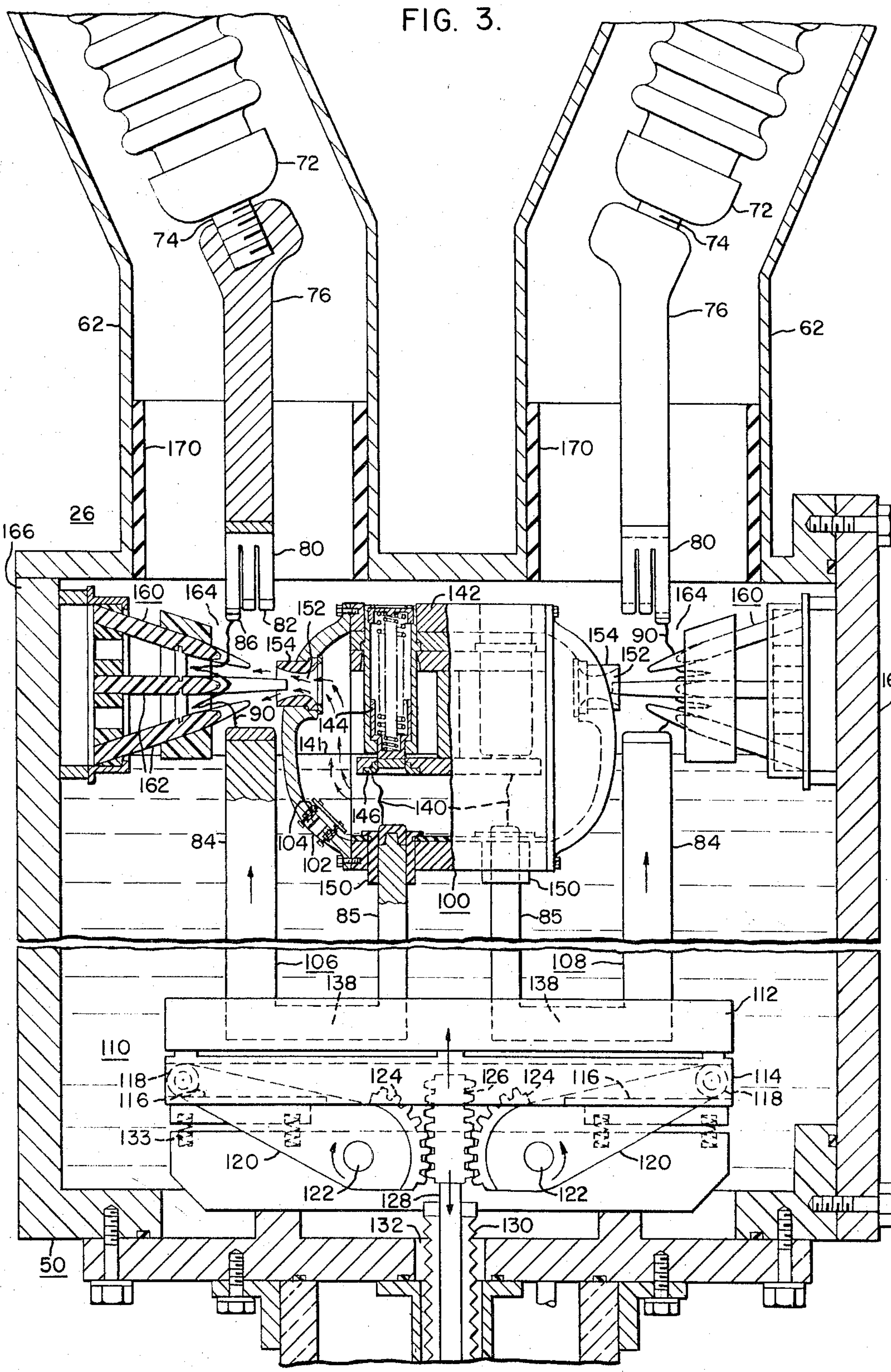


FIG. 1.

FIG. 3.


72
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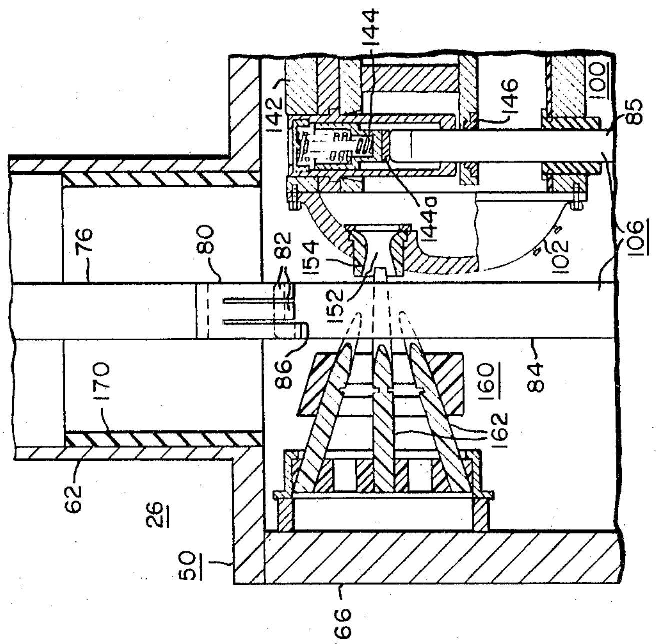

FIG. 4.

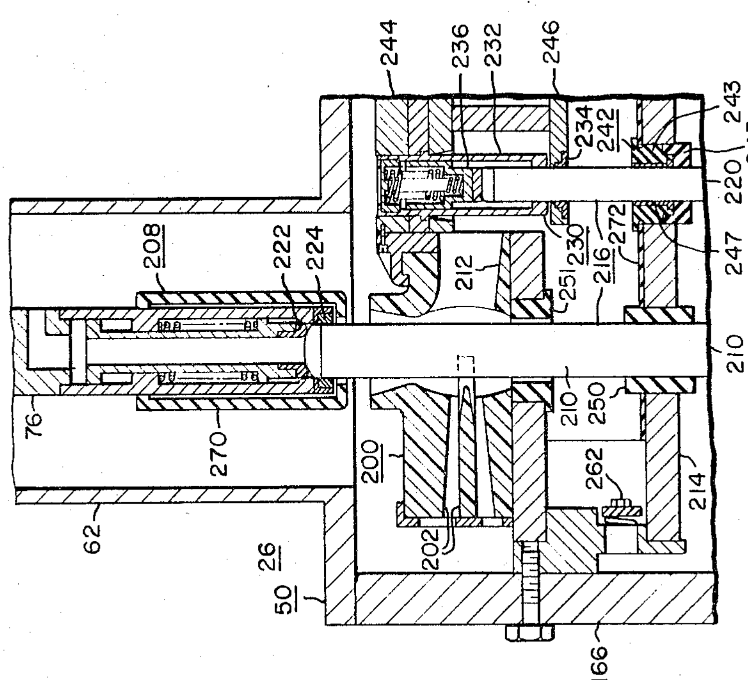

FIG. 6.

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FLUID-BLAST CIRCUIT INTERRUPTERS HAVING IMPROVED ARC SPLITTER STRUCTURE

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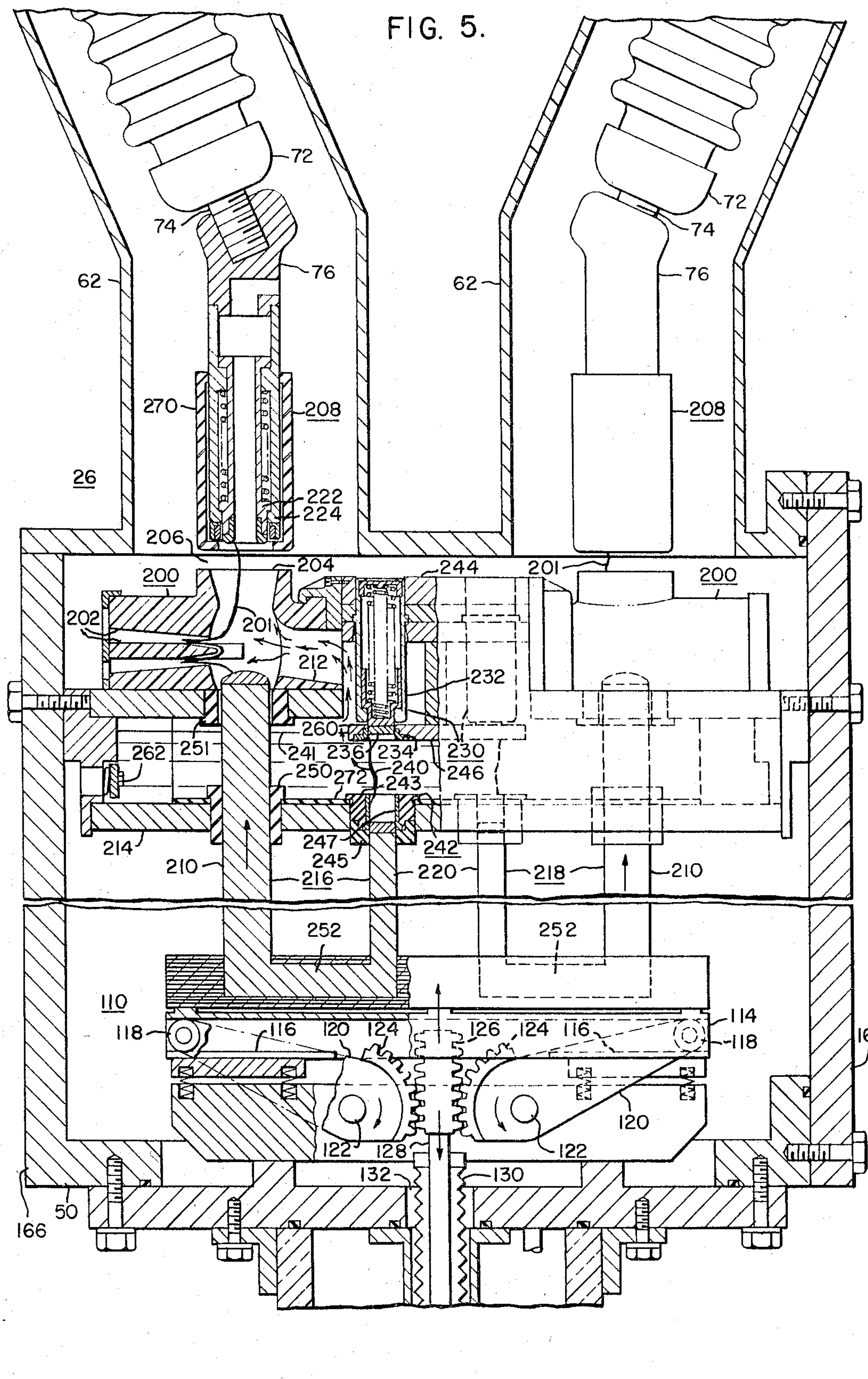
FIG. 5.



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FLUID-BLAST CIRCUIT INTERRUPTERS HAVING IMPROVED ARC SPLITTER STRUCTURE

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14 Claims. (Cl. 200—148)

This invention relates, in general, to circuit interrupters of the fluid blast type, and, more particularly, to such types of circuit interrupters having improved arc-splitter structures.

The ability of a circuit interrupter to withstand high rates of rise of recovery voltages in alternating-current systems is proportional to the arc voltage at current zero. In other words, if a circuit interrupter is to withstand higher rates of rise of recovery voltages, the arc voltage must be increased at current zero. The means for increasing the arc voltage at current zero, however, should not jeopardize other critical areas, such as by "bridging" the contacts of the circuit interrupter with solid insulation when the contacts are in their open position, which would introduce the hazards of creepage. Any means for increasing the arc voltage must maintain an isolating gap between the contacts in their open position.

Accordingly, it is an object of this invention to provide a new and improved fluid-blast circuit interrupter having an improved interrupting structure.

Another object of the invention is to provide a new and improved circuit interrupter which provides a high arc voltage at current zero.

A further object of the invention is to provide a new and improved current interrupter which provides a high arc voltage at current zero, and which has an isolating gap between its contacts when they are in their open-circuit position.

Still another object of the invention is to provide a new and improved fluid-blast circuit interrupter which has an improved interrupting structure capable of withstanding high rates of rise of recovery voltages and which generates the fluid-blast by pressure-generating contacts disposed within a pressure chamber, which operate simultaneously with the interrupting contacts.

Another object of the invention is to provide a new and improved fluid-blast high-voltage circuit interrupter having pressure-generating and interrupting contacts, in which the movable portions of the pressure-generating and interrupting contacts are serially related to form a partial loop.

Briefly, the present invention accomplishes the above-cited objects by providing a live-tank type of circuit interrupter supported by suitable insulating supports, in which is disposed an improved interrupting structure. The fluid blast is generated within a pressure chamber disposed within each tank of the circuit interrupter, with pressure-generating contacts disposed within the pressure chamber. The movable portions of the pressure-generating contacts are serially related and operate simultaneously with the movable portions of the interrupting contacts. The serially-related movable contacts provide a "loop effect" which forces the arc generated between the interrupting contacts to move to the outside of the loop. Splitter-type interrupters, which provide a high arc voltage at current zero, are mounted remotely, such as on one of the tank walls, and are disposed such that the arc moves against the splitter plates by the "loop effect." The fluid blast is directed to force the arc into the splitters, lengthening and cooling the arc and increasing the arc voltage. By mounting the splitter interrupter remotely from the interrupter contact assembly, solid insulation, with its creep hazards, is not permitted to bridge the interrupter contacts, thus allowing an isolation gap to be established between the interrupter contacts when they are in their open-circuit position.

Another embodiment of the invention combines the splitter-type interrupter with the orifice-type interrupter, obtaining the advantages of both types of interrupters, and still providing the desirable isolating gap between the interrupting contacts while they are in their open-circuit position.

Further objects and advantages of the invention will become apparent as the following description proceeds, and features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of the invention, reference may be had to the accompanying drawings, in which:

FIGURE 1 is an end elevational view of a three-phase, high voltage, fluid-blast circuit interrupter of the type which may utilize the teachings of this invention;

FIG. 2 is a side elevational view of one of the pole-units of the circuit interrupter shown in FIG. 1;

FIG. 3 is a vertical sectional view taken through one of the live-tank interrupting structures of FIGS. 1 and 2, with the contact structure shown in the open-circuit position, illustrating one embodiment of the invention;

FIG. 4 is a fragmentary view similar to that of FIG. 3, but the contact structure shown in the closed-circuit position;

FIG. 5 is a vertical sectional view taken through a modified-type of live-tank interrupting structure with the contact structure being shown in the open-circuit position, illustrating another embodiment of the invention; and,

FIG. 6 is a fragmentary view of the contact structure shown in FIG. 5, with the contacts shown in the closed-circuit position.

Referring now to the drawings, and to FIGS. 1 and 2 in particular, there is shown a three-phase circuit-interrupting assemblage **10**, typical of the type which may utilize circuit-interrupting structures constructed according to the teachings of this invention. The circuit-interrupting assemblage **10** may have pole-units **12**, **14** and **16** mounted upon an angle-iron frame **18**, with each pole-unit having two or more similar serially-related interrupting portions, if desired. The frame **18** is at ground potential and may be disposed upon a base **20**, formed of concrete or other suitable material. An enclosure **22**, for the operating mechanism, may be mounted upon the frame **18**, and may house any suitable operating mechanism **24**, such as hydraulic, pneumatic or electric-solenoid.

The mechanical linkage extending from the operating mechanism **24** to the circuit-interrupting units **26** may include a reciprocally-operable rod **28**, as shown in FIG. 2, extending upwardly from the operating mechanism **24** through a housing tube **30**, where it is pivotally connected to one end of a bell-crank lever **32**. The bell-crank lever **32** is keyed to an operating shaft **34** extending in opposite directions from the bell-crank lever **32**. The rotatable operating shaft **34** is keyed to a pair of crank arms **36**, which effect reciprocal horizontal movement of a pair of operating rods **38**, shown in FIG. 1, which extend along the upper portion of frame **18** below insulating supporting columns **40**, which are used to support the circuit-interrupting units **26**. The operating rods **38** are pivotally connected to bell-cranks **42** pivotally mounted on shafts **44**. The operating shafts **44** have crank-arms **46**, to which insulating operating rods **48** are pivotally attached. The insulating operating rods **48** extend upwardly through the insulating supporting columns **40**, and their reciprocal operation effects the opening and closing movements required by the movable portions of the contact structures associated with each of the circuit-interrupting units **26**, which will be described in more detail hereinafter. It is to be understood that the particular operating arrangement and sequence described is illustrative only. Any operating arrangement for effecting the opening and closing movement of the contact structures associated with the interrupting units **26** will be suitable.

Each interrupting unit **26** includes a pressurized metallic enclosure, or housing **50**, and a pair of terminal bushings **52** and **54** having terminals **56** and **58**, respectively, disposed at their outer end portions. The number of interrupting units **26**, serially connected to form each pole-unit, depends upon the operating voltage, with two interrupting units **26**, connected by a conductor **60**, being shown in FIG. 2 for purposes of illustration. Using two interrupting units **26**, the electrical circuit for the pole-unit **16** would enter terminal **56** from line L1, traverse the interior of bushing **52** into the interrupting unit **26**, and out of unit **26** through bushing **54** to terminal **58**. The circuit then continues in a similar manner through the other serially-connected interrupting unit **26**.

As shown in FIG. 2, a pair of cylindrical support members **62** are secured, by welding or by any other suitable means, to the housing **50** of interrupting unit **26**. Each support member **62** includes a flange **64**, which aligns and supports the flange member **66** associated with each of the terminal bushings **52** and **54**. Terminal bushings **52** and **54** may be constructed in a conventional manner, with each having an external weather-proof casing **70** and an internal casing **72** (see FIGS. 3 and 4). A terminal stud **74** (FIGS. 3 and 4) extends centrally through each of the terminal bushings **52** and **54**, and each stud **74** has threadably secured or clamped thereto a fixed contact adapter **76**.

As shown in FIG. 3, each contact adapter **76** has a fixed contact **80** secured to its lower end, with the fixed contact **80** comprising a plurality of contact finger segments **82**, which make contact with a movable knife-blade type of movable interrupting contact **84**. FIG. 4 illustrates the movable interrupting contact **84** in the closed-circuit position, making electrical contact with the contact finger segments **82**. One of the contact finger segments **82** has a portion **86**, which extends below the other finger segments **82** and, since it is the last portion of fixed contact **80** to break contact with movable contact **84**, it always draws the arc **90**, as shown in FIG. 3, which ensures that the other finger segments **82** will be maintained in good contacting condition for continuous current-carrying capability. Although a knife-blade type contact structure **84** is shown in FIG. 3, it is to be understood that any suitable contact arrangement may be employed.

Each pressurized metallic interrupter enclosure **50** includes a pressure chamber, or reservoir **100** maintained in a fixed position within interrupter enclosure **50** by any suitable means, such as by bolts (not shown) or any other suitable fastening means. A check valve **102** is disposed in the wall of the pressure chamber **100**, which closes when the pressure within the chamber **100** exceeds the pressure outside of the chamber **100** by an amount sufficient to overcome the bias of valve springs **104**. When the pressure differential subsides to a predetermined point, the spring bias opens the valve **102** to allow insulating fluid, such as liquid SF_6, to pass into the chamber **100** from the surrounding region.

As shown in FIG. 3, a pair of generally U-shaped movable contact structures **106** and **108**, each including a movable interrupting contact **84** and a movable pressure-generating contact **85**, are shown supported and secured to a reciprocally-operable cross-head structure **110**. The cross-head structure **110**, shown and described herein, is illustrative only, as any suitable operating means for moving the movable contact structures **106**, **108** may be used.

Generally, the cross-head structure **110** includes a spaced pair of insulating bars **112**, which fixedly clamp the lower portions of U-shaped contact structures **106** and **108**. The spaced pair of insulating bars **112** are secured to a metallic channel-shaped member **114**, which provides a pair of raceways **116**. Disposed within the raceways **116** are a pair of driving rollers **118**, secured to the outer free ends of a pair of rotatable driving cranks **120**, pivotally secured on fixed pivot shafts **122**, and having gear segment portions **124**. The gear segment portions **124** mesh with a double-sided rack **126**, which is disposed at the upper end of a metallic coupling member **128**, which is attached to the upper end of the insulating operating rod **48** shown in FIGS. 1 and 2. Opening accelerating springs (not shown) may be disposed around the coupling member **128** in a well known manner. A metallic bellows **130** may be provided to seal the opening **132** leading into the pressurized enclosure **50**. Springs **133** may be used to cushion the movable portion of cross-head structure **110** when the circuit is broken and the cross-head structure **110** returns to its fully open-circuit position, as shown in FIG. 3.

An upward opening motion of coupling member **128** causes the crank-arms **120** to be rotated about their pivot shafts **122** in a direction away from each other, thereby causing the driving rollers **118** to move outwardly to the outer ends of the raceways **116**. The outward movement of the driving rollers **118** will cause the cross-head structure **110** to move downwardly to the open position shown in FIG. 3. This establishes two pressure-generating arcs **140** and two serially-related interrupting arcs **90**, as will be hereinafter explained in more detail.

A downward opening motion of coupling member **128** causes the crank-arms **120** to be rotated in a direction toward each other, which action moves the driving rollers **118** to the inner portions of the raceways **116**, thereby lifting the cross-head structure **110** and causing the movable contacts **84** and **85** to assume their closed-circuit position shown in FIG. 4. This type of cross-head structure arrangement **110** has the advantage of self-alignment and the absence of any lateral forces, which could result in jamming. A more detailed description of the mechanical features and advantages of this type of cross-head arrangement **110** is given in United States patent application Serial No. 101,620, filed April 3, 1961, now U.S. Patent 3,214,541, issued October 26, 1965, to Benjamin P. Baker, et al., and assigned to the same assignee as the present application.

The electrical circuit through interrupter unit **26**, shown in FIGS. 3 and 4, comprises left-hand terminal stud **74**, stationary contact adapter **76**, stationary interrupter contact **80**, movable interrupter contact **84**, connecting portion **138**, movable pressure-generating contact **85**, relatively stationary pressure-generating contact **146**, conducting plate **142**, relatively stationary pressure-generating contact **146**, movable pressure-generating contact **85**, connecting portion **138**, movable interrupting contact **84**, stationary contact assembly **80**, stationary contact adapter **76** and the right-hand terminal stud **74**. Thus, the current path through interrupter unit **26** forms a loop, the benefits of which will be hereinafter described.

The relatively stationary pressure-generating contacts **146** illustrate another type of stationary contact that may be used, comprising an inner spring-loaded portion **144** and a lower arcing portion **144***a*. When the movable pressure-generating contact **85** moves from its closed position shown in FIG. 4, to its open position, shown in FIG. 3, the inner portion **144** follows the movable contact **85** for a limited distance to allow the arc **140** to be generated at the lower arcing portion **146** and not at the lower end **144***a* of the inner portion **144**. This keeps the current-carrying contact portion of the relatively stationary pressure-generating contact **144** in good condition.

It will be noted that the generally U-shaped movable contact structures **106** and **108** are disposed such that the movable pressure-generating contacts **85** enter the pressure chamber **100** through an insulating bushing **150**, and the movable interrupting contacts **84** are disposed externally of the pressure chamber **100**. Openings **152** on opposite sides of pressure chamber **100** have directing orifice members **154** disposed therein, with the orifice members **154** arranged to be adjacent the arcs **90** drawn by the movable interrupting contacts **84**, when they move from their closed to their open-circuit positions.

Arc-splitter means **160** are disposed diametrically opposite the openings in the orifice members **154**. Splitter means **160** include a plurality of splitter members **162**, which may be formed of polytetrafluoroethylene, or other suitable material, and are designed to surround and contain the arc **90**, with portions of the splitter members **162** cut away to allow the movable contact **84** to operate without interference with the splitter members **162**. Splitter means **162** provide the high-extinction arc voltage necessary to interrupt high voltages. It is important to note that the splitter means **160** are mounted remotely from the interrupting contacts **80** and **84**, in order to eliminate any solid insulation that might bridge the gap between contacts **80** and **84** in their open-circuit position. An isolating gap **164** is maintained between contacts **80** and **84** while they are in their open-circuit position, thus preventing possible creepage across solid insulating surfaces. As shown in FIG. 3, the splitter means **160** may be mounted on the side walls **166** of tank enclosure **50** by any suitable securing means.

When the movable interrupting and pressure-generating contacts, **84** and **85** respectively, move from the closed-circuit position shown in FIG. 4 to their open-circuit position shown in FIG. 3, they move downwardly as a unit, and simultaneously establish a pair of pressure-generating arcs **140** within the pressure chamber **100** and a pair of interrupting arcs **90**. Because of the loop shape of the electric circuit, the interrupting arms **90** are forced by the magntic field to the outside of the loop, and thus move into engagement with the splitter fingers **162**. The pressure-generating arcs **140** are not affected by the loop shape of the electric circuit to the degree that the interrupting arcs **90** are, because of substantially equal and opposite magnetic fields produced by the particular configuration of the loop at its internal pressure-generating portion. The movement of the interrupting arc **90** is advantageous in the structure shown in FIG. 3, as when the fluid blast is generated, time will not be lost in moving the arc into engagement with the fingers **162**.

As hereinbefore stated, the pressure-generating arcs **140** are produced at substantially the same instant that the interrupting arcs **90** are produced thereby, building up an extremely high pressure within the pressure chamber **100**. The fluid **141**, such as liquefied SF_6, within the pressure chamber **100**, under the high pressure, is ejected outwardly through the directing orifices **152**, as shown by the arrows, and forces the arcs **90** between the splitter members **162** of splitter means **160**, thus lengthening and cooling the arcs **90** and increasing the arc voltage. It will be noted that by arranging the orifices **152** to discharge the high pressure fluid outwardly in diametrically opposite directions, that the resultant reaction upon the pressure chamber **100** is substantially zero. Since these interrupting units are mounted on relatively long supporting columns **40**, it is important not to generate unbalanced forces. The long moment arm would produce torques which would be difficult to brace against if unbalanced forces were encountered.

When the arc is extinguished, it cannot reignite due to tracking across solid insulation, as there is no continuous path of solid insulation bridging the contacts **80** and **84**. Various metallic portions of the interrupter and supporting structure near to the contacts may be shielded with arc-resistive material, such as polytetrafluoroethylene. For example, tubular member **170** may be formed of polytetrafluoroethylene to protect the metallic supporting member from the action of the interrupting arcs **90**.

The interrupting structure shown in FIGS. 3 and 4 is particularly suitable for use with liquefied gases, although a certain degree of interrupting effectiveness is also achieved with an ordinary arc-extinguishing fluid, such as circuit-breaker oil. Although any number of liquefied gases may be used, singly or in combination, such as CO_2, SO_2, SF_6, SeF_6, SOF_2, CCl_2F_2, ClO_3F, C_2F_6, C_3F_8, $CClF_3$ or CF_3Br, an exceptional performance is obtained with liquefied SF_6 and liquefied SeF_6, as the combination of these two gases is highly effective in arc interruption and it possesses excellent insulating qualities.

Another embodiment of the invention is shown in FIGS. 5 and 6, with like reference numerals in FIGS. 3, 4, 5 and 6, indicating like components. Generally, the embodiment shown in FIGS. 5 and 6 provides an interrupting structure **200**, which extinguishes an arc **201** due to the dual action of the splitter fingers **202** and the interrupting orifice **204**. At lower currents the interrupting action is due primarily to orifice action, as sufficient fluid flow will be produced through the orifice **204** to extinguish the arc **201** before contact **210** has reached a point which exposes the splitter interrupter. As the current increases, a point will be reached where the orifice interrupter **204** will be marginal and pass current zeroes. The arc **201** will thus still be ignited when contact **210** reaches its open circuit position exposing the splitter **202**. The interrupting action will thus be a splitter-orifice action, which obtains an interrupting efficiency higher than would be achieved by either the splitter or orifice of interrupters independently. Also, the higher the current to be interrupted, the greater the loop effect, which forces the arc **201** against the splitter **202**. Further, the interrupting assembly **200** provides these advantages without bridging the interrupting contacts in their open position with solid insulation. It will be noted that an isolating gap **206** is maintained between the relatively stationary interrupting contact **208** and the movable interrupting contact **210**. Further, it should be noted that the directing orifice **212**, the interrupting orifice **204**, and the splitter members **202** are all formed in one integral assembly, from polytetrafluoroethylene, or any other suitable insulating material, thus greatly simplifying installation, alignment and servicing of the interrupting structure.

More specifically, the embodiment shown in FIGS. 5 and 6 includes a pressure-generating tube **214**, which may be formed of aluminum, or any other suitable metallic material, which insures that the pressure-generating tube is at the same floating potential as the casing **50** in the open-circuit position of the interrupting unit **26**. This feature is claimed in the aforesaid Patent 3,214,541. Although it is preferable to construct the pressure tube **214** of metal, it may also be formed of an insulating material of sufficient strength to withstand the pressures generated.

The pair of U-shaped contact structures **216** and **218** are substantially the same as in the embodiment of FIGS. 3 and 4, except the movable interrupting contacts **210** are shown as being cylindrical in shape, similar to the movable pressure-generating contacts **220**. The relatively stationary interrupting contacts **208** include an inner spring-loaded portion **222** which has a limited travel, as shown in the closed-circuit position in FIG. 6 and in the open-circuit position in FIG. 5, which allows the fingers **224** to carry the current and the moving portion **222** to draw the arc. This is silimar to the arrangement for the relatively stationary pressure-generating contacts **230**, in which the fingers **232** are used primarily for the continuous current carrying function and lower portion **234** for the arcing function, with the arc **240** transferring from the spring-loaded central portion **236** to the lower arcing portion **234**. The surfaces of the contact **230** which draw the arc may be coated with an arc-resistant material such as copper-tungsten. The movable pressure-generating contact **220** may be designed, as shown, to withdraw below the upper surface of stationary sealing member **242**. Stationary sealing member **242** includes insulating members **243** and **245**, as well as an insert

247, constructed of copper-tungsten, or other suitable material. Insert 247 prevents the arc 240 from burning insulating members 243 and 245.

Relatively stationary pressure-generating contact structure 230 may be designed such that the upper connecting portion 244 carries the current between the two contact structures 230, while the pressure-generating contacts 230 and 220 are in their closed position, as shown in FIG. 6, and the lower connecting portion 246 carries the arc current during the time the movable pressure-generating contact 220 moves to its open-circuit position shown in FIG. 5.

It should be noted that in the arrangement shown in FIG. 5, that the movable interrupting contacts 210 and the pressure-generating contacts 220 enter the pressure generating tube 214, through insulating members 250 and 242, respectively, with the movable interrupting contacts 210 extending through the opposite side of the pressure-generating tube 214 through insulating member 251. Thus, the interrupting arc 201 is drawn externally of the pressure-generating tube 214, and the pressure-generating arcs 240 are drawn within the pressure-generating tube 214 to generate pressure therein.

The current path through interrupting structure 26, when it is in its closed-circuit position shown in FIG. 6, is from the left-hand terminal stud 74, through contact adapter 76, fixed interrupting contact 208, movable interrupting contact 210, connecting portion 252, movable pressure-generating contact 220, stationary pressure-generating contact 232, connecting portion 244, stationary pressure-generating contact 232, movable pressure-generating contact 20, connecting portion 252, movable interrupting contact 210, stationary interrupting contact 208, contact adapter 76, and right-hand terminal stud 74. The generally U-shaped movable contact structure 216 and 218 may be moved vertically by a cross-head structure 110, as already described in connection with FIG. 3, or by any other suitable mechanism.

When cross-head structure 110 moves downwardly, causing the movable contact structures 216 and 218 to leave their closed-circuit position shown in FIG. 6, arcs 201 and 240 are generated simultaneously, with the pressure-generating arcs 240, through the liquefied gas 241, which is disposed within the pressure-generating tube 214, producing an extremely high pressure within the tube 214. The fluid 241, under pressure, is ejected through the openings 260, and through the directing orifices 212 into the region of the arc 201, as shown by the arrows. The fluid moves both perpendicularly to the arc 201, forcing the arc 201 into the vent openings formed by the interrupting fingers 202, and also moves parallel or axially of the arc through interrupting orifice 204, which aids in extinguishing the arc 201 by orifice action. The arc 201, by the loop action hereinbefore described, immediately moves toward the splitters 200, and the gas blast forces the arc into the splitter vent openings, lengthening and cooling the arc and increasing the arc voltage. The gas movement, parallel with the arc, also cools the arc and aids its extinguishment by the abrupt pressure change due to orifice action. Once extinguished, isolation gap 206 ensures that there will be no restriking due to creepage across solid insulation surfaces. The splitter 200 is mounted remotely from the stationary interrupting contacts 208. In this instance, the splitter-orifice assembly is mounted upon the pressure-generating tube 214.

Once the high pressure within pressure tube 214 subsides, a pressure valve 262, which closes when the pressure builds up to a predetermined magnitude, opens to allow fluid 241 to enter the pressure tube 214 to make up for the fluid loss by the ejectment of fluid under high pressure. The types of fluids usable in the embodiment shown in FIG. 5 may be the same as those discussed relative to FIG. 3. Arc shields, such as shields 270 and 272, may be constructed of polytetrafluoroethylene and disposed to protect metallic surfaces from the effects of the arcs 201 and 240.

Thus, there has been shown and described a new and improved interrupting unit suitable for very high voltages, which provides the advantage of high arc voltage without the disadvantage of furnishing creepage paths across solid insulation between open interrupting contacts. Also, a new and improved interrupting unit, which combines the high dielectric disconnect gap of the orifice-type interrupter unit with the high arc voltage of the splitter-type interrupter, to provide an interrupter of high efficiency, has been shown and described. In the embodiment of FIG. 5, the directing orifice, the interrupting orifice and splitter may be formed in one simple integral assembly, which greatly facilitates manufacturing, assembly and maintenance of the interrupter unit.

Since numerous changes may be made in the above-described apparatus, and different embodiments of the invention may be made without departing from the spirit thereof, it is intended that all matter contained in the foregoing description, or shown in the accompanying drawings, shall be interpreted as illustrative, and not in a limiting sense.

I claim as my invention:

1. A circuit interrupter comprising a plurality of interrupting and pressure-generating contacts connected in series circuit relation which open and close at substantially the same time to break and complete an electrical circuit, a pressure chamber, said pressure-generating contacts being disposed to break and complete the electrical circuit within said pressure chamber and to generate a pressure therein, said interrupting contacts being disposed to break and complete the electrical circuit externally of said pressure chamber, said pressure chamber having opposed side orifice openings with one orifice opening disposed adjacent each of said interrupting contacts, arc-interrupting means including an arc splitter structure disposed adjacent said interrupting contacts diametrically opposite the opposed side orifice openings in said pressure chamber, said arc-interrupting means being arranged by remote mounting to allow isolation gaps to be produced between said interrupting contacts when they are in their open position.

2. A circuit interrupter comprising first and second substantially U-shaped movable contact structures each providing a movable interrupting contact and a movable pressure-generating contact, a pressure chamber having two diametrically opposite side orifices therein, a pair of serially-connected stationary pressure-generating contacts disposed within said pressure chamber, a pair of stationary interrupting contacts disposed externally and on opposite sides of said pressure chamber adjacent the side orifices in said pressure chamber, a pair of interrupting means each including an arc splitter disposed adjacent said pair of stationary interrupting contacts and diametrically opposite a side orifice in said pressure chamber, the interrupting contacts of said movable U-shaped contact structures being movable into engagement with said stationary interrupting contacts, the associated pressure-generating contact of each U-shaped movable contact structure being cooperable with one of said interiorly-located stationary pressure-generating contacts for generating a pressure within said pressure chamber to provide opposed side fluid blasts out through the two side orifices, said pair of arc-interrupting means each being secured to a point remote from said stationary and movable interrupting contacts to allow an isolating gap to be created between said stationary and movable interrupting contacts when they are in their open position.

3. A circuit interrupter including a casing and comprising first and second substantially U-shaped movable contact structures each providing a movable interrupting contact and a movable pressure-generating contact, a pressure chamber disposed interiorly of said casing and having two diametrically opposite side orifices therein,

a pair of serially-connected stationary pressure-generating contacts disposed within said pressure chamber, a pair of stationary interrupting contacts disposed externally of the pressure chamber and adjacent the orifices in said pressure chamber, a pair of arc-splitter means disposed adjacent said pair of stationary interrupting contacts and diametrically opposite the orifices in said pressure chamber, said pair of arc-splitter means being secured to opposite side walls of said casing, the interrupting contacts of said movable U-shaped contact structure being movable into engagement with said stationary interrupting contacts, the associated pressure-generating contact of each U-shaped movable contact structure being cooperable with one of said interiorly-located stationary pressure-generating contacts for generating a pressure within said pressure chamber for providing opposed side fluid blasts out of the two side orifices, said pair of arc-splitter means each being so secured to the side walls of the casing at a point remote from said stationary and movable interrupting contacts to allow an isolating gap between said stationary and movable interrupting contacts when they are in their open position.

4. A circuit interrupter comprising an outer casing and a pair of substantially U-shaped movable contact structures disposed therein, each providing an interrupting contact and a pressure-generating contact, a pressure chamber disposed interiorly of said casing and having two lower openings for receiving the movable pressure generating contact of each U-shaped movable contact structure and two diametrically opposite side fluid-directing orifices therein, a pair of serially connected stationary pressure-generating contacts disposed within said pressure chamber and cooperable with said movable pressure-generating contacts, a pair of stationary interrupting contacts disposed externally of said pressure chamber but interiorly of said outer casing and cooperable with the movable interrupting contact of said U-shaped movable contact structure, said stationary and movable interrupting contacts being disposed so that an arc drawn between them will be adjacent said side fluid-directing orifices, a pair of arc-splitter means disposed adjacent said stationary and movable interrupting contacts and diametrically opposite said fluid-directing orifices, said pair of arc-splitter means being secured to the opposed side walls of said outer casing to create an isolating gap free of adjacent solid insulation between said stationary and movable interrupting contacts when they are in their open position.

5. A fluid-blast type of circuit interrupter comprising a pressure-resistant outer enclosure, a pair of terminal bushings extending into said outer enclosure, a pair of stationary interrupting contacts disposed at the interior ends of said terminal bushings, a dielectric fluid disposed within said outer enclosure, a pressure chamber having a pair of side fluid-directing orifices disposed therein, a pair of serially-connected stationary pressure-generating contacts disposed within said pressure chamber, a pair of substantially U-shaped movable contact structures each including a movable interrupting contact and a movable pressure-generating contact for engaging said pair of stationary interrupting contacts and said pair of stationary pressure-generating contacts, said stationary and movable interrupting contacts being disposed adjacent said pair of side fluid-directing orifices, a pair of arc-splitter means disposed adjacent said stationary and movable interrupting contacts and diametrically opposite said side fluid-directing orifices, said pair of arc-splitter means being secured to the opposed end walls of said outer casing to allow an isolating gap to be created between said stationary and movable interrupting contacts when in their open position, and means moving said pair of U-shaped movable contact structures simultaneously to establish a pair of serially-related pressure-generating arcs within said pressure chamber between said stationary and movable pressure generating contacts which forces fluid through said pair of side fluid-directing orifices to effect the extinction in said arc splitter means of two serially-related interrupting arcs drawn between said stationary and movable interrupting contacts.

6. An electrical circuit interrupter of the fluid-blast type comprising a first and second set of serially-connected contacts each having a stationary and movable contact, a pressure chamber having a fluid-directing orifice disposed therein, said second set of contacts being disposed to break and complete an electrical circuit within said pressure chamber and generate a pressure therein, said first set of contacts being disposed to break and complete the electrical circuit outside of said pressure chamber adjacent the fluid-directing orifice in said pressure chamber, confining arc-interrupter means including an arc splitter and an interrupting orifice, said arc splitter being disposed diametrically opposite said fluid directing orifice, said interrupting orifice being disposed to allow the movable contact of said second set of contacts to move through the opening in said orifice and draw an arc from its associated stationary contact therethrough and interiorly of said confining arc-interrupter means, the pressure generated within said pressure chamber by said second set of contacts causing a fluid flow out of the directing orifice into said arc splitter and said interrupting orifice, said arc interrupter means being secured remotely from said first set of contacts to allow an isolating gap to be produced between the stationary and movable contacts of said first set of contacts when they are in their open position.

7. A circuit interrupter of the fluid blast type comprising first and second substantially U-shaped movable contact structures each providing a movable interrupting contact and a movable pressure-generating contact, a pressure chamber having two diametrically opposite fluid-directing openings therein, a pair of serially-connected stationary pressure-generating contacts disposed within said pressure chamber, a pair of stationary interrupting contacts disposed externally of the pressure chamber and adjacent the fluid-directing openings in said pressure chamber, a pair of confining arc-interrupting means each including an arc splitter and an interrupting orifice, the movable interrupting contacts of said movable U-shaped contact structures being movable through the interrupting orifices of said confining arc interrupting means and into engagement with said stationary interrupting contacts, the movable pressure-generating contacts of each of said U-shaped movable contact structures being cooperable with one of said interiorly-located stationary pressure-generating contacts for generating a pressure within said pressure chamber for generating a fluid blast out of said fluid-directing openings, said pair of arc-interrupting means each being secured remotely from said stationary and movable interrupting contacts to allow an isolating gap between said stationary and movable interrupting contacts to be created when they are in their open position.

8. A circuit interrupter of the fluid-blast type comprising a pair of substantially U-shaped movable contact structures each providing a movable interrupting contact and a movable pressure-generating contact, a pressure chamber having openings for receiving the movable interrupting and pressure generating contacts, with the movable interrupting contacts extending completely through said pressure chamber, said pressure chamber also having a pair of fluid-directing openings for allowing fluid to escape when the pressure in said pressure chamber exceeds the external pressure, a pair of serially-connected stationary pressure-generating contacts disposed within said pressure chamber and cooperable with said movable pressure-generating contacts, a pair of stationary interrupting contacts disposed external to said pressure chamber and cooperable with the movable interrupting contacts extending through said pressure chamber, said stationary and movable interrupting contacts being disposed so that an arc drawn between them will be adjacent

one of the fluid-directing openings in said pressure chamber, a pair of confining arc-interrupting means including an arc splitter and an interrupting orifice, said interrupting orifice being aligned with one of said movable interrupting contacts such that said movable interruping contact moves through said interrupting orifice to make engagement with said stationary interrupting contact and draws an arc back through said interrupting orifice when said movable interrupting contact moves back to its open position, said arc splitter being disposed such that it is diametrically opposite the directing orifice, with the fluid flow from the directing orifice forcing the arc into said arc splitter, said pair of arc-interrupting means being secured remotely from said stationary and movable interrupting contacts to create an isolating gap free of solid insulation between said stationary and movable interrupting contacts when they are in their open position.

9. A fluid-blast type circuit interrupter comprising a pressure-resistant outer enclosure, a pair of terminal bushings extending into said outer enclosure, a pair of stationary interrupting contacts disposed at the interior ends of said terminal bushings, a dielectric fluid disposed within said outer enclosure, a pressure chamber having a pair of fluid-directing openings disposed therein, a pair of serially-connected stationary pressure-generating contacts disposed within said pressure chamber, a pair of substantially U-shaped movable contact structures each including a movable interrupting contact, and a movable pressure-generating contact for engaging said pair of stationary interrupting contacts and said pair of stationary pressure-generating contacts, said stationary and movable interrupting contacts being disposed adjacent said pair of fluid-directing openings, a pair of confining arc-interrupting means including an arc splitter and an interrupting orifice, said interrupting orifice being aligned with one of said movable interrupting contacts with the movable interrupting contact moving through the interrupting orifice to make engagement with said stationary interrupting contact and drawing an arc back through said interrupting orifice when said movable interrupting contact moves to its open position, said arc splitter being disposed diametrically opposite the fluid-directing opening, with fluid flow from the directing opening extinguishing the arc drawn between the stationary and movable interrupting contacts by forcing the arc into the arc splitters and by fluid flow through the interrupting orifice, said pair of arc-interrupting means being secured remotely from said stationary and movable interrupting contacts to allow an isolating gap to be created between said stationary and movable interrupting contacts when they move to their open position.

10. A fluid-blast circuit interrupter comprising, in combination, means defining a pressure chamber, a U-shaped movable contact structure including a movable pressure-generating contact and a movable interrupting contact, said movable pressure-generating contact being movable interiorly of said pressure chamber, a stationary pressure-generating contact disposed interiorly of said presssure chamber and cooperable with said movable pressure-generating contact to establish a pressure-generating arc within said pressure chamber for establishing pressure therein, a stationary interrupting contact disposed externally of said pressure chamber and cooperable with said movable interrupting contact to establish an interrupting arc externally of said pressure chamber, a confining arc-interrupting means including an arc-extinguishing splitter structure and an orifice structure disposed adjacent the path of movement of said movable interrupting contact, fluid-directing means associated with said pressure chamber for directing fluid under pressure out of said pressure chamber to force the interrupting arc laterally into said arc-extinguishing splitter structure with a portion of the fluid flowing through said orifice structure, and means providing a free space between said stationary interrupting contact and said confining arc-interrupting means in the open-circuit position of the interrupter to prevent tracking and creepage breakdown in the open-circuit position.

11. A fluid-blast circuit interrupter according to the combination of claim **10**, wherein two such U-shaped movable contact structures are employed and the parts duplicated to result in a generally U-shaped current path through the interrupter so that magnetic action assists the fluid-blasting action to drive the two interrupting arcs into the two laterally positioned splitter structures.

12. A fluid-blast circuit interrupter including an insulating arc-extinguishing structure for extinguishing an arc, said arc-extinguishing structure including an axially-disposed exhaust orifice means (**204**) and a laterally-disposed fluid-entrance orifice means (**212**), contact means including a movable contact rod actuable to withdraw through said axially-disposed exhaust orifice means (**204**) and laterally past said fluid-entrance orifice means (**212**), an arc-splitter structure disposed diametrically on the opposite side of the path of movement of said movable contact rod from said fluid-entrance orifice means, means forcing fluid under pressure through said fluid-entrance orifice means transversely against the established arc to force the latter toward said arc-splitter structure, and said fluid also exhausting out of the insulating arc-extinguishing structure through the axially-disposed exhaust orifice means.

13. The combination of claim **12** wherein means provide a free gap space between the arc-extinguishing structure and the stationary contact of the contact means.

14. The combination according to claim **12**, wherein a serially-related pressure-generating arc provides the fluid flow through said fluid-entrance orifice means (**212**).

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