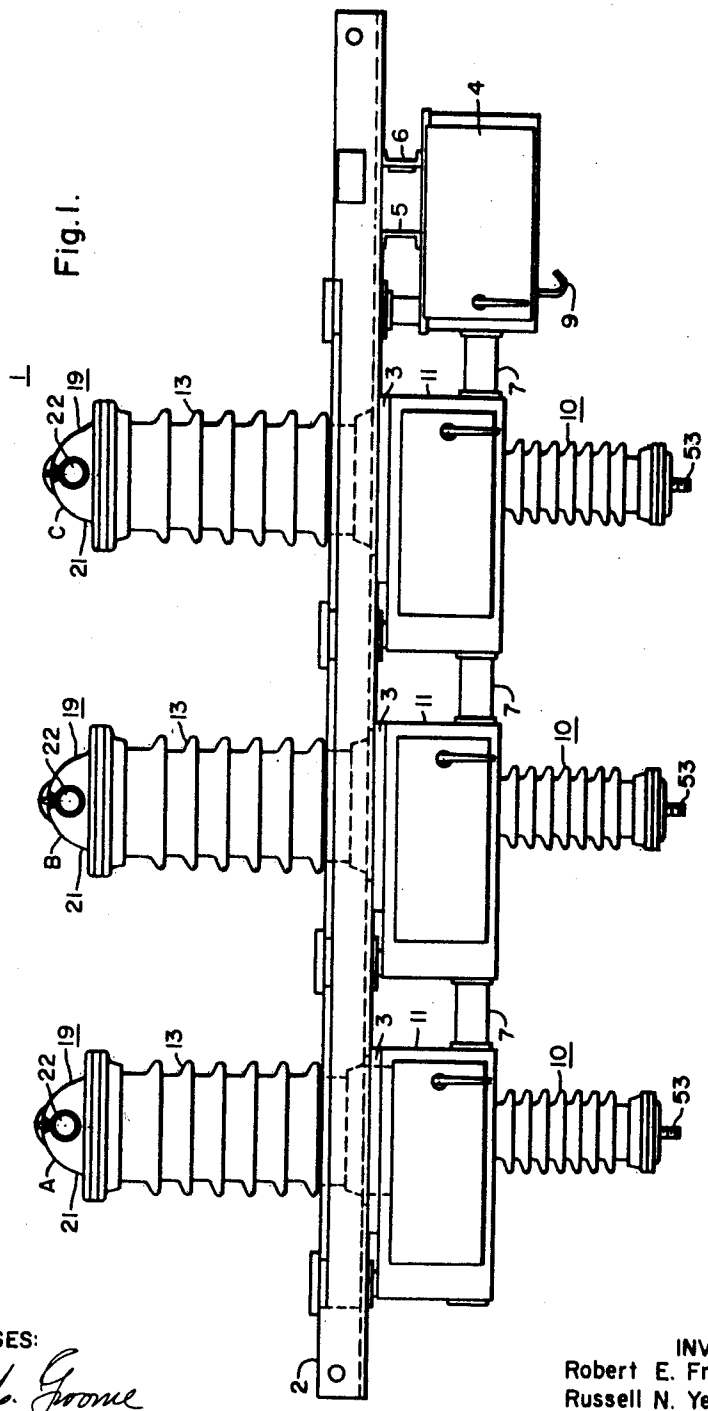
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CIRCUIT INTERRUPTERS

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7 Sheets-Sheet 1

Fig. 1.



WITNESSES:

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CIRCUIT INTERRUPTERS

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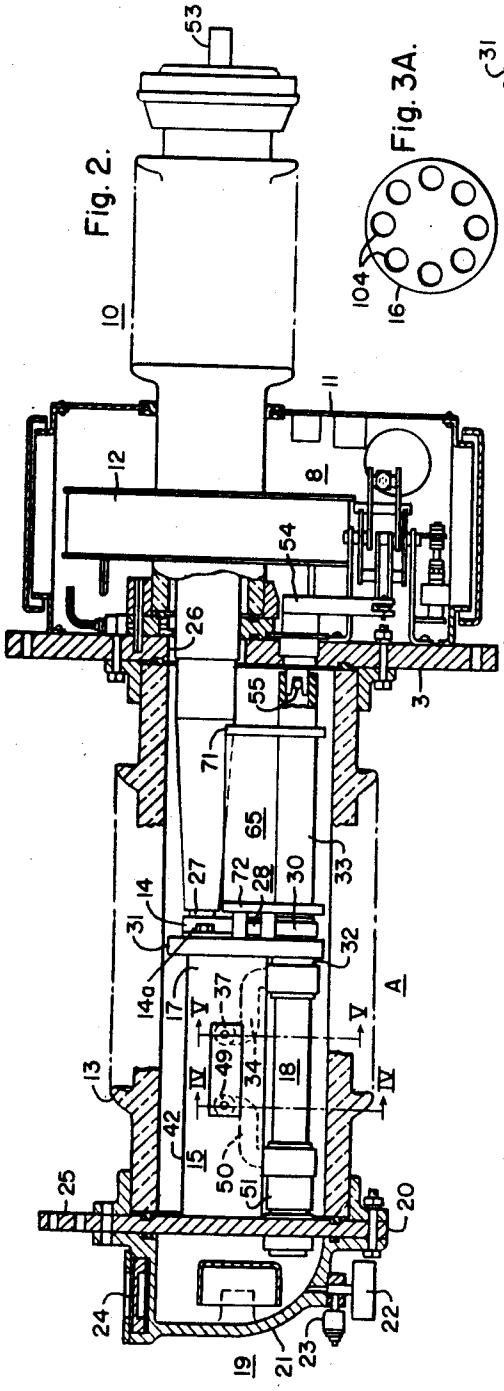


Fig. 2.

Fig. 3A.

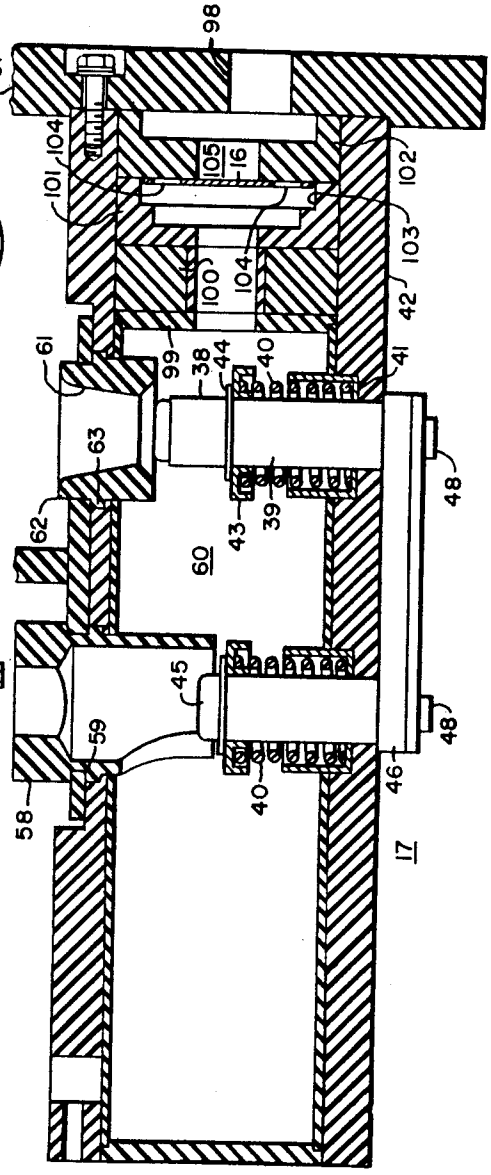


Fig. 3.

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Fig. 4.

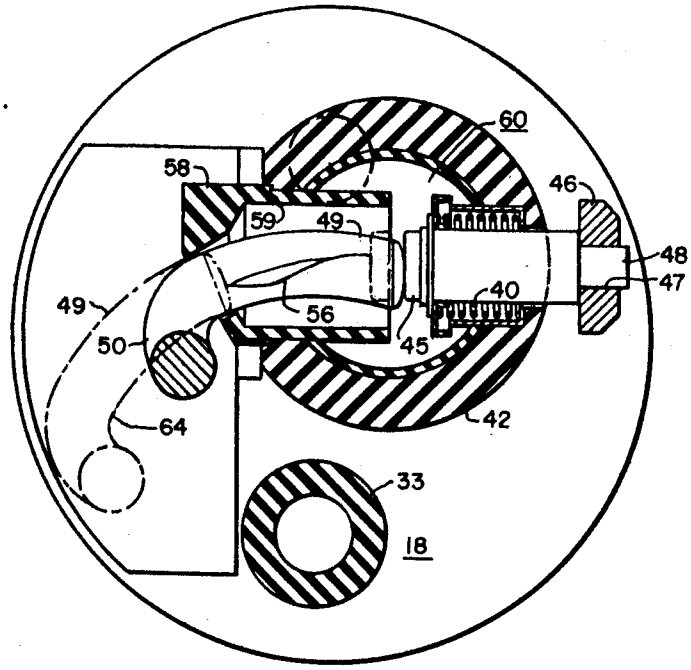
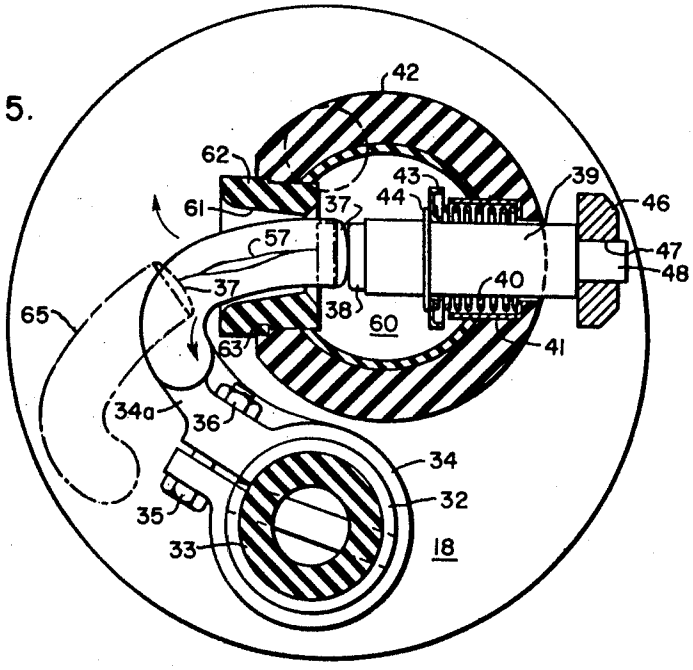


Fig. 5.



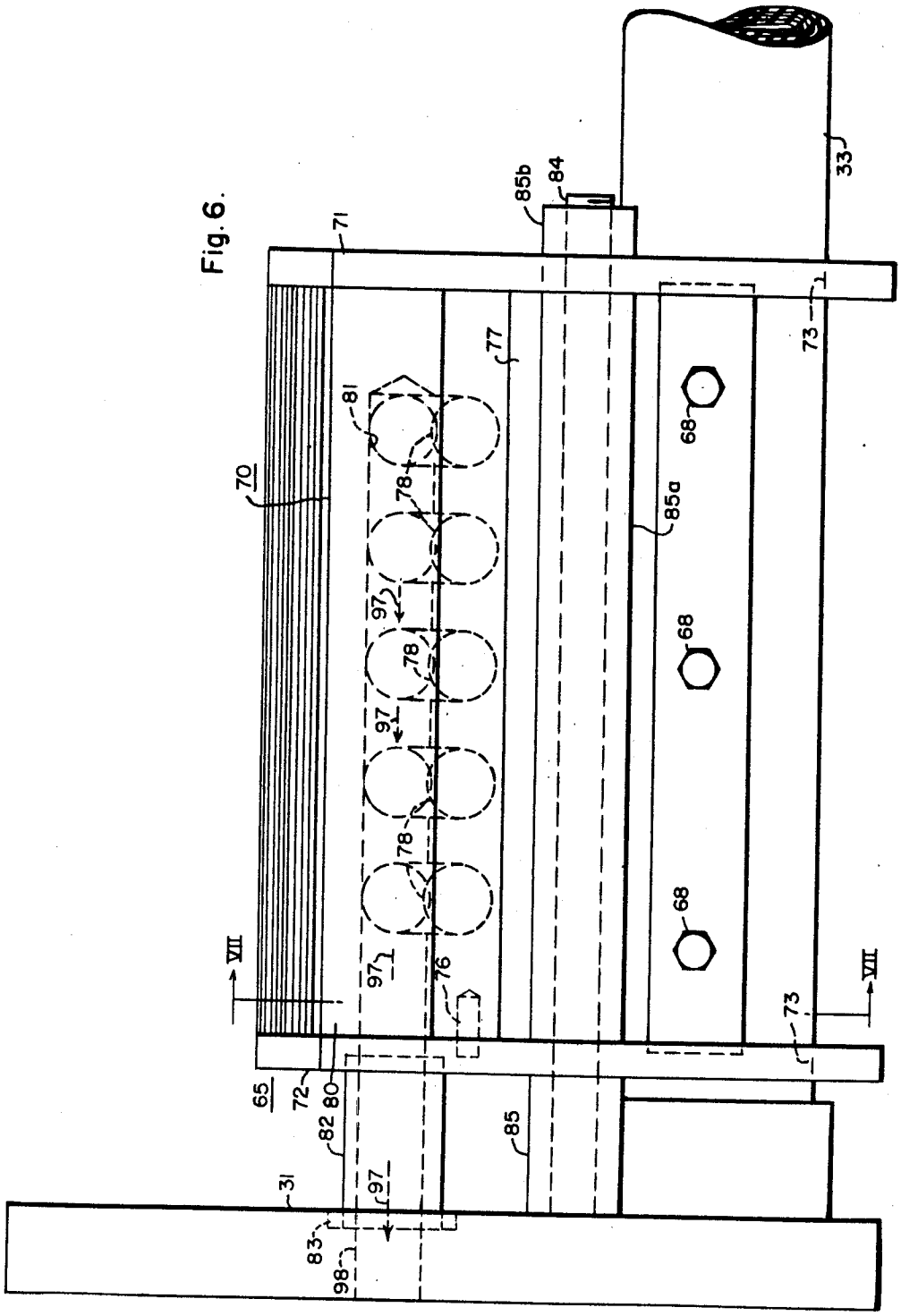
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Fig. 6.



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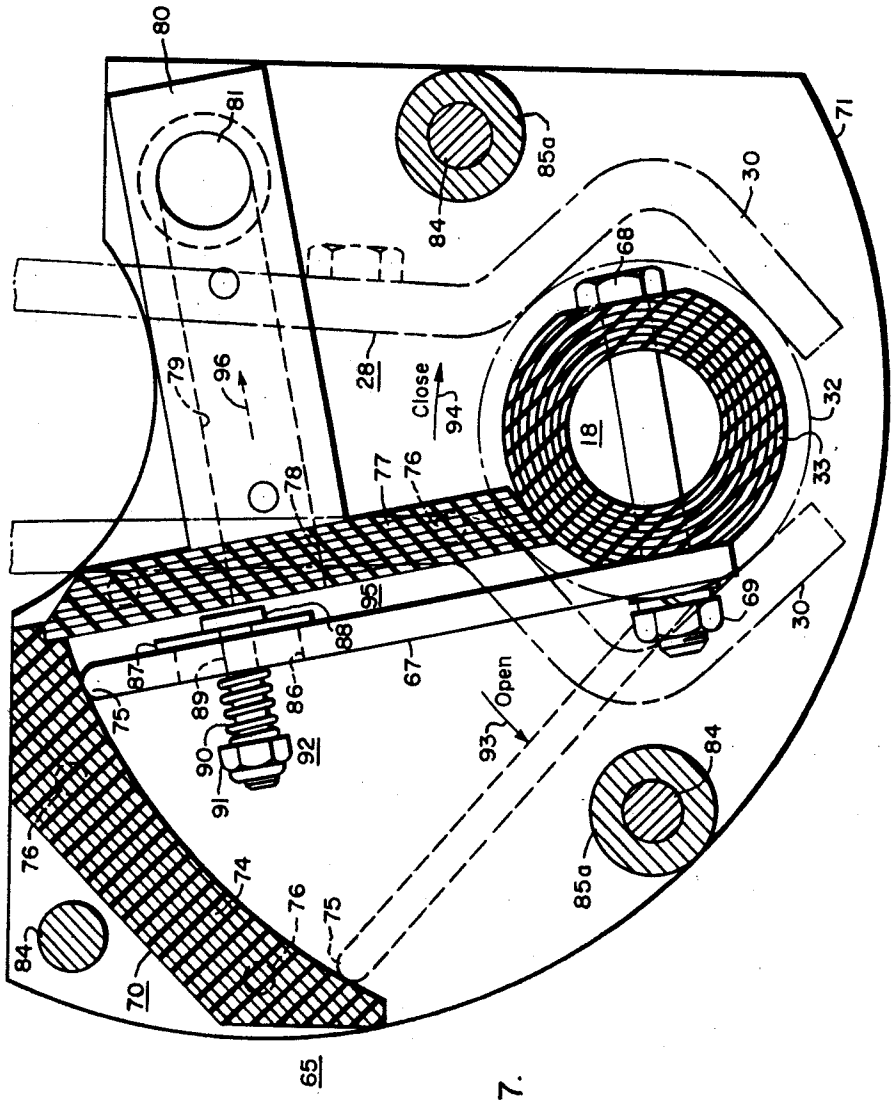


Fig. 7.

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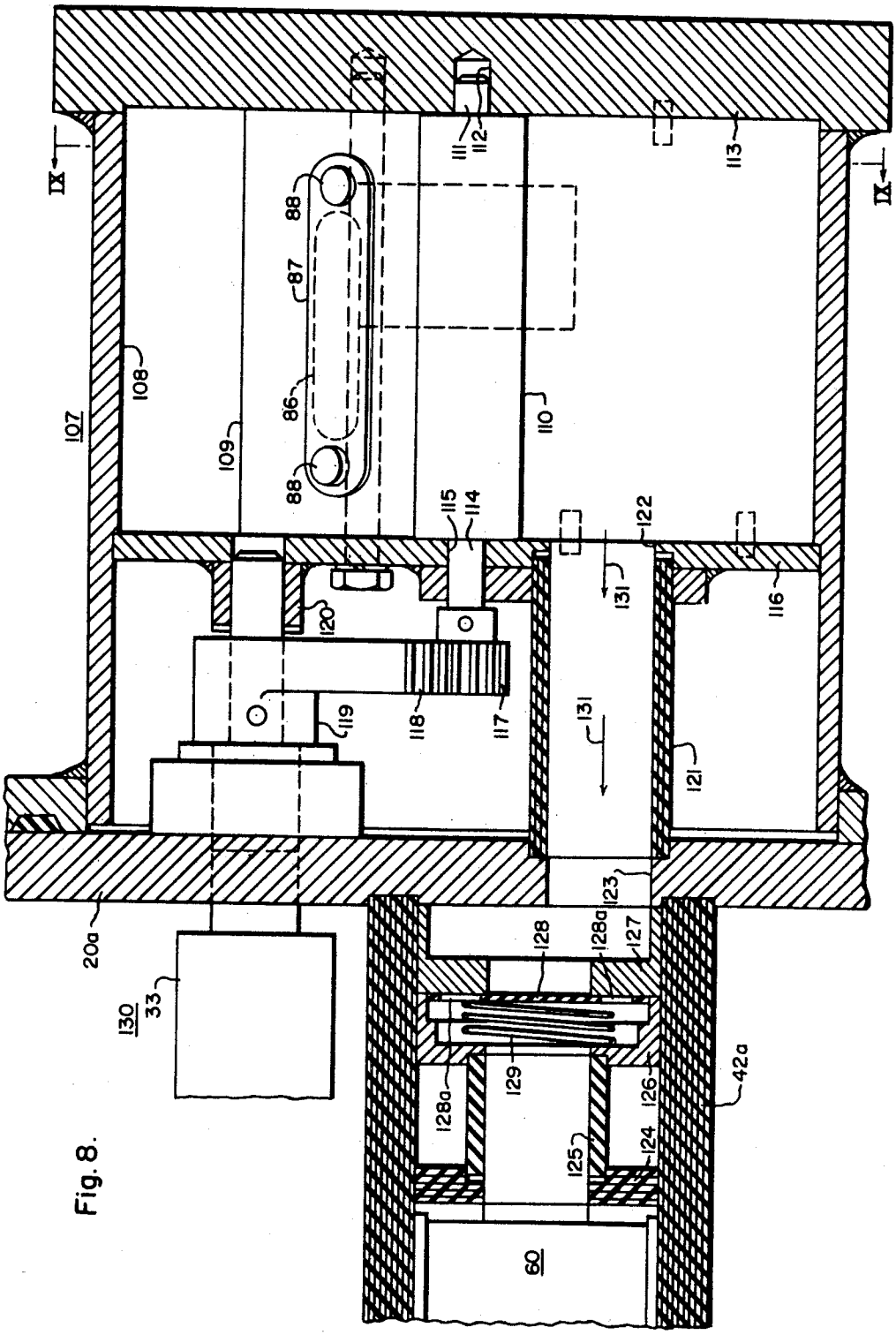


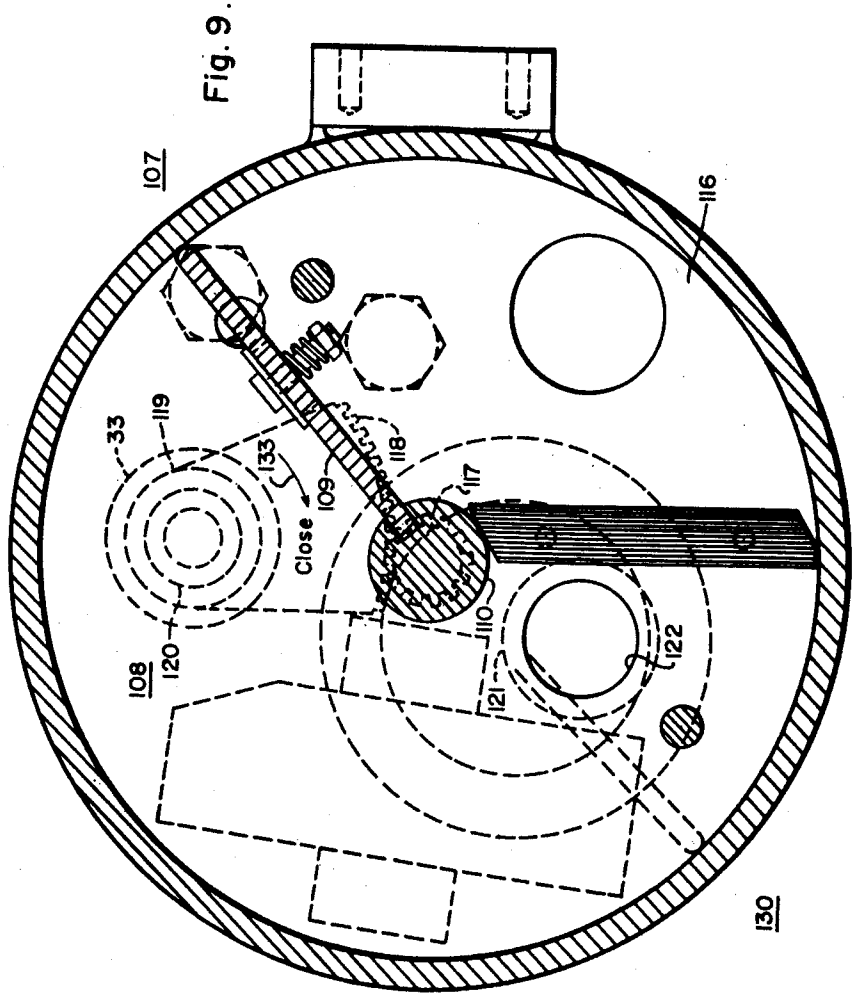
Fig. 8.

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Fig. 9.



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2,933,576

CIRCUIT INTERRUPTERS

Robert E. Friedrich, Baldwin, and Russell N. Yeckley, Monroeville, Pa., assignors to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application October 3, 1958, Serial No. 765,173

11 Claims. (Cl. 200—148)

This invention relates to circuit interrupters in general and, more particularly, to arc-extinguishing structures and piston assemblies therefor.

With the rapid growth of the electrical industry in recent years and consequent system expansion, some existing sub-transmission or "middle voltage" 46 kv. systems have virtually become distribution systems supplying power to industrial and distribution substations. This change in the basic use from bulk power supply to local power supply can be expected to become more prevalent with continued load growth. It is, therefore, necessary to provide equipment for sectionalizing lines to eliminate or minimize outages on these circuits.

Power circuit breakers manufactured to conform to present standards assure more interrupting ability than is required, and are, therefore, under most circumstances, uneconomical for this application. The automatic circuit recloser for these higher voltage distribution systems, designed for lower interrupting capacity, is fundamentally lower in cost and at the same time provides other advantages.

In U.S. patent application, filed September 14, 1956, Serial No. 609,915, by Robert E. Friedrich, entitled "Circuit Interrupter," and assigned to the assignee of the instant application, there is described and claimed a novel circuit-interrupter construction particularly adapted for the "middle voltage" circuits, such, for example, as those from 23 to 69 kv. It is a general object of the present invention to improve upon the interrupting ability of the circuit interrupters described in the aforesaid application, by associating with such a circuit interrupter a piston assembly, which is adapted to effect purging of the contaminated or heated gases within the interrupting chamber during the closing operation of the interrupter.

Another object of the present invention is to provide an improved piston, or puffer assembly for a fluid-blast circuit interrupter, which is of compact size, simple and effective in operation, and is readily adaptable for inclusion in the interrupting structure of fluid-blast circuit interrupters.

Another object of the present invention is to provide an improved piston assembly for a fluid-blast circuit interrupter, in which means are incorporated to increase the speed of travel of the piston vane relative to the speed of operation of the contact structure, so as to provide an increased volume of fluid flow into the arcing chamber to effect purging of the arced gases therein.

Although the piston or puffer assembly disclosed in the present invention has applicability to any type of fluid-blast circuit interrupter, it has particular applicability and advantage when applied to a circuit interrupter utilizing a substantially enclosed arcing chamber, which is vented with some difficulty. For example, in the type of circuit interrupter employing two arcs in series, one of which is a pressure-generating arc and the other being an interrupting arc, necessarily the surrounding interrupting chamber must be substantially closed, so as to utilize the pressure effectively resulting from the

thermal expansion of the gas. It has been found that in such types of circuit interrupters there may exist the possibility of local high-temperature regions.

Development testing of fluid-blast circuit interrupters, particularly those of the gas-blast form of the self-pressure-generating type, has indicated a decrease in interrupting performance during consecutive tests, using short-time intervals between tests, in particular multiple-reclosings. The decrease in interrupting ability on multiple-reclosings has been found to be caused by the formation of a less dense gas in the interrupter chamber. During interruption, arcing heats the gas in the interrupter chamber. Operations immediately following will not allow enough time to permit the dissipation of this heat by natural means, such as convection or conduction. Since the interrupting chamber is connected to the volume of the circuit interrupter, the result is that the substantially enclosed arcing chamber contains gas at normal pressure, elevated temperature and decreased density. Since interrupting performance is a function of density, this condition of decreased gas density within the substantially enclosed interrupting chamber will result in a lowering, or a drop in interrupting ability.

It is, therefore, a further object of the present invention to provide an improved puffer assembly, which will function in conjunction with a circuit interrupter to purge the arced gas within the substantially enclosed interrupting chamber.

In the specification and in the accompanying claims, it is to be understood that the term "fluid" includes gases, liquids, vapors and sprays. For purposes of illustration, however, and not by way of limitation, the present invention will be described as applied to a 46 kv. relatively low-capacity circuit interrupter adaptable for multiple reclosing duty, and utilizing as the arc-extinguishing fluid sulfur hexafluoride (SF_6). The remarkable insulation and arc-interrupting characteristics of sulfur hexafluoride are described in detail in U.S. Patent No. 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.

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 front elevational view of a three-pole automatic circuit recloser, embodying the principles of the present invention;

Fig. 2 is an enlarged side elevational view, partially in vertical section, of one of the pole-unit assemblies, the contact structure being illustrated in the closed-circuit position;

Fig. 3 is a vertical sectional view through the arc-interrupting unit of the pole-unit assembly of Fig. 2;

Fig. 3A is a plan view of the apertured valve plate disposed within the interrupting chamber to prevent reverse flow to the piston assembly;

Figs. 4 and 5 are enlarged sectional views taken substantially along the lines IV—IV and V—V, respectively, of Fig. 2, the contact structures being shown in the closed-circuit position;

Fig. 6 is an enlarged side elevational view of the puffer assembly employed in the pole unit of Fig. 2;

Fig. 7 is an end sectional view of the puffer assembly of Fig. 6, taken substantially along the line VII—VII of Fig. 6, with the movable parts being illustrated in the closed-circuit position;

Fig. 8 illustrates a modified type of puffer assembly, which may be applied at the upper end of a pole-unit assembly, such as ilustrated in Fig. 2, taking the place of the upper cap assembly; and,

Fig. 9 is a top plan view, in section, of the modified

type puffer assembly of Fig. 8, taken substantially along the line IX—IX thereof, with the contact structure being illustrated in the closed-circuit position.

Referring to the drawings, and more particularly to Fig. 1 thereof, it will be observed that the circuit interrupter of the present invention is illustrated as of the automatic circuit-recloser type, and is generally designated by the reference numeral 1. Generally, the circuit interrupter 1 includes three pole-unit assemblies, designated by the reference letters A, B, and C in Fig. 1. The pole-unit assemblies A, B and C are identical in structure, and, therefore, a description of the operating features of one of the pole-unit assemblies will suffice for an understanding of the operation of all three of them.

As noted in Fig. 1, the pole-unit assemblies A, B and C are supported upon a pair of spaced, horizontally extending, angle irons 2, only one of which is illustrated in Fig. 1. Grounded mounting plates 3, composed of sheet steel, are fixedly secured between the horizontally extending angle irons 2, resulting in a rigid structure. Disposed at the right-hand end of the circuit interrupter 1, as viewed in Fig. 1, is a mechanism compartment 4, secured to a pair of channel members 5, 6, which may be welded below the angle irons 2.

Generally, the mechanism compartment 4 houses a closing solenoid, not shown, which serves to actuate a horizontally extending operating rod, which extends horizontally through pipes 7, interconnecting the several pole units. The horizontally extending operating rod is suitably linked to the operating mechanism 8 (Fig. 2) associated with each pole-unit assembly. Thus, should any pole-unit assembly be tripped open upon overload, or by the passage of fault current, the solenoid, within the mechanism compartment 4, will be actuated so as to move the horizontally extending operating rod, within pipes 7, to the right, effecting thereby contact reclosure in one or more pole units which have been opened by the fault current. If any pole unit assembly has opened, the solenoid mechanism will be effective to close that pole-unit assembly, which has opened, the other two pole-unit assemblies remaining closed. A preferable type of operating mechanism for the automatic circuit recloser 1, herein illustrated, is set out and claimed in U.S. patent application filed December 24, 1956, Serial No. 630,304, by Roswell C. Van Sickle, Fritz E. Florschutz and Joseph Sucha, and assigned to the assignee of the instant application.

The solenoid mechanism, disposed within mechanism compartment 4, is effective to reclose the pole units a number of times following repeated reopening, before an integrator, not shown, functions to prevent further reclosing action of the solenoid mechanism, and permits the pole-unit assemblies to remain open. A manually operable trip lever 9 may be manually engaged by an operator with a hook stick, and this will effect, through suitable linkage, horizontal movement of a second horizontally extending rod, also passing through pipes 7, which will trip the mechanism 8 associated with each pole-unit assembly.

With particular reference to Fig. 2 of the drawings, it will be noted that each pole-unit assembly includes a single terminal bushing, which may be of the condenser type, generally designated by the reference numeral 10, a mechanism housing 11 enclosing a current transformer 12, and an operating mechanism 8. As observed in Fig. 2, the terminal bushing 10 and the mechanism housing 11 depend from the grounded mounting plate 3, the latter resting upon the spaced angle irons 2, as hereinbefore described.

In addition, each pole-unit assembly includes an upstanding, weatherproof, insulating casing 13, preferably composed of a suitable weatherproof material, such as porcelain. The insulating casing 13 encloses, in a gas-tight manner, an interrupter assembly, generally designated by the reference numeral 15, and including an arc-extinguishing unit 17 and a rotatable contact structure 18.

Enclosing the upper open end of the hollow porcelain casing 13 is a cap structure, generally designated by the reference numeral 19, and including a mounting terminal plate 20, in this particular instance composed of aluminum, and a cap casting 21, also composed of aluminum. The cap structure 21 supports a pressure gauge 22, a valve 23 and a rupture disc 24. The mounting terminal plate 20 has a terminal pad extension 25 (Fig. 2) for the accommodation of a transmission-line cable.

With particular reference to Fig. 2 of the drawings, it will be observed that the terminal bushing 10 is clamped by means, not shown, to the grounded mounting plate 3 and extends therethrough, through an opening 25, and has the interior end of the terminal stud 27 thereof received between a pair of contact fingers 28. As set out in detail in the aforesaid patent application Serial No. 609,915, the contact fingers 28 are biased toward each other by a compression spring, surrounding a bolt and are spaced apart by a surrounding spacing sleeve, not shown.

The contact fingers 28 are enclosed within a substantially T-shaped bracket member 14, secured by bolts 14a to an insulating support plate 31, in a manner more fully disclosed in the aforesaid Friedrich application.

As shown more clearly in Fig. 7 of the drawings, the inwardly biased clamp-type contact fingers 30 of the finger assembly 28 make resilient engagement with a contact sleeve 32 surrounding an insulating tubular drive shaft 33. The contact sleeve 32 extends upwardly through the insulating support plate 31, and, above the plate 31 has clamped thereabout a rotatable contact-arm casting 34, as illustrated in Fig. 5 of the drawings. With reference to Fig. 5, it will be observed that the contact-arm casting 34 has a clamping bifurcated portion 34a, which is clamped about the contact sleeve 32 by a bolt 35 and a nut 36. The configuration of the contact arm 34 is apparent from a study of Figs. 2 and 5 of the drawings.

At the outer free extremity of the contact arm 34 is a rotatable interrupting contact 37, which makes abutting, resilient, contacting engagement with a relatively stationary interrupting contact 38 (Fig. 3). The shank portion 39 of the relatively stationary interrupting contact 38 has a helical contact pressure spring 40 disposed thereabout, which bears at one end within a cup-shaped recess 41 provided in the inner side wall of an insulating tubular interrupting chamber 42. The outer end of the contact biasing spring 40 bears against a cup-shaped washer 43, which surrounds the shank 39 of contact 38 and is maintained in position by a locking ring 44 (Fig. 3).

It will be noted, with reference to Fig. 3 that there are provided two such relatively stationary contacts 38, 45, of substantially identical construction, which are electrically and mechanically interconnected externally of the interrupting chamber 42 by an intermediate contact plate 46, which has openings 47 (Figs. 4 and 5) provided therein. The openings 47 accommodate reduced stud portions 48 of the stationary contacts 38, 45 which are brazed thereto, thus forming a resilient, substantially U-shaped relatively stationary contact structure.

Making abutting contacting engagement with the upper relative stationary contact 45 is a rotatable pressure-generating contact 49, more clearly shown in Figs. 2 and 4 of the drawings. The rotatable movable pressure-generating contact 49 constitutes the outer free extremity of a contact casting arm 50, which, as was the case with contact-arm casting 34, encircles and clampingly engages a contact sleeve 51 (Fig. 2) disposed adjacent the upper end of the tubular insulating drive shaft 33. A relatively stationary rotatable contact bar, pivotally mounted

on a conducting pivot to the underneath side of the terminal mounting plate **20**, not shown, is biased laterally against the upper contact sleeve **51** in a manner illustrated in detail in the aforesaid Friedrich application, and provides a means for electrically interconnecting the contact sleeve **51** with the terminal plate **20**.

In the closed-circuit position of the circuit recloser A, the electrical circuit extending therethrough traverses terminal mounting plate **20**, contact bar, not shown, bearing against contact sleeve **51**, contact arm casting **50**, rotatable pressure-generating contact **49**, relatively stationary pressure-generating contact **45**, intermediate contact bar **46**, lower relatively stationary interrupting contact **38**, rotatable movable interrupting contact **37**, contact-arm casting **34**, contact sleeve **32**, resiliently biased fingers **30**, Fig. 2, contact portions **28** of the resilient fingers to terminal stud **27** (Fig. 2) of terminal bushing **10**. The lower extremity **53** of terminal stud **27** is connected to the other distribution line.

During the opening operation, as manually effected, the tripping latch **9** may be pulled downwardly by a hook stick. This will effect release of the energy stored within an opening accelerating spring, disposed interiorly within housing **4**, to effect lateral movement of an operating rod, not shown, extending laterally through the interconnecting pipes **7** and connected to the several operating mechanisms **8** associated with the pole units A, B, and C.

The mechanism **8** associated with each pole unit will effect rotative motion of a crank-arm assembly **54** (Fig. 2) supported from the mounting plate **3** and coupled by a pin-and-slot coupling **55** to the lower end of the insulating tubular drive shift **33**.

The rotative opening motion of the tubular drive shaft **33** will effect consequent rotative opening motion of the pressure-generating and interrupting contacts **49**, **37**, respectively. The relatively stationary contacts **45**, **38** will follow the movable contacts **37**, **49** for a short distance, as provided by the springs **40** until the intermediate contact bar **46** abuts the external wall of the tubular interrupting chamber **42**. When this occurs, the rotatable movable pressure-generating contact **49** will establish a pressure-generating arc **56**, as indicated in Fig. 4 of the drawings. In a similar manner, the movable interrupting contact **37** will establish an interrupting arc **57**, as indicated in Fig. 5 of the drawings.

It will be observed that the rotatable movable pressure-generating contact **49** does not unplug from an orifice member **58** secured through an opening **59** in the side wall of the tubular interrupting chamber **42**, so that consequently the pressure of the gas within region **60** within tubular chamber **42** rises because of thermal expansion. The rise of pressure within region **60** forces gas, in this particular instance sulfur hexafluoride (SF_6), under pressure, out of the interrupting orifice **61** provided by an orifice member **62** likewise secured through an opening **63** of the tubular interrupting chamber **42**. The rapid expulsion of gas under pressure out of the interrupting orifice **61** quickly effects extinction of the interrupting arc **57**, and consequently the electrical circuit passing through the recloser A is interrupted.

In the fully open-circuit position of the recloser A, the rotatable contact castings **34**, **50** attain the open-circuit position, indicated by the dotted lines **64**, **65** as shown in Figs. 4 and 5, thereby providing two isolating gaps serially into the circuit.

As mentioned hereinbefore, testing has revealed during consecutive tests, with short intervals of time between tests, that is, during multiple reclosing operations, that local high-temperature regions within region **60**, interiorly of tubular interrupting chamber **42**, result in a lowering of the density of the gas within the interrupting chamber **42**, and that this brings about a lowering or a drop, in the interrupting ability of the recloser **1**.

To remedy this condition, the present invention is concerned with associating with the interrupting chamber **42** a piston or a puffer assembly generally designated by the reference numeral **65** in Fig. 2, and more clearly illustrated in Figs. 6 and 7 of the drawings.

The puffer assembly **65** generally includes a piston vane **67** (Fig. 7) having a substantially rectangular configuration, which is secured by a plurality of bolts **68** and nuts **69** to the tubular insulating drive shaft **33**, so that it rotates therewith. A piston chamber, generally designated by the reference numeral **70**, is provided by a pair of substantially identical end plates **71**, **72** having an external configuration more clearly shown in Fig. 7 of the drawings. Each of the piston-chamber end plates **71**, **72** has a circular mounting opening **73** therethrough, to accommodate the tubular drive shaft **33**. Since the drive shafe **33** is fixed in position, and merely rotates, it will be apparent that the drive shaft **33** assists in fixedly supporting the insulating end plates **71**, **72**, and consequently, the piston chamber **70** as a whole.

An arcuately-shaped plate **74** extends longitudinally of the piston chamber **70** between the end plates **71**, **72**, and the outer free end **75** of the rectangularly-shaped piston vane **67** slides therealong having a rather close sliding fit therewith. The side plate **74** has openings for dowel pins **76**, which assist in maintaining the side plate **74** in the proper position. Another plate **77** extends longitudinally of the piston chamber **70** and is likewise maintained in position by dowel pins **76**. The plate **77** has a plurality of circular openings **78** extending, in alignment, lengthwise thereof, which register with a plurality of side bores **79** (Fig. 7) provided in a longitudinally extending insulating support plate **80**. The plate **80** has an elongated end bore **81** bored through the end thereof, which interconnects with all the several bores **79**, thereby constituting a manifold gas passage. The common manifold gas passage **81** is extended, by an insulating sleeve **82**, which fits into a recess **83** provided in the insulating support plate **31**, as shown in Fig. 6 of the drawings.

Tie-rods **84** extend lengthwise of the piston chamber **70** and, with spacing sleeves **85**, **85***a* and nuts **85***b* maintain the entire puffer assembly **65** in a fixed stationary position relative to the support plate **31**.

To insure unidirectional fluid passage through the piston vane **67**, the latter is provided with an elongated slot **86** (Fig. 7), which may be closed by an elongated valve plate **87**. Two bolts **88** pass through the ends of the elongated valve plate **87**, and also pass through openings **89** of the piston vane **67**. Helical springs **90** and nuts **91**, surrounding the two bolts **88**, provide biasing means **92** for biasing the elongated valve plate **87** closed over the elongated slot **86** in the piston vane **67**.

From the foregoing description, it will be apparent that the piston chamber **70** is defined by portions of the end plates **71**, **72**, the two longitudinally extending side plates **74**, **77** and the rotatable piston vane **67** itself. During the opening operation of the interrupter, the tubular drive shaft **33** rotates in a counterclockwise direction, as indicated by the arrow **93** in Fig. 7. This draws gas through the elongated slot **86**, the valve plate **87** opening. During the closing operation of the interrupter, the tubular drive shaft **33** rotates in a clockwise direction, as indicated by the arrow **94**, and this compresses the gas within region **95** within piston chamber **70**, closing the valve plate **87** and forcing the compressed gas to flow through the openings **78** and through the registering bores **79**, in longitudinally extending plate **80**, to the common manifold gas passage **81**, extending lengthwise through plate **80**. The gas passes in the direction indicated by the arrows **96** in Fig. 7 and lengthwise through the common manifold passage **81**, as indicated by the arrows **97** in Fig. 6. The compressed gas then passes through connecting sleeve **82** and through

an opening 98 in mounting plate 31 and into the end of tubular interrupting chamber 42.

With reference to Fig. 3 of the drawings, it will be noted that disposed interiorly within the lower end of tubular interrupting chamber 42 are a plurality of apertured circular insulating plugs 99, 100, 101, and 102. A circular valve plate 16 (Fig. 3A) is movable within a recess 103 provided in insulating plug member 101. The valve plate 16 has a plurality of circumferentially disposed valve openings 104, which are closed when the valve plate 16 is in its lower position, as illustrated in Fig. 3.

During the opening operation of the recloser A, the pressure of the gas within the region 60, interiorly of tubular interrupting chamber 42, is sufficient to maintain the circular valve plate 16 in its lowermost position within circular recess 103, as illustrated in Fig. 3. Gravity assists in this positioning of corcular valve plate 16. Arc interruption takes place in the manner previously described, and, with reference to Fig. 7, it will be noted that counterclockwise rotation of piston vane 67 during the opening operation will open valve plate 87 and recharge the interior 95 within piston chamber 70 with fresh gas.

During the closing operation of the recloser A, the tubular insulating drive shaft 33 rotates in a clockwise direction, as indicated by the arrow 94 in Fig. 7. This will not only effect contact reclosure within interrupting chamber 42, but, in addition, the clockwise rotative movement of piston vane 67 will force compressed, fresh gas in the direction indicated by the arrows 97 (Fig. 6) into the region 105 (Fig. 3). The compressed gas within region 105 will force circular valve plate 16 upwardly, against the force of gravity, so that the gas may now pass through the circumferentially disposed openings 104 and into the interior 60 of the interrupting chamber 42. This fresh gas, provided by the piston assembly, will purge the arced or contaminated and heated gas out of the interrupting chamber 42, and will provide therein fresh gas of high density in readiness for a subsequent opening operation.

A particular advantage of the foregoing construction is that since the puffer assembly operates during the closing operation, it does not have to act against the arcing pressure, and, therefore, requires less mechanical effort for operation. Also, the puffer action, during the closing operation, will aid in the prevention of long prestrikes during the closing strokes. A "prestrike" is arcing between the approaching contacts during a closing operation of the recloser due to the voltage thereacross.

Figs. 8 and 9 illustrate a modification of the invention in which the cap structure 10, illustrated in Figs. 1 and 2 of the drawings is omitted, and in place thereof a modified cap structure 107 is substituted therefor at the upper extremity of the recloser. Fig. 8 illustrates a modified type of terminal mounting plate 20*a*, from which the tubular interrupting chamber 42*a* depends, in a manner similar to that illustrated in Fig. 2 of the drawings.

It will be noted that the modified cap structure 107 constitutes a generally circular piston chamber 108 (Fig. 9) within which a rotatable piston vane, or wing, 109 rotates. The piston wing 109 is laterally secured to a vertically extending supporting rod 110 having an upper reduced end portion 111 journalled within a recess 112 provided in top plate 113. The lower end of supporting rod 110 has a reduced shank portion 114, which extends through an opening 115 provided in a piston-chamber end plate 116. Pinned to the lower extremity of reduced shank portion 114 of supporting rod 110 is a pinion gear 117, which meshes with a gear segment 118 pinned to a rotatable drive shaft 119 in a manner more clearly shown in Fig. 8 of the drawings. As shown, the drive shaft 119 is journalled within a depending sleeve portion 120 of piston end plate 116.

Coupled to the lower end of drive shaft 119 is the upper extremity of the tubular drive shaft 33, so that rotation of the tubular drive shaft 33, during reclosure operation will effect corresponding rotation of gear segment 118 and rotation of piston wing 109 within piston chamber 108.

With reference to Fig. 8, it will be observed that an insulating sleeve 121 extends between openings 122 provided in piston end plate 116 and an opening 123 provided in modified terminal mounting plate 20*a*. The upper end of interrupting chamber 42*a* has a plurality of members 124–127 which support the circular valve plate 128, biased to its upper closed position by a light, helical compression spring 129. The valve plate 128 has a plurality of openings 128*a* as did the valve plate 16 in Fig. 3A.

The fundamental operation of the modified piston assembly 130, illustrated in Figs. 8 and 9 is identical to that of the piston assembly 65 in Figs. 6 and 7 of the drawings, namely during the opening operation of the recloser A, arcing pressure within region 60 maintains valve plate 128 in its upward closed position. During this time, rotation of the tubular drive shaft 33 effects, through the multiplying gears 117, 118, charging rotation of the piston wing 109, the latter having a spring-biased valve plate 87, the same as the piston vane 67 in the arrangement shown in Fig. 7 of the drawings.

During the closing operation, the rotative motion of drive shaft 33, indicated by arrow 133 in Fig. 9, not only effects contact reclosure within interrupting chamber 42*a*, but also, through the multiplying gear segment 118 effects driving movement of piston vane 109 to force gas to flow in the direction of the arrows 131 through connecting sleeve 121 to force valve plate 128 to its lowermost open position. The lowering of valve plate 128 will permit the compressed gas to flow from the modified piston assembly 130 into the upper end of tubular interrupting chamber 42*a*, and thereby effect therein a purging of the contaminated and heated arced gases.

From the foregoing description of two modifications of the invention, it will be apparent that the puffer assembly of the present invention provides an effective means to purge high-temperature arced gases out of the arcing chamber, and to replace them with relatively high-density gas in readiness for a subsequent opening operation. As a result, there is no possibility of local high-temperature regions within the interrupting chamber 42, 42*a*, and insurance is obtained that the arcing chamber contains gas of the same density as is contained throughout the interior of the circuit recloser. As a result, during multiple reclosings, effective circuit interruption is obtained during each opening operation, since during each closing operation the high-temperature, arced, contaminated gases are ejected out of the arcing chamber by operation of the piston assembly.

A particular advantage of the constructions illustrated is that the operation of the puffer assembly during the closing operation does not have to act against the arcing pressure, and therefore the mechanical effort required for operation of the puffer assembly is a minimum.

It will be obvious to those skilled in the art that the present invention is applicable to any type of circuit interrupter. However, particular advantage is obtained by an application of the present invention to interrupting structures provided with substantially enclosed arcing chambers, in which there is some difficulty in rapidly replenishing the gas therein due to the substantially enclosed construction. Particularly is this true in the case of multiple-break, interrupting structures involving a pressure-generating arc in series with an interrupting arc, in which interruption takes place in a substantially enclosed arcing chamber. Since a substantially enclosed interrupting chamber is employed, difficulty is obtained in replenishing the gas during successive interruptions, and an application of the present invention remedies

this situation. Insurance is had that fresh gas is swept into the arcing chamber during the closing stroke prior to each opening operation, and that high-temperature gas of relatively low density is ejected out of the interrupting chamber.

It will also be readily perceived by those skilled in the art that the present invention may be employed in interrupters using different mediums than gases. For example, liquid-break interrupters may, with advantage, use the piston assembly of the present invention. Merely for purposes of illustration has the present invention been described as applied to a gas-type of circuit interrupter.

Although certain piston or puffer assembly constructions have been illustrated, 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.

We claim as our invention:

1. In a circuit interrupter, contact means cooperable to establish an arc, operating means for said contact means operable to effect closure of said contact means during the closing operation of the circuit interrupter, a piston assembly including a piston chamber and a movable piston movable therein, piston operating means for effecting opening and closing motion of said movable piston within said piston chamber, unidirectional-acting valve means associated with said movable piston to effect fluid-driving effort only during the closing movement of the movable piston and relatively free non-driving motion of the piston during the opening movement thereof, and means correlating said piston operating means with said contact operating means so that driving piston motion occurs within said piston chamber during the closing operation of the interrupter whereby relatively fresh fluid is forced adjacent said contact means during such closing operation of the contact means.

2. The combination in a circuit interrupter of contact means cooperable to establish an arc, operating means for said contact means operable to effect closure of said contact means during the closing operation of the circuit interrupter, a piston assembly including a piston chamber and a movable piston movable therein, fluid passage means interconnecting said piston chamber with the region about said contact means, unidirectional acting valve means disposed within said fluid passage means preventing fluid flow through said fluid passage means toward said piston chamber, piston operating means for effecting opening and closing motion of said movable piston within said piston chamber, unidirectional-acting valve means associated with said movable piston to effect fluid-driving effort only during the closing movement of the movable piston and relatively free non-driving motion of the piston during the opening movement thereof, and means correlating said piston operating means with said contact operating means so that driving piston motion occurs within said piston chamber during the closing operation of the intercepter whereby relatively fresh fluid is forced against said contact means during such closing operation of the contact means.

3. A circuit interrupter including means defining an interrupting chamber, contact means disposed within said interrupting chamber and cooperable to establish an arc therein, operating means for said contact means operable to effect closure of said contact means during the closing operation of the circuit interrupter, a piston assembly including a piston chamber and a movable piston movable therein, fluid passage means interconnecting said piston chamber with the region about said contact means within said interrupting chamber, piston operating means for effecting opening and closing motion of said movable piston within said piston chamber, unidirectional-acting valve means associated with said movable piston to effect fluid-driving effort only during the closing movement of the movable piston and relatively free non-driving motion of the piston during the opening movement thereof, and means correlating said piston operating means with said contact operating means so that driving piston motion occurs within said piston chamber during the closing operation of the interrupter whereby relatively fresh fluid is forced adjacent said contact means during such closing operation of the contact means.

4. A circuit interrupter including means defining an interrupting chamber, contact means disposed within said interrupting chamber and cooperable to establish an arc therein, operating means for said contact means operable to effect closure of said contact means during the closing operation of the circuit interrupter, a piston assembly including a piston chamber and a movable piston movable therein, fluid passage means interconnecting said piston chamber with the region about said contact means within said interrupting chamber, unidirectional acting valve means disposed within said fluid passage means preventing fluid flow through said fluid passage means toward said piston chamber, piston operating means for effecting opening and closing motion of said movable piston within said piston chamber, unidirectional-acting valve means associated with said movable piston to effect fluid-driving effort only during the closing movement of the movable piston and relatively free non-driving motion of the piston during the opening movement thereof, and means correlating said piston operating means with said contact operating means so that driving piston motion occurs within said piston chamber during the closing operation of the interrupter whereby relatively fresh fluid is forced adjacent said contact means during such closing operation of the contact means.

5. A circuit interrupter of the fluid-blast type including means defining a substantially enclosed interrupting chamber, serially related contact means disposed interiorly within said substantially enclosed interrupting chamber separable to establish a pressure-generating arc and a serially related interrupting arc, operating means for said contact means operable to effect closure of said contact means during the closing operation of the circuit interrupter, a piston assembly including a piston chamber and a movable piston movable therein, fluid passage means interconnecting said piston chamber with the region about said contact means within said substantially enclosed interrupting chamber, piston operating means for effecting opening and closing motion of said movable piston within said piston chamber, unidirectional-acting valve means associated with said movable piston to effect fluid-driving effort only during the closing movement of the movable piston and relatively free non-driving motion of the piston during the opening movement thereof, and means correlating said piston operating means with said contact operating means so that driving piston motion occurs within said piston chamber during the closing operation of the interrupter whereby relatively fresh fluid is forced adjacent said contact means during such closing operation of the contact means.

6. A circuit interrupter of the fluid-blast type including means defining a substantially enclosed interrupting chamber, serially related contact means disposed interiorly within said substantially enclosed interrupting chamber separable to establish a pressure-generating arc and a serially related interrupting arc, operating means for said contact means operable to effect closure of said contact means during the closing operation of the circuit interrupter, a piston assembly including a piston chamber and a movable piston movable therein, fluid passage means interconnecting said piston chamber with the region about said contact means within said substantially enclosed interrupting chamber, unidirectional acting valve means disposed within said fluid passage means preventing fluid flow through said fluid passage means toward said piston chamber, piston operating means for effecting opening and closing motion of said movable piston with-

in said piston chamber, unidirectional-acting valve means associated with said movable piston to effect fluid-driving effort only during the closing movement of the movable piston and relatively free non-driving motion of the piston during the opening movement thereof, and means correlating said piston operating means with said contact operating means so that driving piston motion occurs within said piston chamber during the closing operation of the interrupter whereby relatively fresh fluid is forced adjacent said contact means during such closing operation of the contact means.

7. A fluid-blast circuit interrupter including a rotatable drive shaft, movable contact structure carried by said rotatable drive shaft, relatively stationary contact structure cooperable with said movable contact structure to establish arcing, operating means for effecting opening and closing rotative movement of said rotatable drive shaft, means defining a piston chamber, a piston vane secured to said drive shaft and operable within said piston chamber, passage means connecting said piston chamber with the region about said contact structure, and valve means carried by said piston vane to effect fluid driving motion of said piston vane only during the closing rotative movement of said drive shaft.

8. A fluid-blast circuit interrupter including a rotatable drive shaft, movable contact structure carried by said rotatable drive shaft, relatively stationary contact structure cooperable with said movable contact structure to establish arcing, operating means for effecting opening and closing rotative movement of said rotative drive shaft, means defining a piston chamber, a piston vane secured to said drive shaft and operable within said piston chamber, passage means connecting said piston chamber with the region about said contact structure, valve means carried by said piston vane to effect fluid driving motion of said piston vane only during the closing rotative movement of said drive shaft, and unidirectional acting valve means disposed within said passage means to prevent reverse flow of fluid through said passage means toward said piston chamber pending high-pressure conditions during the opening operation.

9. A fluid-blast circuit interrupter including a hollow cylindrical insulating casing, a terminal bushing having one end thereof projecting into one end of said hollow insulating casing, a rotatable drive shaft projecting into the same end of said hollow insulating casing, means defining an interrupting chamber disposed adjacent the other end of said hollow casing, movable contact structure carried by said drive shaft and movable into said interrupting chamber, relatively stationary contact structure disposed interiorly within said interrupting chamber and cooperable with said movable contact structure to establish arcing within said interrupting chamber, a piston assembly including a piston wing carried by said drive shaft and a piston chamber having a pair of piston chamber end plates, said piston chamber end plates having openings therein through which said drive shaft extends, passage means interconnecting said piston chamber with said interrupting chamber, and valve means carried by said piston vane to effect fluid-driving motion of said piston vane only during the closing rotative movement of said drive shaft.

10. A fluid-blast circuit interrupter including a hollow cylindrical insulating casing, a terminal bushing having one end thereof projecting into one end of said hollow insulating casing, a rotatable drive shaft projecting into the same end of said hollow insulating casing, means defining an interrupting chamber disposed adjacent the other end of said hollow casing, movable contact structure carried by said drive shaft and movable into said interrupting chamber, relatively stationary contact structure disposed interiorly within said interrupting chamber and cooperable with said movable contact structure to establish arcing within said interrupting chamber, a piston assembly including a piston wing carried by said drive shaft and a piston chamber having a pair of piston chamber end plates, said piston chamber end plates having openings therein through which said drive shaft extends, passage means interconnecting said piston chamber with said interrupting chamber, valve means carried by said piston vane to effect fluid driving motion of said piston vane only during the closing rotative movement of said drive shaft, and unidirectional acting valve means disposed within said passage means to prevent reverse flow of fluid through said passage means toward said piston chamber pending high-pressure conditions during the opening operation.

11. A fluid-blast circuit interrupter including a hollow cylindrical insulating casing, a terminal bushing having one end thereof projecting into one end of said hollow insulating casing, a rotatable drive shaft projecting into the same end of said hollow insulating casing, means defining an interrupting chamber disposed adjacent the other end of said hollow casing, movable contact structure carried by said drive shaft and movable into said interrupting chamber, relatively stationary contact structure disposed interiorly within said interrupting chamber and cooperable with said movable contact structure to establish arcing within said interrupting chamber, a piston assembly disposed adjacent said other end of said hollow insulating casing, the piston assembly including a movable piston and a piston chamber, means correlating movement of said piston with said rotatable drive shaft so that rotation of said drive shaft will effect movement of said piston within said piston chamber, passage means interconnecting said piston chamber with said interrupting chamber, and valve means carried by said piston vane to effect fluid driving motion of said piston vane only during the closing rotative movement of said drive shaft.

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