April 27, 1965 J. B. MacNEILL ETAL 3,180,959

MULTI-BREAK FLUID-BLAST CIRCUIT BREAKER

Filed Oct. 28, 1960 4 Sheets-Sheet 1

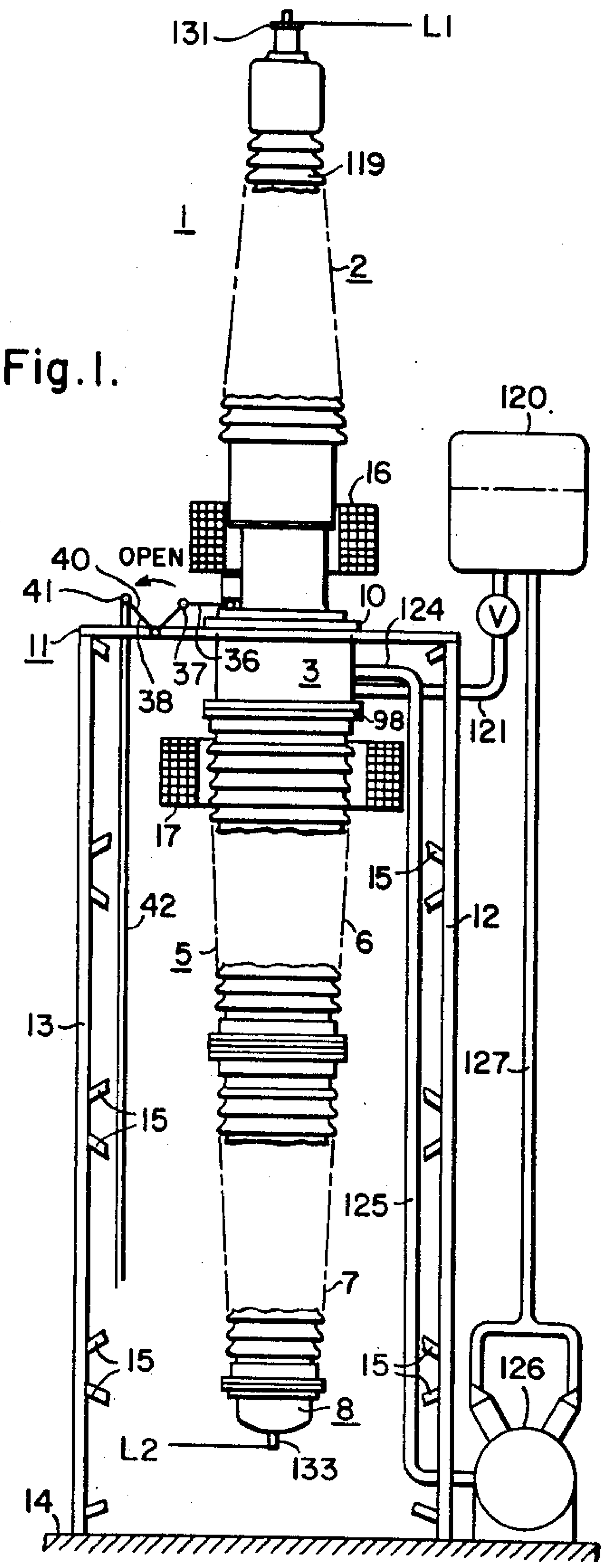

Fig. 1.

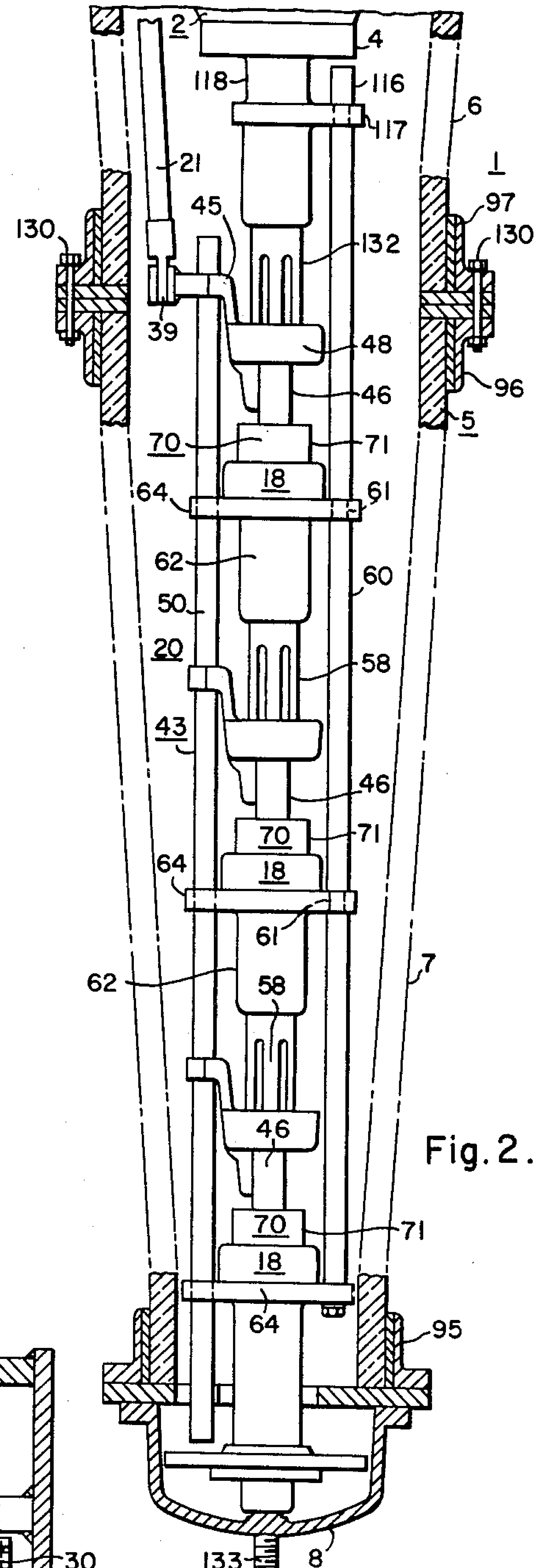

Fig. 2.

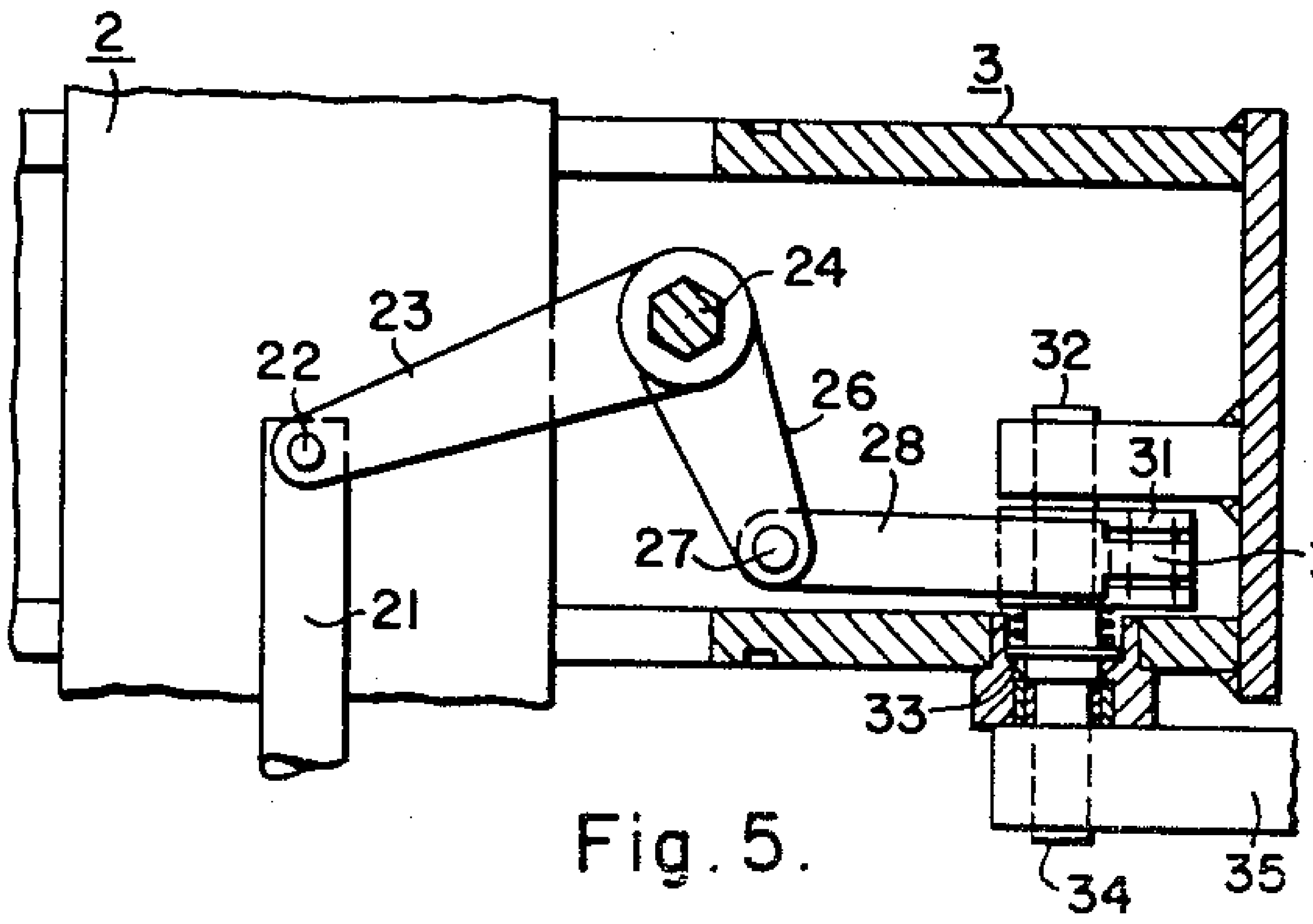

Fig. 5.

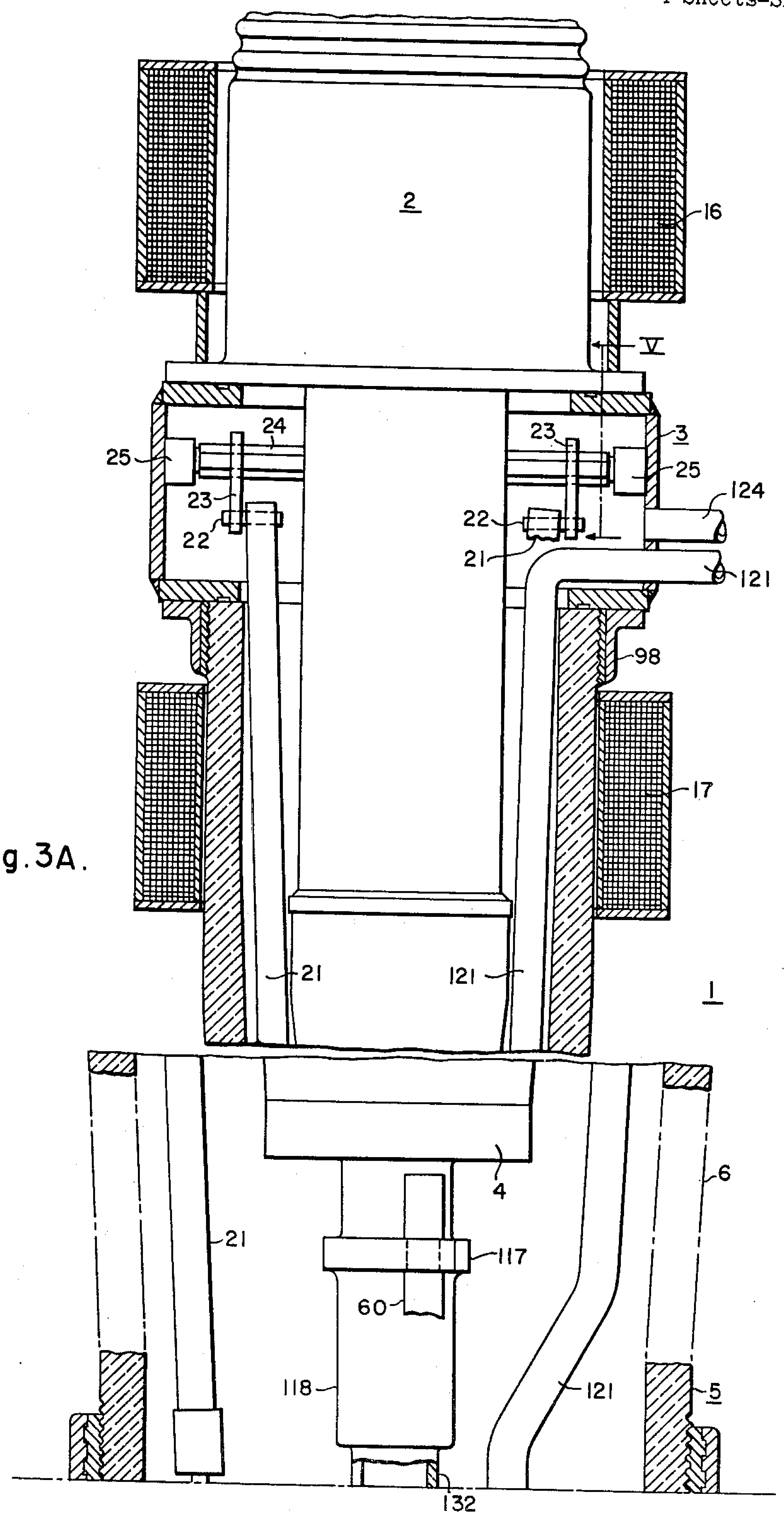
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Fig.3A.

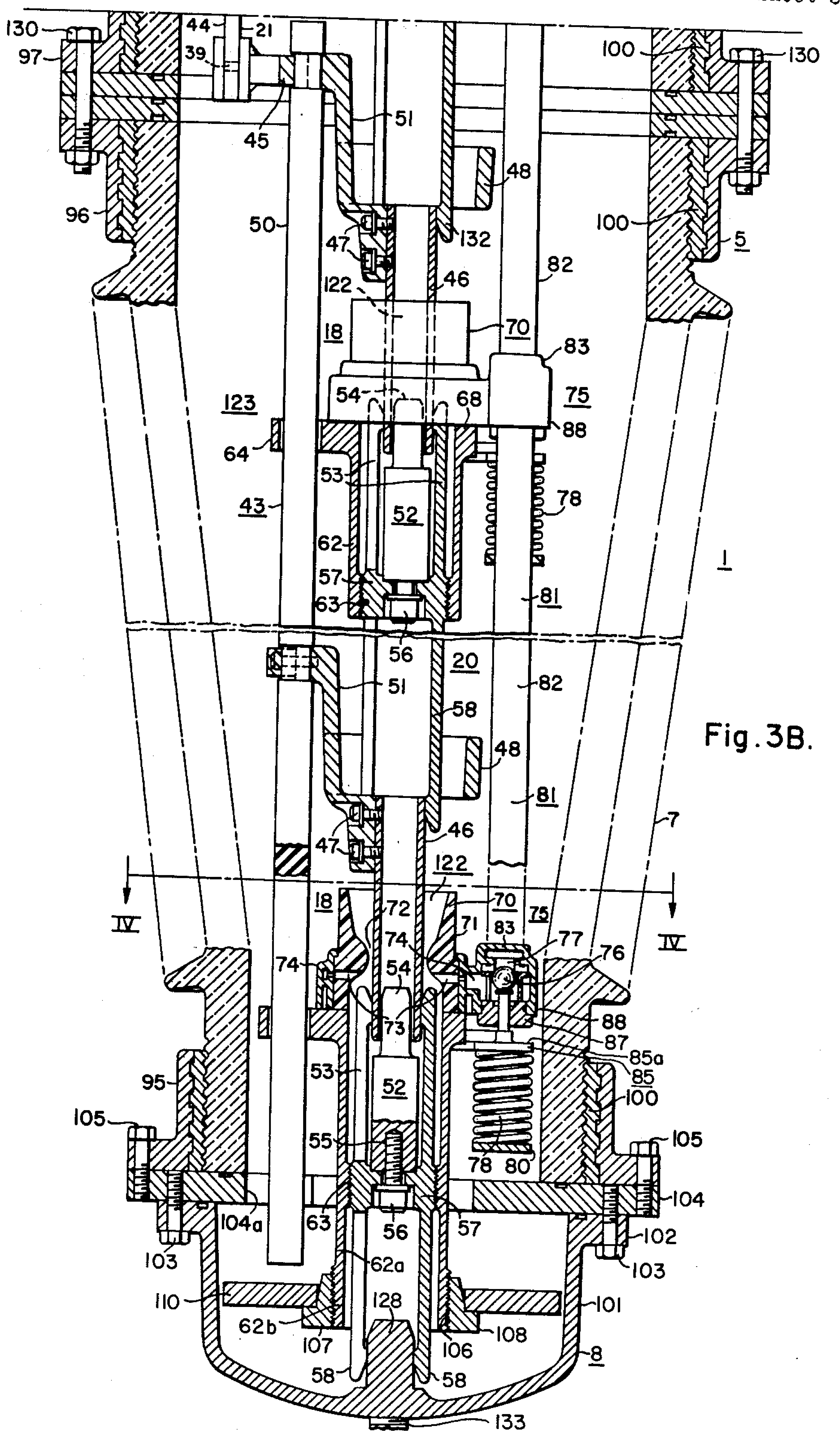
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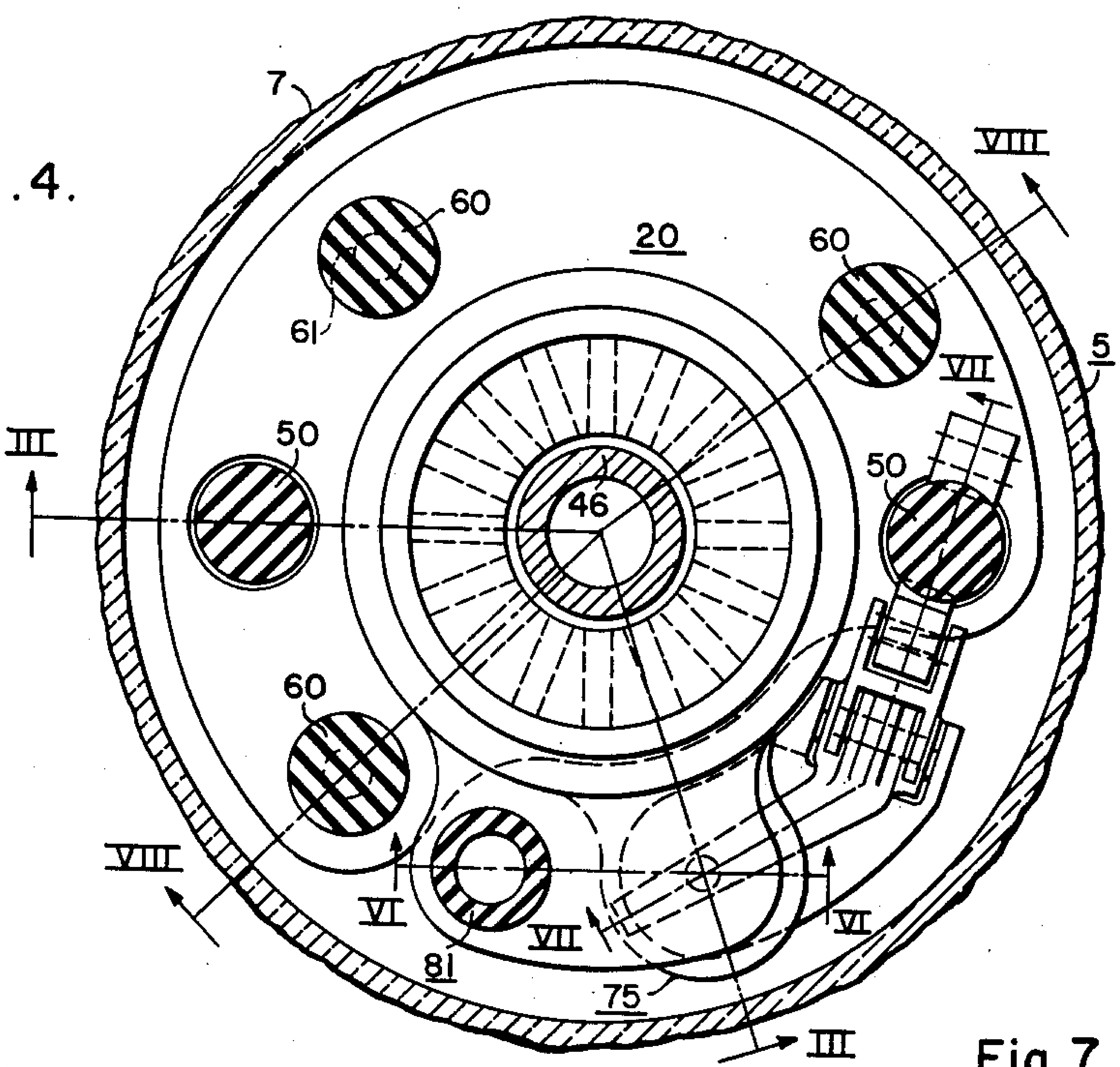
Fig. 3B.

Fig. 4.



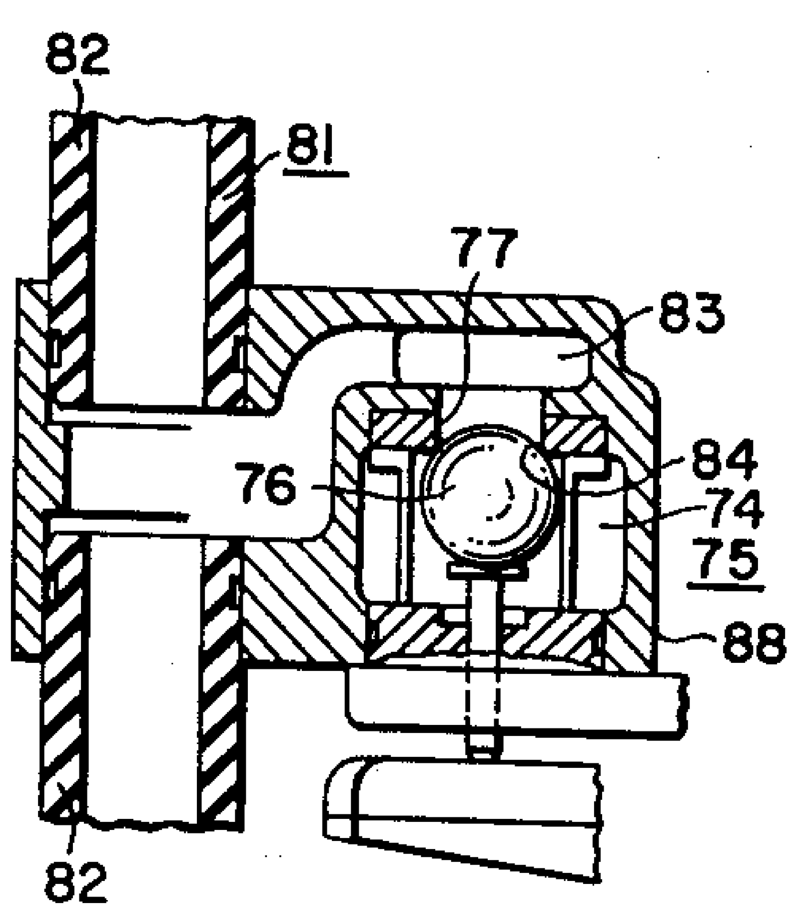
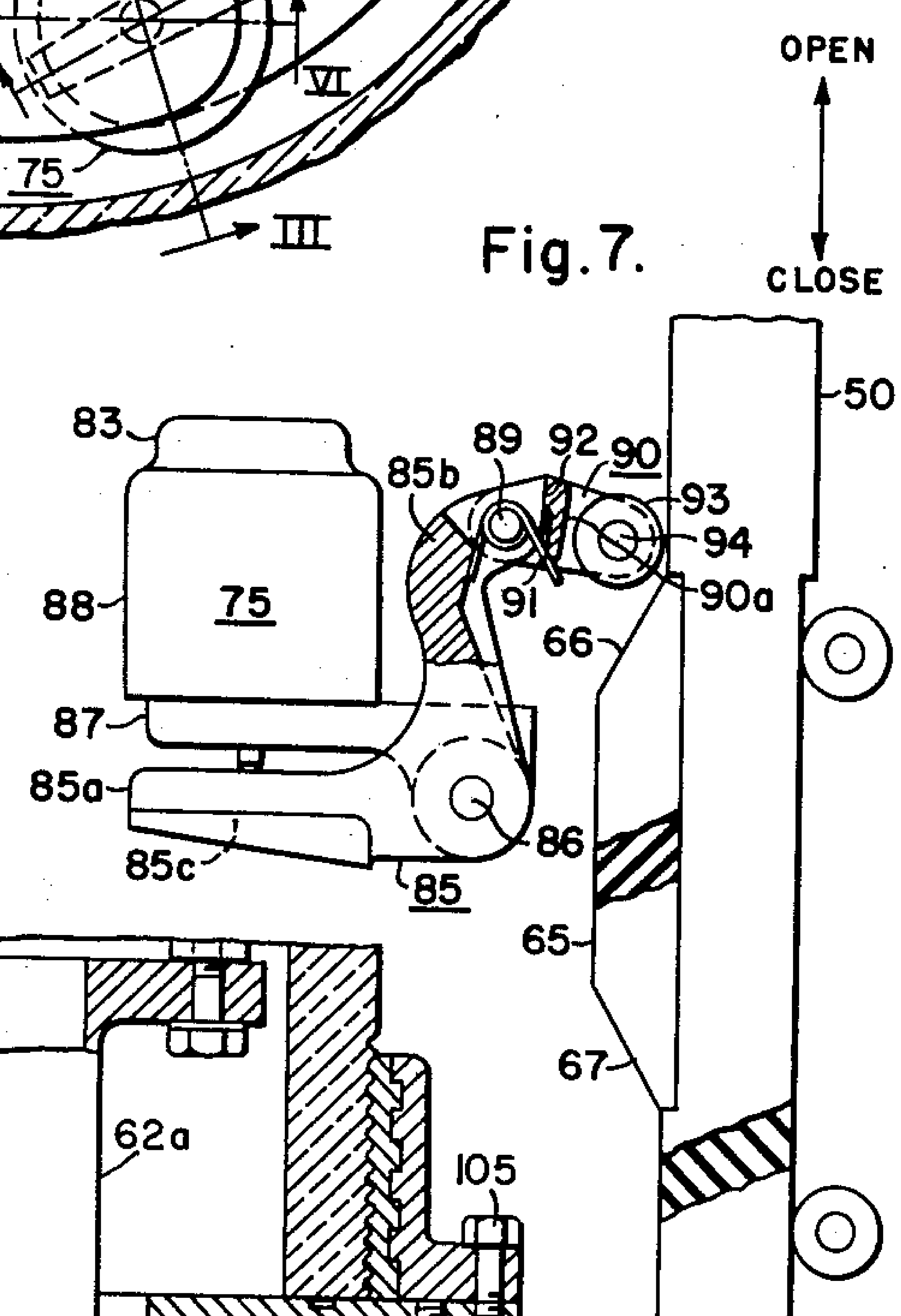


Fig. 6.

Fig. 7.



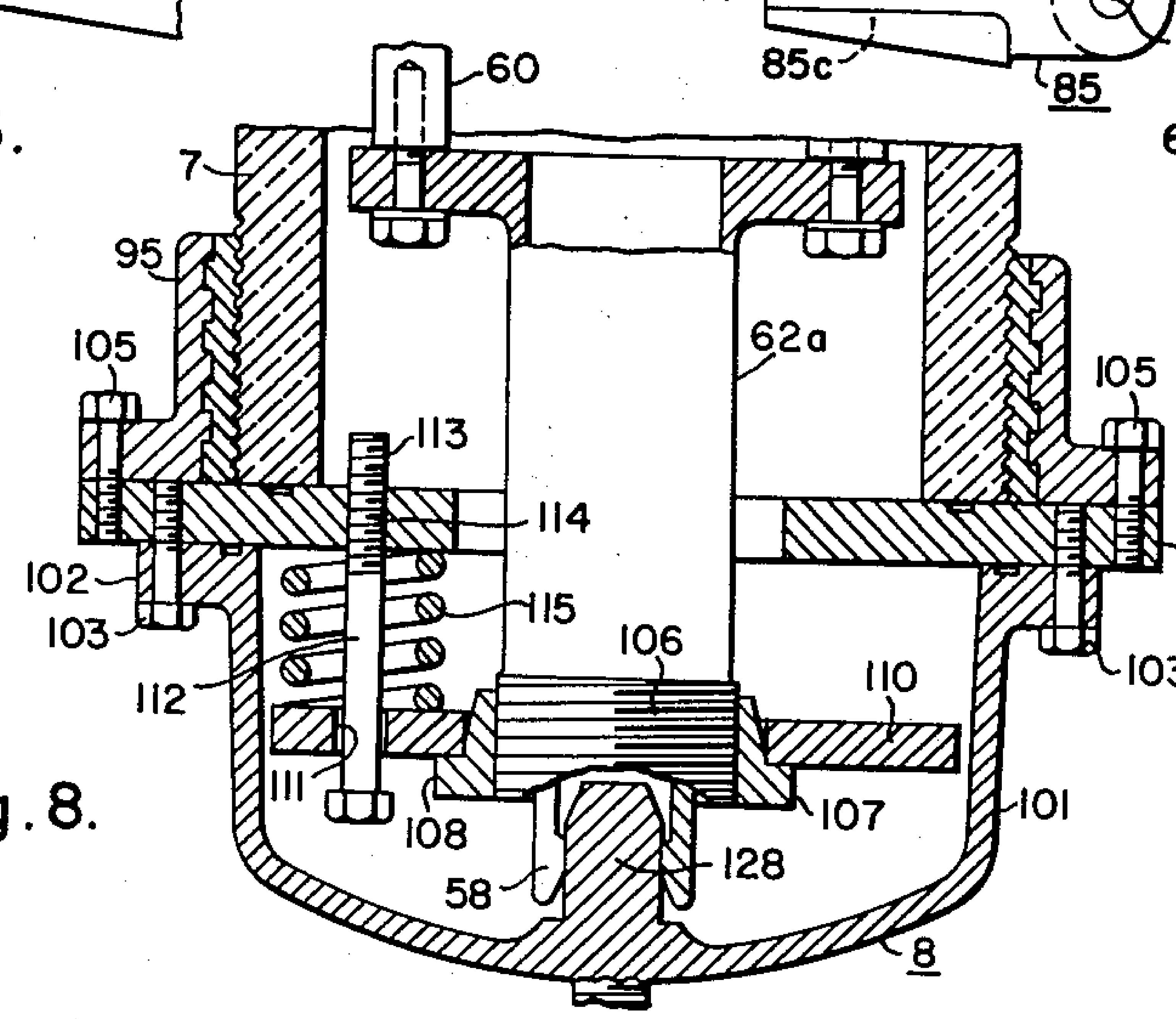


Fig. 8.

United States Patent Office

3,180,959

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MULTI-BREAK FLUID-BLAST CIRCUIT BREAKER

John B. MacNeill, Pittsburgh, Pa., and Benjamin P. Baker, deceased, late of Monroeville, Pa., by Mellon National Bank and Trust Company, executor, and Wayne S. Aspey, Monroeville, Pa., assignors to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Filed Oct. 28, 1960, Ser. No. 65,859

9 Claims. (Cl. 200—145)

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

A general object of the present invention is to provide an improved circuit interrupter, particularly adapted for interrupting high-amperage currents at high voltages, but it will be obvious to those skilled in the art that certain features of the invention are applicable to low-power ratings. For purposes of illustration, the circuit interrupter described herein is suitable for 230 kv. circuits and is capable of interrupting 15 million kva.

In United States patent application, filed September 13, 1957, Serial No. 683,760, now United States Patent 3,150,245, issued September 22, 1964, to Winthrop M. Leeds and Benjamin P. Baker, and assigned to the assignee of the instant application, there is illustrated and claimed circuit-interrupting structures utilizing liquefied gases as the arc-extinguishing mediums.

It is an additional object of the present invention to improve upon the interrupting structures set out in the aforesaid patent application, and to render the same suitable over a wide current and voltage range.

A more specific object of the present invention is to provide an improved circuit interrupter in which a plurality of arc-extinguishing units are secured to one end of a conventional-style terminal bushing, and the interrupting units extend into a porcelain-clad, or other weather-proof casing and are adaptable for ready inspection.

Another object is to provide an improved circuit interrupter involving one or more arc-extinguishing units in which improved valve means are associated with the movable contact structure so as to control the jetting of a suitable arc-extinguishing liquid under pressure into the one or more arc-extinguishing units.

A further object of the present invention is to provide an improved mounting arrangement for multiple-unit-type circuit interrupters in which one or more tie-rods, under tension, are associated with spring means to retain a surrounding weather-proof casing under compression. Preferably, suitable means are additionally provided to enable a rapid inspection and replacement of parts of the interrupter, if needed, following long operational life of the interrupter.

Yet a further object of the present invention is to provide an improved valve means which will insure a feeding, or jetting of arc-extinguishing liquid into one or more arc-extinguishing units only during the opening operation, while retaining the said valve means closed during the closing operation.

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 side elevational view, partially in section, of a circuit interrupter embodying the present invention;

FIG. 2 is a fragmentary vertical sectional view taken through the lower end of the arc-extinguishing assemblage of FIGURE 1, the contact structure being illustrated in the closed-circuit position;

FIGS. 3A and 3B collectively illustrate, in enlarged fashion, a vertical sectional view taken through the lower end of the arc-extinguishing assemblage, substantially along the line III—III of FIG. 4, one of the three serially-arranged arc-extinguishing units being omitted for purposes of clarity, and the contact structure being shown in the closed-circuit position;

FIG. 4 is a sectional view taken along the line IV—IV of FIG. 3B looking in the direction of the arrows;

FIG. 5 is a fragmentary sectional view taken along the line V—V of FIG. 3A, looking in the direction of the arrows;

FIG. 6 is a fragmentary sectional view taken along the line VI—VI of FIG. 4 looking in the direction of the arrows;

FIG. 7 is a fragmentary sectional view taken along the line VII—VII of FIG. 4 looking in the direction of the arrows, the several operative parts being shown in the closed-circuit position; and,

FIG. 8 is a fragmentary vertical sectional view taken along the line VIII—VIII of FIG. 4 at the lower end of the interrupting assemblage to illustrate the compression-spring arrangement.

Referring to the drawings, and more particularly to FIG. 1 thereof, the reference numeral 1 generally designates a circuit interrupter comprising a rather conventional-type terminal bushing 2 supported within a mechanism housing 3 and having the lower end 4 (FIG. 3A) thereof extending downwardly interiorly within a casing structure, generally designated by the reference numeral 5 in FIG. 1.

The casing structure 5 includes a pair of porcelain, or other weather-proof casings 6, 7 secured together in end-to-end arrangement as shown. A cap structure 8 is secured to the lower end of porcelain casing 7, as shown in FIGS. 1 and 8.

The mechanism housing 3 is of generally cylindrical configuration, and has an outwardly extending grounded flange ring 10, which is supported by a grounded metallic frame-work comprising angle-irons 11, which extend in a horizontal direction, as shown in FIG. 1. The angle-iron horizontally-extending frame-work 11, is, in turn, supported an adequate distance up in the air by vertically-extending angle-irons 12, 13, supported on a suitable base 14 and are diagonally interbraced by diagonally-extending angle-irons 15. The inter-braced vertically-extending structural members 12, 13 rigidly secure the mechanism housing 3 fixedly in a proper position and, in the particular embodiment of the invention illustrated in FIG. 1, support the upper end of the terminal bushing 2 vertically. However, it will be apparent that the circuit interrupter 1, instead of being supported vertically, as shown, could be supported generally horizontally or in any other desired position.

Surrounding the terminal bushing 2 and also disposed below the mechanism housing 3 is a pair of current transformers 16, 17, which, may be arranged, if desired, for differential relay protection, as described and claimed in United States patent application filed March 31, 1958, Serial No. 725,206, now United States Patent 3,032,689, issued May 1, 1962, to B. P. Baker and R. F. Karlicek and assigned to the assignee of the instant application.

With reference to FIG. 2, it will be noted that secured to the lower internal end 4 of the terminal bushing 2 is a plurality, in this particular instance three, arc-extinguishing units 18 collectively comprising an arc-extinguishing assemblage, generally designated by the reference numeral 20, and, as shown, disposed interiorly within the casing structure 5. The three arc-extinguishing units 18 are adapted to be simultaneously actuated to the open and closed-circuit positions by a pair of insulating operating rods 21, only one of which is shown in FIG. 2. Reference may be had to FIG. 3A for a showing of the second operating rod 21. With reference to FIG. 3A, it will be observed that the upper ends of the insulating operating rods 21 are pivotally secured, by pins 22, to crank-arms 23, the latter being affixed to a rotatable crank-shaft 24, journaled in bearings 25 extending interiorly of the mechanism housing 3.

With reference to FIG. 5, it will be observed that rotation of the crank-shaft 24 is effected by means of a crank-arm 26, pivotally connected by a pin 27 to a link 28. The right-hand end of the link 28 is pivotally connected, by a pin 30, to a bifurcated crank-arm 31, affixed to a vertically extending crank-shaft 32, which extends through a gas-tight seal 33 externally of the mechanism housing 3.

With reference to FIGS. 1 and 5, it will be noted that the lower external end 34 of the crank-shaft 32 is keyed to a crank-arm 35. The free end of crank-arm 35 is pivotally connected to a link 36 (FIG. 1), which is pivotally connected, as at 37, to a bell-crank 38, the latter being pivotally mounted upon the horizontal framework 11. To the outer end of one arm 40 of bell-crank 38 is pivotally connected, as at 41, an upwardly-extending insulating operating rod 42, the lower end of which may be connected to any suitable driving mechanism, not shown.

Thus, downward movement of operating rod 42 will effect rotation of the bell-crank 38 in a counterclockwise direction to effect thereby rotation of crankshaft 32 and upward opening movement of the pair of insulating operating rods 21 interiorly of the upper porcelain casing 6.

As mentioned, the two insulating operating rods 21 effect simultaneous opening and closing movements of the movable contact structure 43. With reference to FIG. 3B, it will be observed that the lower end 44 of insulating operating rod 21 is pivotally connected, as at 39, to a reciprocally movable bracket 45, the lower end of which is secured to the upper movable contact 46 by a pair of machine screws 47. The bracket 45 has an encircling annular portion 48, to which is integrally formed, but not shown in FIG. 3B, a second upstanding bracket 45, which is secured to the second operating rod 21 in the same manner that the bracket portion 45 is secured to the first mentioned operating rod 21, as shown in FIGS. 2 and 3B.

As shown in FIGS. 3B and 4, two insulating operating rods 50 mechanically interconnect the several movable contacts 46 for simultaneous movement. A bracket 51, somewhat similar to the bracket 45, is secured to the operating rod 50 at one end, and has its other lower end secured by screws 47 to the lower-most movable contact 46, as shown in FIG. 3B. Actually, there are three interrupting units 18 comprising the arc-extinguishing assemblage 20, but FIG. 3B only shows the upper and lowermost arc-extinguishing units 18, the middle unit 18 being omitted for purposes of clarity.

Cooperating with each movable contact 46 is a relatively stationary contact structure, generally designated by the reference numeral 52, and including stationary resilient finger contacts 53. As shown in FIG. 3B, the finger contacts 53 resiliently engage the lower ends of the movable contacts 46. In addition, an arcing contact stud 54 projects interiorly of each hollow movable tubular contact 46 in the closed-circuit position, as shown in FIG. 3B. The arcing contact stud 52 has a tapped bore 55 provided at its lower end to accommodate a machine bolt 56, which rigidly secures the arcing contact stud 52 to a contact support 57. It will be noted that the contact fingers 53 are formed by slotting the upper tubular portion of the contact support 57. The lower end of the contact support 57 likewise forms resilient finger contacts 58, which bear upon the upper sides of the movable contacts 46.

The several contact supports 57 are maintained in fixed spaced relation relative to each other by three tie-rod supports 60, more clearly shown in FIGS. 2 and 4. As shown in FIG. 2, the three insulating tie-rods 60 have reduced portions 61 thereon, which secure support sleeves 62 in spaced fixed relation. As shown in FIG. 3B, the support sleeves have threaded support holes 63 provided therein, into which are threadedly secured the contact supports 57. The support sleeves 62 have outwardly-jutting apertured bracket portions 64, which assist in guiding the longitudinal reciprocal motion of the two insulating operating rods 50 and hence the movable contacts 46.

As illustrated in FIGS. 2 and 3B, one of the insulating operating rods 50 is effective to bring about opening and closing movement of the several movable contacts 46 by virtue of the bracket portions 45, 51. The companion operating rod 50, as shown more clearly in FIGS. 4 and 7, has secured thereto a plurality of spaced cams 65 having beveled ends 66, 67. Besides carrying the three cams 65, the companion operating rod 50 is likewise secured to a bracket 51, not shown, secured to the annular portion 48. It will be remembered that FIGS. 3A and 3B are a somewhat quarter-section view, as taken along the line III—III of FIG. 4; consequently, only one insulating operating rod 50 is shown, and reference must be had to FIG. 4 for a showing of the companion operating rod 50, which carries the three spaced cams 65, the purpose for which will be described hereinafter.

With reference to FIG. 3B, it will be observed that secured to the upper side 68 of each contact support 62 is an insulating orifice structure, generally designated by the reference numeral 70. The orifice structure 70 includes an insulating orifice sleeve member 71 having a restricted orifice opening 72. Viewing the lower orifice structure 70 of FIG. 3B, it will be noted that immediately below the restricted orifice opening 72 is a plurality of, in this particular instance sixteen, jet apertures 73, which direct liquid under pressure radially inwardly into the arc region to effect immediate extinction of the arc, not shown, drawn between each movable contact 46 and each stationary contact 52.

Surrounding the insulating orifice structure 70 is a metallic feeding manifold structure 74, which serves to supply liquid, under pressure, into each of the sixteen jet apertures 73. The supply manifold structure 74 is connected to a valve means 75, comprising a ball valve 76, which is spring-biased closed over an inlet opening 77 by a compression spring 78. The lower end of the compression spring 78 seats upon a spring seat 80, which is supported from the contact support 62.

An insulating liquid supply tube 81, shown more clearly in FIGS. 4 and 6, connects to all three valve means 75. As shown in FIG. 6, the liquid supply tube 81 comprises a plurality of tube sections 82, which feed into an inlet passage 83 associated with each of the valve means 75. Normally, in the open and closed-circuit positions of the interrupter 1, the ball valve 76 is maintained closed over the inlet opening by the biasing action exerted by the compression spring 78. It is desired to effect opening of the ball valves 76 by relaxing the spring pressure only during the opening operation of the circuit interrupter 1. During the closing stroke of the interrupter, it is desired to maintain the ball valve 76 closed upon its valve seat 84. To effect this end, a collapsible valve-operating lever, generally designated by the reference numeral 85 in FIG. 7, is employed. The valve operating lever 85 is pivotally mounted, by a pivot pin 86, to a valve support 87, which constitutes an integral part of the valve casing 88. The valve operating lever 85 has a spring compressing arm

85a, which effects a slight compression of the compression spring 78, the latter tending to maintain the ball valve 76 in its closed position over inlet opening 77. In addition, the valve-operating lever 85 has a second valve-actuating portion 85b, to which is pivotally connected, by a pivot pin 89, a bifurcated cam lever 90. The cam lever 90, as shown in FIG. 7, has an integral web, or bight portion 90a, which is biased by a torsion spring 91 into abutting engagement with an outer extremity, or stop 92 of the valve actuating arm 85b.

With reference to FIG. 7, it will be apparent that upward opening motion of the insulating operating rod 50 will carry upwardly therewith the cam 65. The upper beveled end 66 of cam 65 will engage a cam roller 93 pivotally mounted upon a pin 94 to the outer end of the cam lever 90. In the opening, or upward motion of the operating rod 50, the cam 65 will force the web portion 90a of cam lever 90 against abutment 92 of valve-operating lever 85 to effect compression of the compression spring 78. This will permit liquid under pressure contained within supply tube 81 to pass through inlet passage 83 over valve seat 84, past ball valve 76 and into the manifold supply structure 74 to jet liquid under pressure through the sixteen liquid jet passages 73 and into the established arc.

During the closing operation of the circuit interrupter 1, that is, during downward motion of the operating rod 50, with reference to FIG. 7, the beveled end 67 of cam 65 will strike cam roller 93, and will collapse the cam lever 90 in a clockwise direction about pivot pin 89 in opposition to the biasing action exerted by torsion spring 91. This will render the valve operating lever 85 inactive during the closing operation of the interrupter as far as compressing spring 78 is concerned. From the foregoing, it will be apparent that only during the opening operation is liquid jetted through the jet orifices 73 to effect arc extinction. During the closing operation, the valve structure 75 remains closed.

With reference to FIGS. 2, 3A and 3B, it will be noted that the porcelain casings 6, 7 have cemented to their opposite ends mounting-flange rings 95, 96, 97 and 98, as by cement 100. The cap structure 8, disposed at the lower end of the circuit interrupter 1, includes a cup-shaped metallic closure cap 101 having a peripheral flange portion 102, which is secured by bolts 103 to a support plate 104. The mounting-flange ring 95, disposed at the lower end of the porcelain casing 7, is secured, by bolts 105, to the support plate 104.

With reference to FIG. 3B, it will be observed with the contact-mounting sleeve 62a, associated with the lower-most arc-extinguishing unit 18, has a lower sleeve-like depending portion 62b, which is exteriorly threaded, as at 106. Threadedly secured to the support sleeve 62a is a clamping nut 107, which has an outer flange portion 108, which bears against an annular apertured spring plate 110. The apertured spring plate 110 has a plurality of apertures 111 (FIG. 8), through which extend spring bolts 112, the upper ends 113 of which are threadedly secured in tapped apertures 114.

Encircling the spring bolts 112, and disposed between the annular spring plate 110 and the support plate 104, are a plurality of strong compression springs 115, which exert compressive stress upon the porcelain casings 6, 7 and correspondingly exert tension upon the tie-rod supports 60.

Since the upper ends 116 (FIG. 2) of the tie-rod supports 60 are fixedly secured to laterally jutting brackets 117, integrally formed with a clamping casting 118 threaded to the lower end 4 of the bushing 2, it will consequently be observed that the terminal stud, not shown, passing interiorly through the terminal bushing 2, together with the tie-rods 60 are all in tension and not only exert compression upon the casings 6, 7, but also exert compression upon the external porcelain casing 119 associated with the upper end of the terminal bushing 2.

With reference to FIG. 3B, it will be noted that the support plate 104 has cut-out portions 104a to accommodate longitudinal reciprocating opening and closing motion of the two insulating operating rods 50.

As shown in FIG. 1, a liquid storage reservoir 120 is provided, which is preferably at least partially filled with a liquid under pressure. This liquid could be oil, or any suitable arc-extinguishing liquid under pressure, but preferably it is desired to utilize a liquefied gas, such as liquefied sulfur hexafluoride (SF_6) gas under a pressure of say 1000 p.s.i. As shown, a supply pipe 121 leads through the mechanism housing 3 (FIG. 3A) and downwardly interiorly within the upper porcelain casing 6, connecting with the lower supply tube 81, which feeds the several inlet passages 83. Following the jetting of the liquefied (SF_6), or other liquid, into the several arcing regions 122, the liquefield SF_6 gas expands into its gaseous phase, and exhausts into the interior region 123 interiorly of the casing 6, 7. This region 123 may be at several atmospheres pressure, in the case of sulfur hexafluoride gas, to insure adequate dielectric strength in the open-circuit position of the contact structure. This exhaust SF_6 gas is collected by a collecting pipe 124 (FIG. 3A) and is drawn downwardly through a pipe 125 (FIG. 1) into a compressor 126, where it is liquefied and forced, in liquid form, upwardly through a feed pipe 127 back to the liquid reservoir 120.

A distinct advantage of the circuit interrupter construction illustrated in FIG. 1 is the ease of inspection and replacement of worn parts. For example, following exhausting of the SF_6 gas from the interior of the circuit interrupter 1, the lower closure cap 101 may be removed by unscrewing the bolts 103. This will cause a contact stud portion 128 to be retracted from spring fingers 58 associated with the lower contact support 57. Following removal of the cap 101, the clamping nut 107 is backed off of the support sleeve 62a to release the compressive force exerted by the several compression springs 115. The clamping nut 107 is removed, and bolts 130 (FIG. 3B) are removed to permit dropping of the lower-most porcelain casing 7 downwardly from the circuit interrupter 1, exposing the several spaced serially related arc-extinguishing units 18 for inspection. The interrupter 1 may then be operated to the open and closed-circuit positions, noting the condition of the contacting parts. With the units 18 exposed, any worn parts may readily be replaced. The lower casing 7 may then be secured, by the bolts 130, to the flange ring 97 (FIG. 3B), and the clamping nut 107 screwed over the threads 106 to compress the spring plate 110, thereby causing compressive force to be exerted along the casings 119, 6 and 7. Finally, the lower closure cap 101 may be put back into place with the stud portion 128 engaged by the lower-most contact fingers 58 and with the bolts 103 secured into place.

The opening operation of the circuit interrupter 1 will now be described. In the closed-circuit position of the interrupter 1, the circuit obviously extends from the upper terminal 131 through the terminal stud, not shown, exteriorly through the terminal bushing 2, to the lower clamping casting 118 threadedly secured to the lower end of the terminal stud. The circuit then extends through a dependent slotted contact-sleeve portion 132 to the upper-most movable contact 46. The circuit then extends through the fingers 53 of upper fixed contact support 57, through the lower fingers 58 of said contact support 57 to the middle movable contact 46. The circuit continues in similar fashion down through the fingers 58, associated with the lower-most contact support 57, and to the terminal stud 128 of removable closure cap 101. The circuit continues by way of the lower stud portion 133 to the other transmission line L_2.

To effect an opening operation of the interrupter 1, the insulating operating rod 42 (FIG. 1) is pulled downwardly by any suitable operating mechanism, not shown. This will effect, through the linkage previously described, upward opening movement of the insulating operating rods 21, and upward corresponding opening movement of the two insulating contact operating rods 50. Prior to contact disengagement, the cams 65, associated with the right-hand contact rod 50 (FIG. 4), engage the several cam rollers 93 to effect counter-clockwise rotative motion of the several valve operating levers 85. The spring seat engaging portions 85c of the valve levers 85 compress the compression springs 78 to permit the liquid pressure to force the ball valves 76 downwardly, thereby permitting liquefied sulfur hexafluoride (SF_6) gas to pass by the ball valves 76, through the supply manifold passages 74 and through the several jets 73 of the units 18 into the arcing regions 122. This preferably occurs prior to contact disengagement.

Continued upward opening movement of the contact rods 50 causes contact disengagement between contacts 46, 53, so that an arc, not shown, is drawn through each restricted orifice 72 associated with each arc-extinguishing unit 18. The inwardly jetting streams of liquefied sulfur hexafluoride (SF_6) gas, directed into the several arcs quickly effects the extinction thereof, and continued opening motion of the contact operating rods 50 causes the cams 65 to slide off, or disengage the cam rollers 93, thereby permitting the compression springs 78 to effect reclosure of the several ball valves 76. This stops the jetting action, and the contact structure separates to an isolated open-circuit position.

To effect reclosure of the contact structures and thereby effect closing of the circuit interrupter 1, the external operating rod 42 (FIG. 1) is moved upwardly. Through the linkage, previously described, this effects downward closing motion of the pair of insulating operating rods 21, thereby effecting corresponding downward closing motion of the two contact operating rods 5. When the beveled ends 67 of the several cams 65 strike the rollers 93, the cam levers 90 rotate in a clockwise direction about pins 89, against the biasing action exerted by torsion springs 91, and the valve levers 85 remain stationary and inoperative during such a closing operation. The contact rods 50 effect contact reclosure between contacts 46, 53, and the circuit is completed through the circuit interrupter 1.

From the foregoing description, it will be apparent that there is described a novel circuit interrupter 1 readily adaptable for different voltage and current ratings by utilizing one or more elemental arc-extinguishing units 18 in series. It will be observed that all of the extinguishing units 18 are dependent from the lower end 4 of the terminal bushing 2 in the preferred mounting arrangement, and are readily observed for inspection purposes by dropping the lower-most porcelain casing 7, as previously described. The liquefied sulfur hexafluoride (SF_6) gas is jetted into the arcing regions 122 prior to arc drawal although the time of feeding, or supply may obviously be varied depending upon the application requirements. The valve means 75 is so arranged as to open only during the opening operation.

From the foregoing description of the invention, it will be apparent that there is disclosed a novel type of circuit interrupter utilizing liquefied gas injected into the arcing zone. Although liquefied sulfur hexafluoride (SF_6) gas has been described as an example of a possible liquefied gas, in describing the structure, it is to be clearly understood that liquefied selenium hexafluoride (SeF_6), or any one or a mixture of two or more of the liquefied gases enumerated above and below may be employed in substitution of liquid sulfur hexafluoride (SF_6) gas.

The various gases, which are suitable for use in interrupters of the type considered, have similar properties and characteristics are set out in the following table.

	Boiling Point ° C.	Vapor Pressure, #/sq. in. Gauge at 20° C.	Dielectric Strength with Air or N_2
CO_2	−78	830	0.9
SO_2	−10	35	2.0
SF_6	−63.8	300	2.2
SeF_6	−34.5	----------	2.9
SOF_2	−30	160	2.5
CCl_2F_2	−28	68	2.4
ClO_3F	−47.5	139	3.0
C_2F_6	−78	----------	1.8
C_3F_8	−37	----------	2.0
$CClF_3$	−81.5	325	1.4
CF_3Br	−58	195	1.25

Although the foregoing liquefied gases may be used to advantage, exceptional and unusual performance is obtained with liquid SF_6 and liquid SeF_6, since the gaseous phases of these two materials are so highly effective in arc interruption and high dielectric insulation.

In addition, conventional arc-extinguishing liquids under pressure, such as oil, carbon tetrachloride, etc. may be employed with advantage.

Although there has been shown and described a specific circuit interrupting structure, it is to be clearly understood that the same was 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. A multi-break circuit interrupter including a terminal bushing, grounded supporting means for supporting said terminal bushing adjacent the mid-portion thereof, line terminal means disposed at one end of said terminal bushing, insulating casing means disposed at the other end of said terminal bushing, the other end of the terminal bushing extending within one end of said insulating casing means, the external end of said terminal bushing having an insulating casing, second line terminal means disposed adjacent the other end of said casing means, the terminal bushing and the casing means being in substantial alignment, a multi-break arc-extinguishing assemblage supported by said other end of the terminal bushing and positioned between said other end of the terminal bushing and said second line terminal means within the insulating casing means, the arc-extinguishing assemblage including a plurality of liquid-jet arc extinguishing units, valve means associated with each unit, liquid supply means for supplying liquid under pressure to each valve means, an orifice structure through which the arc in each unit is drawn and having a plurality of radially disposed jet passages, a movable contact cooperable with a relatively stationary contact within each unit to establish an arc through the orifice structure of the unit, and a plurality of insulating tie rods terminating at said other end of the terminal bushing and supporting said arc extinguishing units in fixed spaced relation and additionally maintaining said insulating casing means and said casing in compression.

2. A multi-break circuit interrupter including a terminal bushing, grounded supporting means for supporting said terminal bushing adjacent the mid-portion thereof, line terminal means disposed at one end of said terminal bushing, insulating casing means disposed at the other end of said terminal bushing, the other end of the terminal bushing extending within one end of said insulating casing means, second line terminal means including a terminal cap and a spring plate disposed adjacent the other end of said casing means, the terminal bushing and the casing means being in substantial alignment, a multi-break arc-extinguishing assemblage supported by one or more tie rods at said other end of the terminal bushing and positioned between said other end of the terminal bushing and said second line terminal means within the insulating casing means, the arc extinguishing assemblage including a plurality of liquid-jet arc extinguishing units, valve

means associated with each unit, liquid supply means for supplying liquid under pressure to each valve means, an orifice structure through which the arc in each unit is drawn and having a plurality of radially disposed jet passages, a movable contact cooperable with a relatively stationary contact within each unit to establish an arc through the orifice structure of the unit, said one or more insulating tie rods supporting said arc-extinguishing units in fixed spaced relation and maintaining said insulating casing means in compression by means of said spring plate, one or more compression springs disposed within said terminal cap and bearing against the spring plate and said casing means, and a clamping nut mounted upon the assemblage adjacent said second line terminal means for increasing pressure upon the spring plate.

3. A multi-break circuit interrupter including a terminal bushing, grounded supporting means for supporting said terminal bushing adjacent the mid-portion thereof, line terminal means disposed at one end of said terminal bushing, insulating casing means disposed at the other end of said terminal bushing, the other end of the terminal bushing extending within one end of said insulating casing means, second line terminal means disposed adjacent the other end of said casing means, the external end of the terminal bushing having a weatherproof insulating shell, the terminal bushing and the casing means being in substantial alignment, a multi-break arc-extinguishing assemblage supported by said other end of the terminal bushing and positioned between said other end of the terminal bushing and said second line terminal means within the insulating casing means, the arc-extinguishing assemblage including a plurality of arc-extinguishing units, separable contact means associated with each unit to establish an arc within the unit, and a plurality of insulating tie rods secured to said other end of the terminal bushing and supporting said arc-extinguishing units in fixed spaced relation and maintaining said insulating casing means and external insulating shell in compression.

4. A multi-break circuit interrupter including a terminal bushing, grounded supporting means for supporting said terminal bushing adjacent the mid-portion thereof, line terminal means disposed at one end of said terminal bushing, insulating casing means disposed at the other end of said terminal bushing, the other end of the terminal bushing extending within one end of said insulating casing means, second line terminal means disposed adjacent the other end of said casing means, the terminal bushing and the casing means being in substantial alignment, a multi-break arc-extinguishing assemblage supported by said other end of the terminal bushing and positioned between said other end of the terminal bushing and said second line terminal means within the insulating casing means, the arc-extinguishing assemblage including a plurality of arc-extinguishing units, separable contact means associated with each unit to establish an arc within the unit, a terminal cap associated with said second line terminal means and having a plurality of compression springs therein, a spring plate, said compression springs exerting compressive force upon the insulating casing means and against the spring plate, and clamping means secured to the arc-extinguishing assemblage and forcing the spring plate to compress the springs, whereby the casing means will be subjected to compressive force whereas the arc-extinguishing assemblage will be subjected to tensile stress.

5. An arc-extinguishing assemblage including a plurality of serially-related arc-extinguishing units, each unit including a generally tubularly-shaped contact support having a stationary contact adjustably threadedly supported adjacent one end thereof, the other end of the tubularly-shaped contact support fixedly securing an insulating orifice structure into operative position, each stationary contact having opposed contact fingers and an arcing rod secured to a mid-web portion thereof, and a plurality of laterally-supported tubular movable contacts making separable contacting engagement with one set of contact fingers of one relatively stationary contact and also constant contacting engagement with the next adjacent relatively stationary contact.

6. A multi-break circuit interrupter including a terminal bushing, grounded supporting means for supporting said terminal bushing adjacent the mid-portion thereof, line-terminal means disposed at one end of said terminal bushing, insulating casing means disposed at the other end of said terminal bushing, the other end of the terminal bushing extending within one end of said insulating casing means, second line terminal means disposed adjacent the other end of said casing means, the terminal bushing and the casing means being in substantial alignment, a multi-break arc-extinguishing assemblage supported by said other end of the terminal bushing and positioned between said other end of the terminal bushing and said second line terminal means within the insulating casing means, said arc-extinguishing assemblage including a plurality of serially-related arc-extinguishing units, each unit including a generally tubularly-shaped contact support having a stationary contact adjustably threadedly supported adjacent one end thereof, the other end of the tubularly-shaped contact support fixedly securing an insulating orifice structure into operative position, each stationary contact having opposed contact fingers and an arcing rod secured to a mid-web portion thereof, and a plurality of laterally-supported tubular movable contacts making separable contacting engagement with one set of contact fingers of one relatively stationary contact and also constant contacting engagement with the next adjacent relatively stationary contact.

7. The combination according to claim 6, wherein a removable closure cap is associated with the second line-terminal means and has a terminal-stud portion which makes contacting engagement with the set of contact fingers of the relatively stationary contact most remote from said other end of said terminal bushing.

8. A multi-break circuit interrupter including a terminal bushing, grounded supporting means for supporting said terminal bushing adjacent the mid-portion thereof, line-terminal means disposed at one end of said terminal bushing, insulating casing means disposed at the other end of said terminal bushing, the other end of the terminal bushing extending within one end of said insulating casing means, second line-terminal means disposed adjacent the other end of said casing means, the terminal bushing and the casing means being in substantial alignment, a multi-break arc-extinguishing assemblage supported by said other end of the terminal bushing and positioned between said other end of the terminal bushing and said second line-terminal means within the insulating casing means, the arc-extinguishing assemblage including a plurality of serially-related liquid-jet arc-extinguishing units, each unit including a generally tubularly-shaped contact support having a stationary contact adjustably threadedly supported adjacent one end thereof, the other end of the tubularly-shaped contact support fixedly securing an insulating orifice structure into operative position, each stationary contact having opposed contact fingers and an arcing rod secured to a mid-web portion thereof, a plurality of laterally-supported tubular movable contacts making separable contacting engagement with one set of contact fingers of one relatively stationary contact and also constant contacting engagement with the next adjacent relatively stationary contact, valve means associated with each unit, liquid-supply means for supplying liquid under pressure to each valve means, and means movable with the movable contact structure for actuating said valve means to the open position for supplying a quantity of liquid into each unit during the opening operation for arc-extinguishing purposes.

9. The combination according to claim 8, wherein the orifice structure of each unit has a plurality of radially-disposed jet passages and a supply-and-manifold passage communicating with the radially-disposed jet passages.

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