United States Patent

Fischer et al.

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[45] **Feb. 1, 1972**

[54] OPERATING MECHANISM FOR A CIRCUIT INTERRUPTER

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[52] **U.S. Cl.** ..... **200/148 R**, 200/82 A

[51] **Int. Cl.** **H01h 35/38**

[58] **Field of Search** 200/148, 148.2, 148.4, 148.6, 200/82.1; 92/8, 10, 143; 91/399

[56] **References Cited**

UNITED STATES PATENTS

1,051,510	1/1913	Nazel et al.	92/10
2,740,859	4/1956	Beatty et al.	200/82 B
3,205,787	9/1965	Volkmann	91/399
3,302,533	2/1967	Hutter et al.	92/8
3,407,709	10/1968	Bade	91/399 X
2,435,162	1/1948	Scott, Jr.	200/148 X
2,555,898	6/1951	Paterson et al.	200/148 X
2,783,338	2/1957	Beatty	200/82.1 X
3,005,077	10/1961	Forwald	200/148
3,094,601	6/1963	Forwald	200/148 B
3,264,440	8/1966	Forwald	200/148

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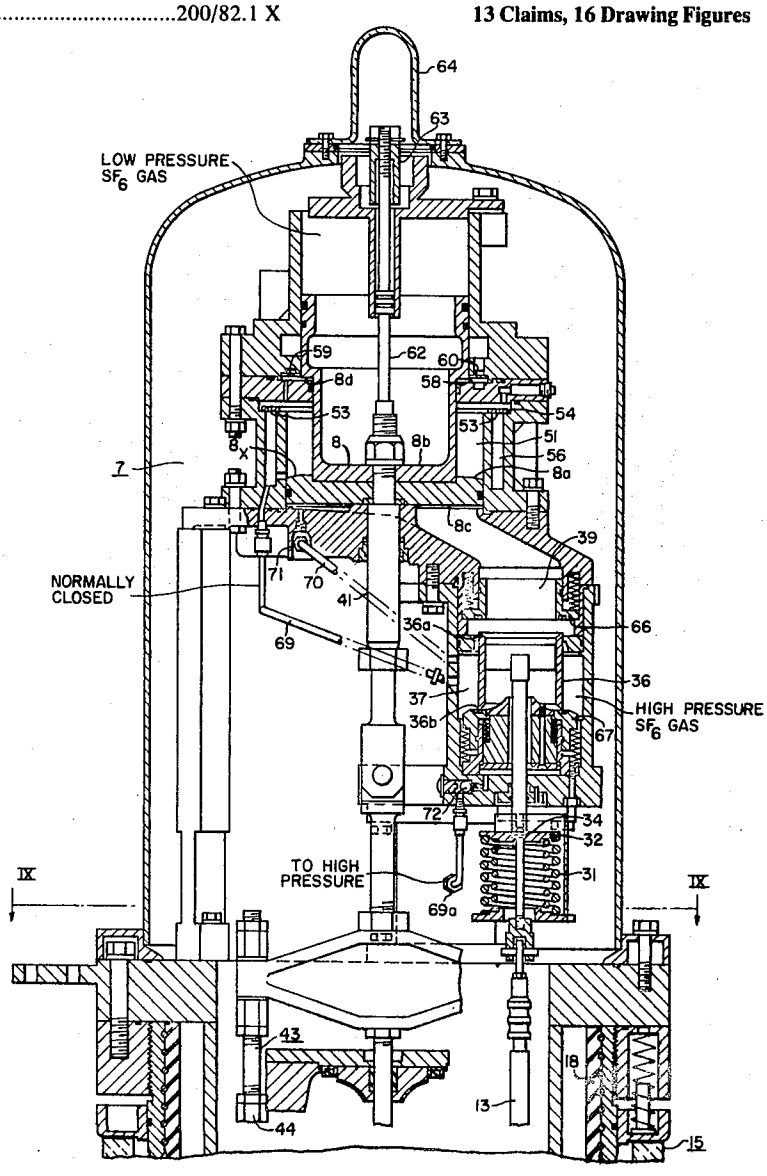
[57] **ABSTRACT**

A dual-acting piston operable within an operating cylinder is mechanically connected to the moving contact structure of a circuit breaker. The piston has a portion constantly acted upon in the closing direction by a high-pressure operating fluid. A large portion of the piston structure is at low pressure, and the opposite face of the piston structure is alternately pressurized or exhausted to effect, respectively, an opening or a closing operation of the circuit breaker.

A portion of the piston structure fits into a recess thereby affording a shock-absorbing function during the closing operation. Another portion of the piston structure traps high-pressure operating fluid so as to constitute a shock absorber during the opening operation of the interrupter.

In the case that a gas is used, which tends to liquefy, provision is made for the removal of the liquefied gas during the operation of the mechanism.

13 Claims, 16 Drawing Figures



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SHEET 01 OF 12

FIG. 1.

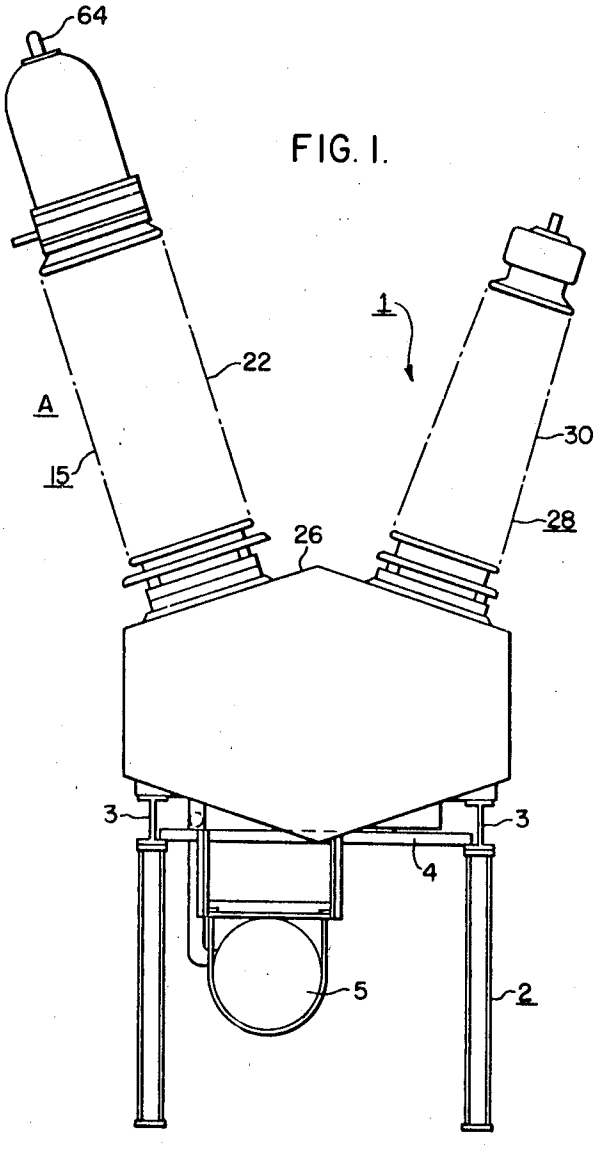
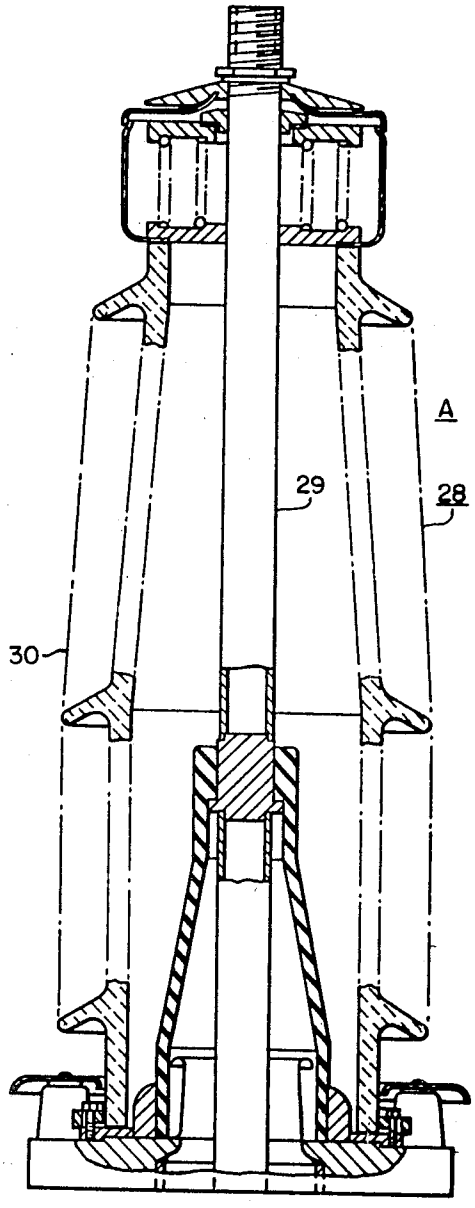


FIG. 5C.



WITNESSES

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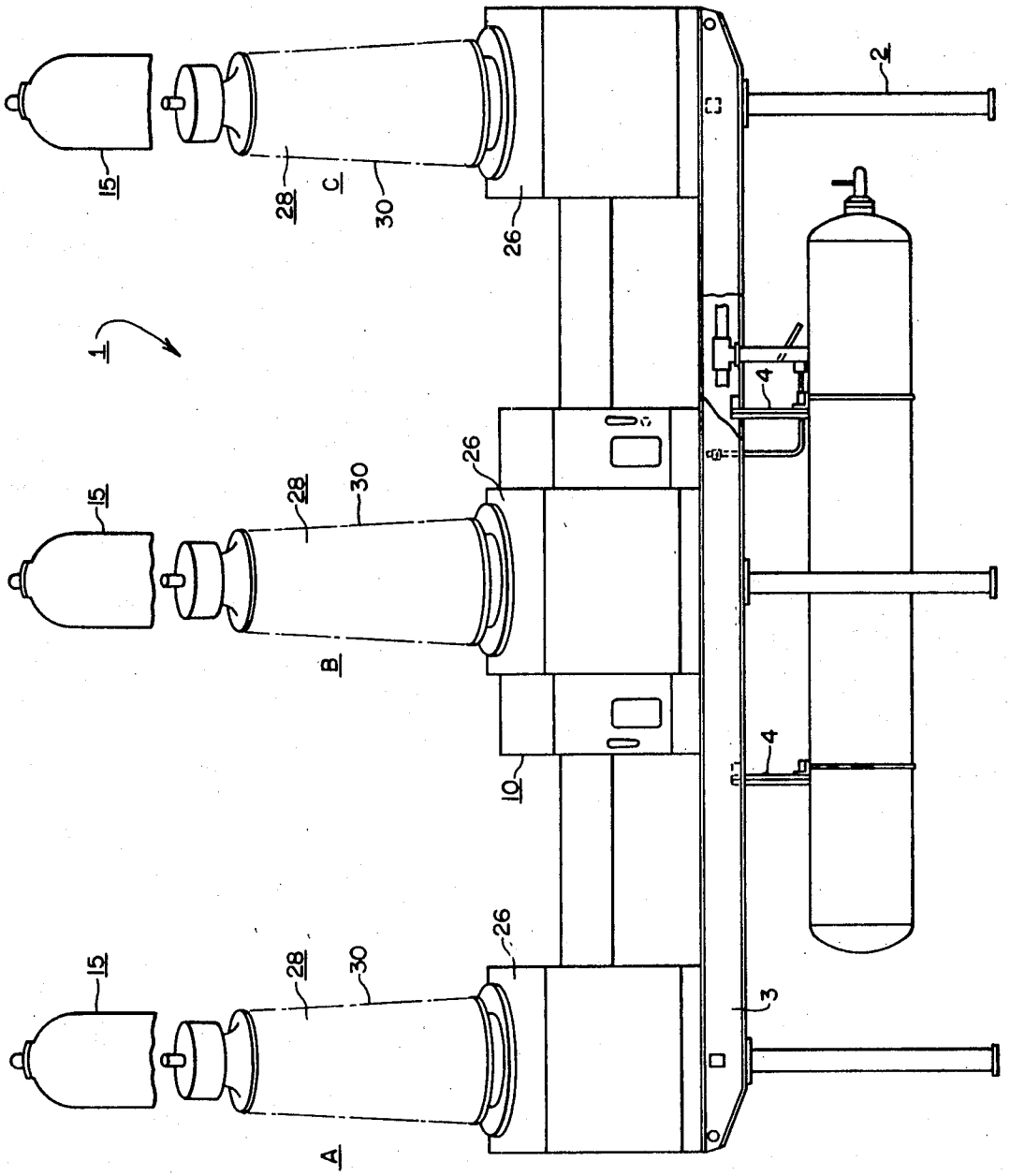


FIG. 2.

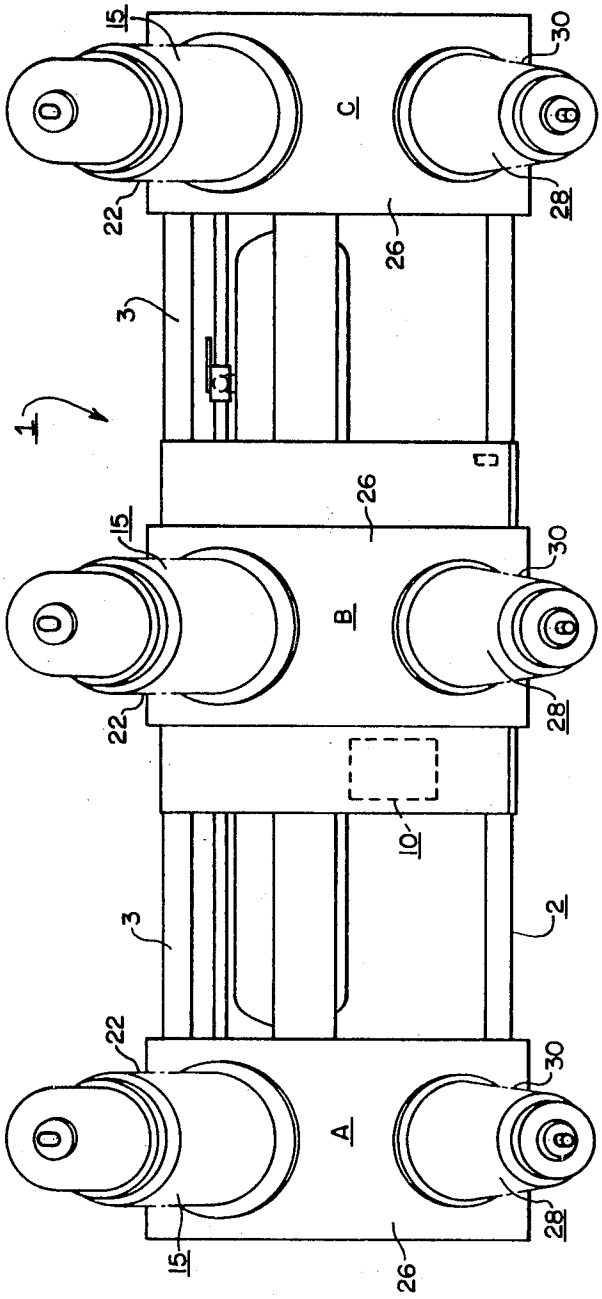


FIG. 3.

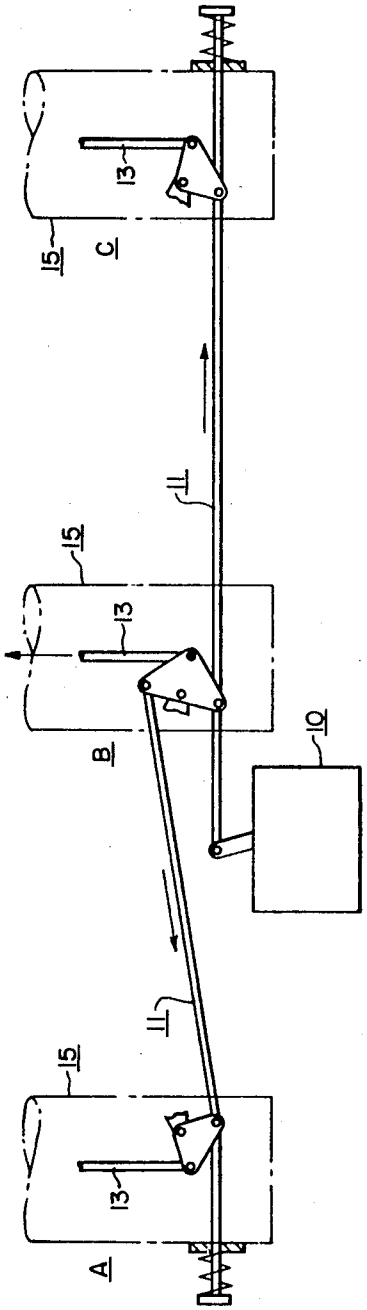


FIG. 4.

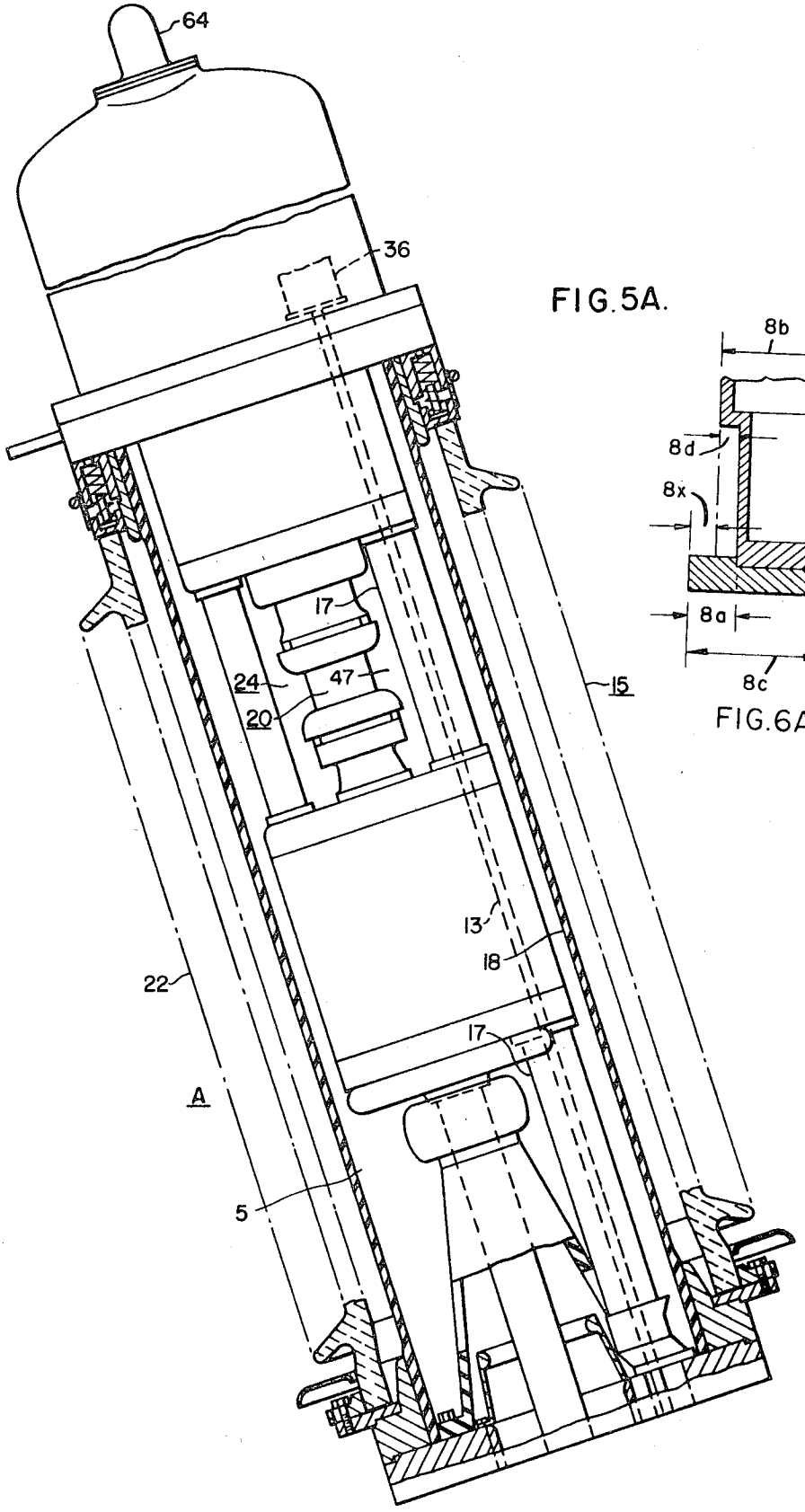


FIG.5A.

FIG.6A

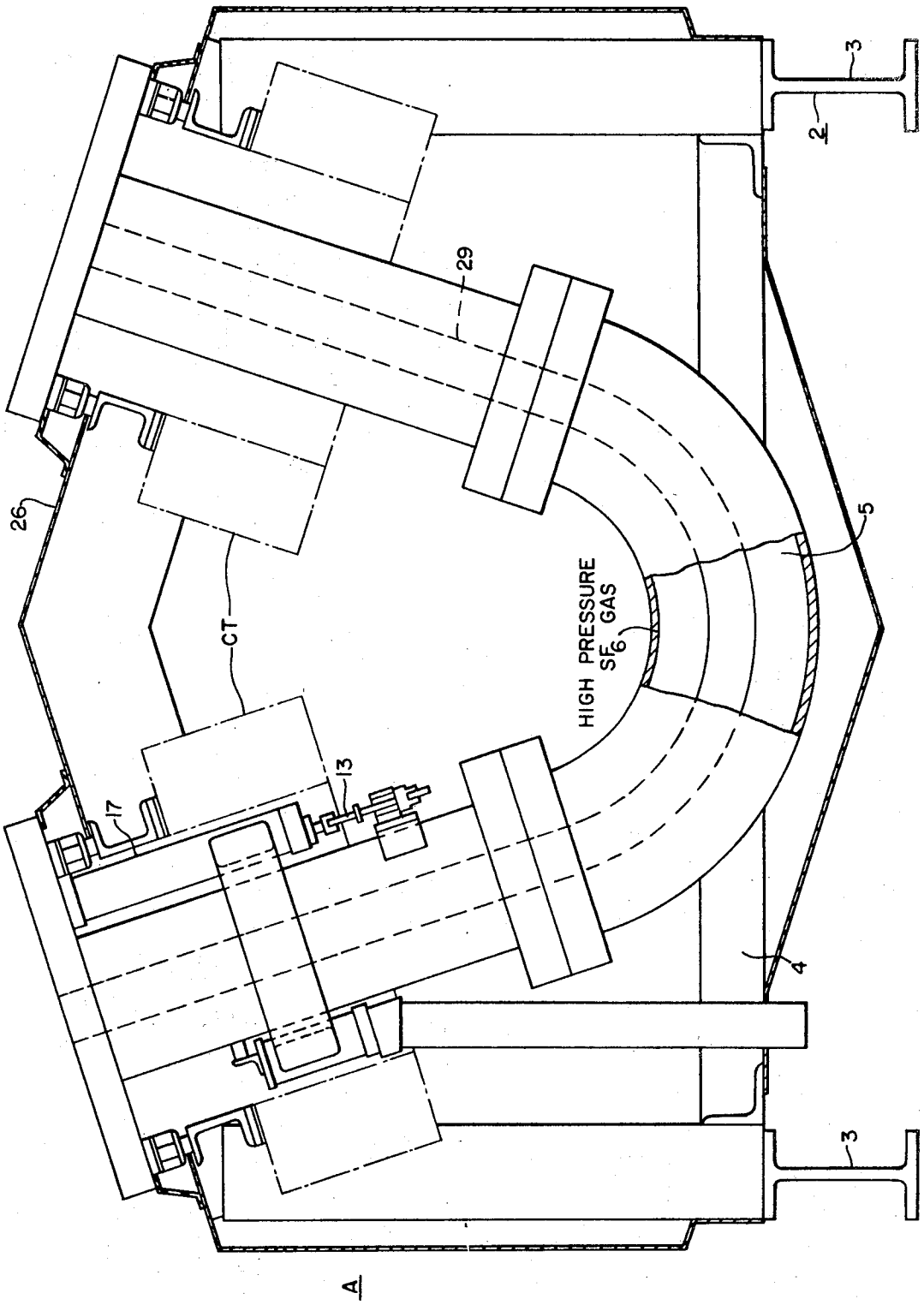


FIG.5B.

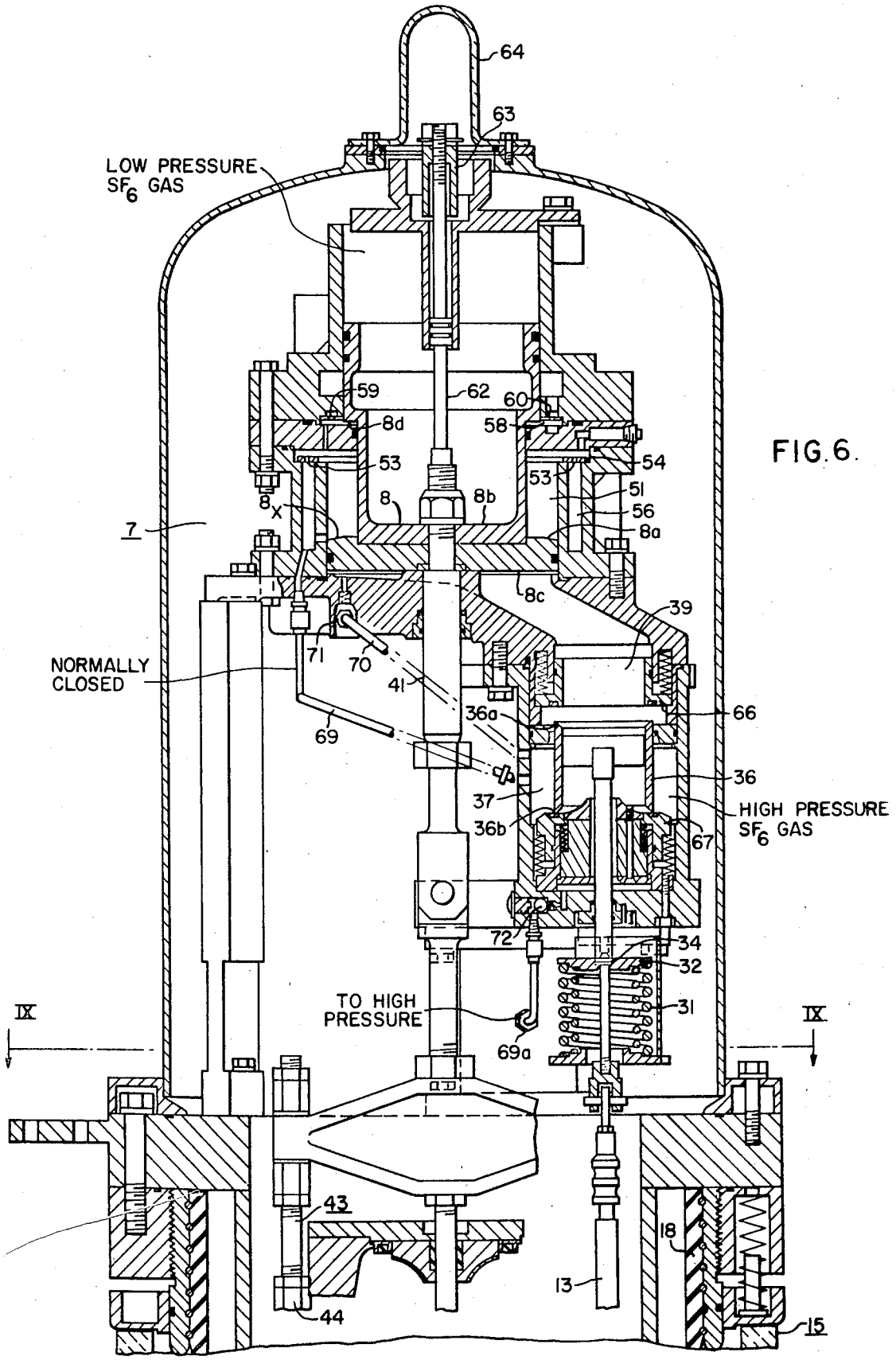
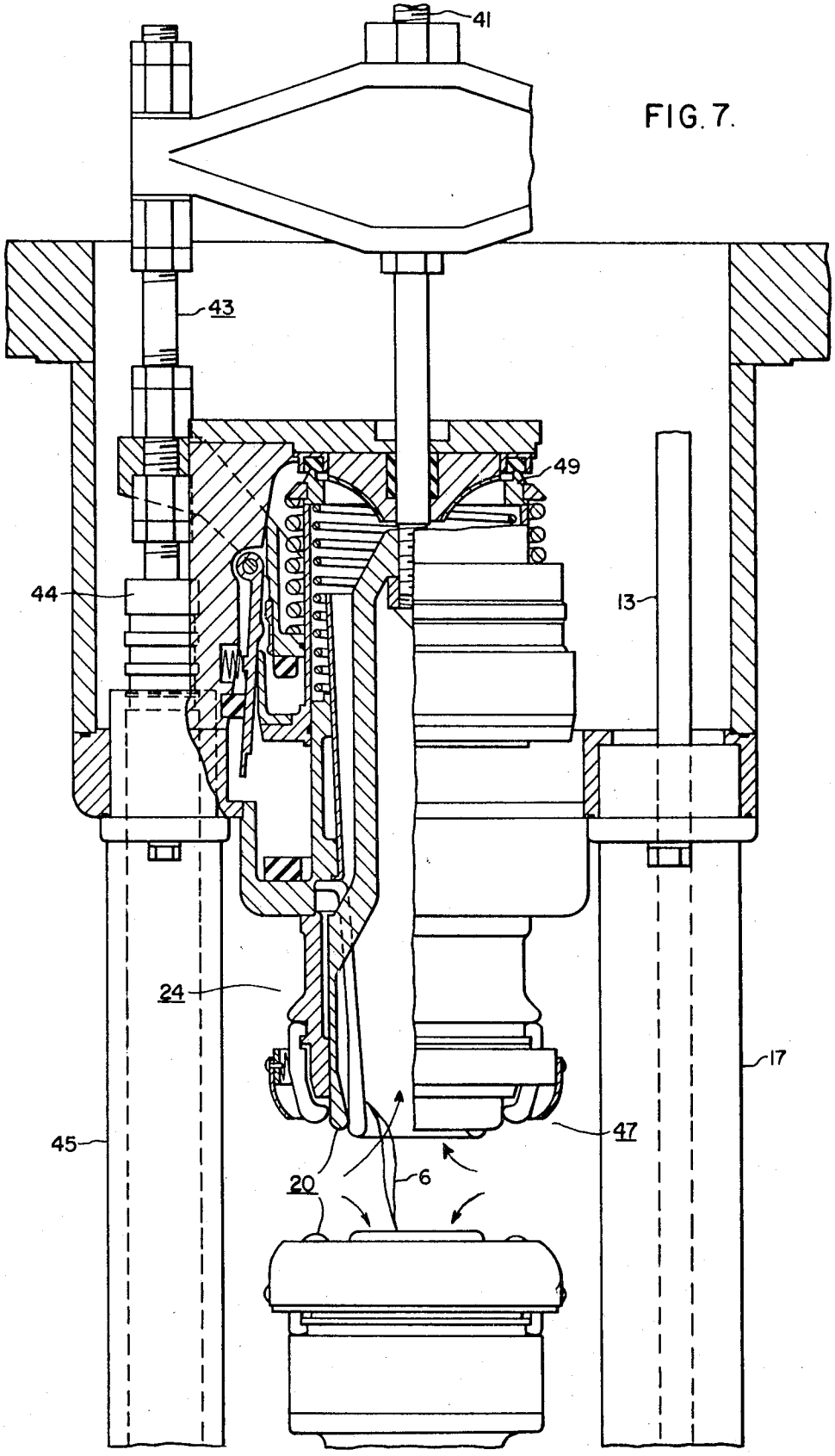

64
63
LOW PRESSURE
SF_6 GAS
59
62
60
8d
58
53
54
53
51
8x
8
8b
56
7
8a
8c
39
NORMALLY
CLOSED
71
70
41
69
36a
66
36
37
HIGH PRESSURE
SF_6 GAS
36b
67
72
34
32
IX
TO HIGH
PRESSURE
31
IX
69a
43
18
13
44
15

FIG. 6.

FIG. 7.



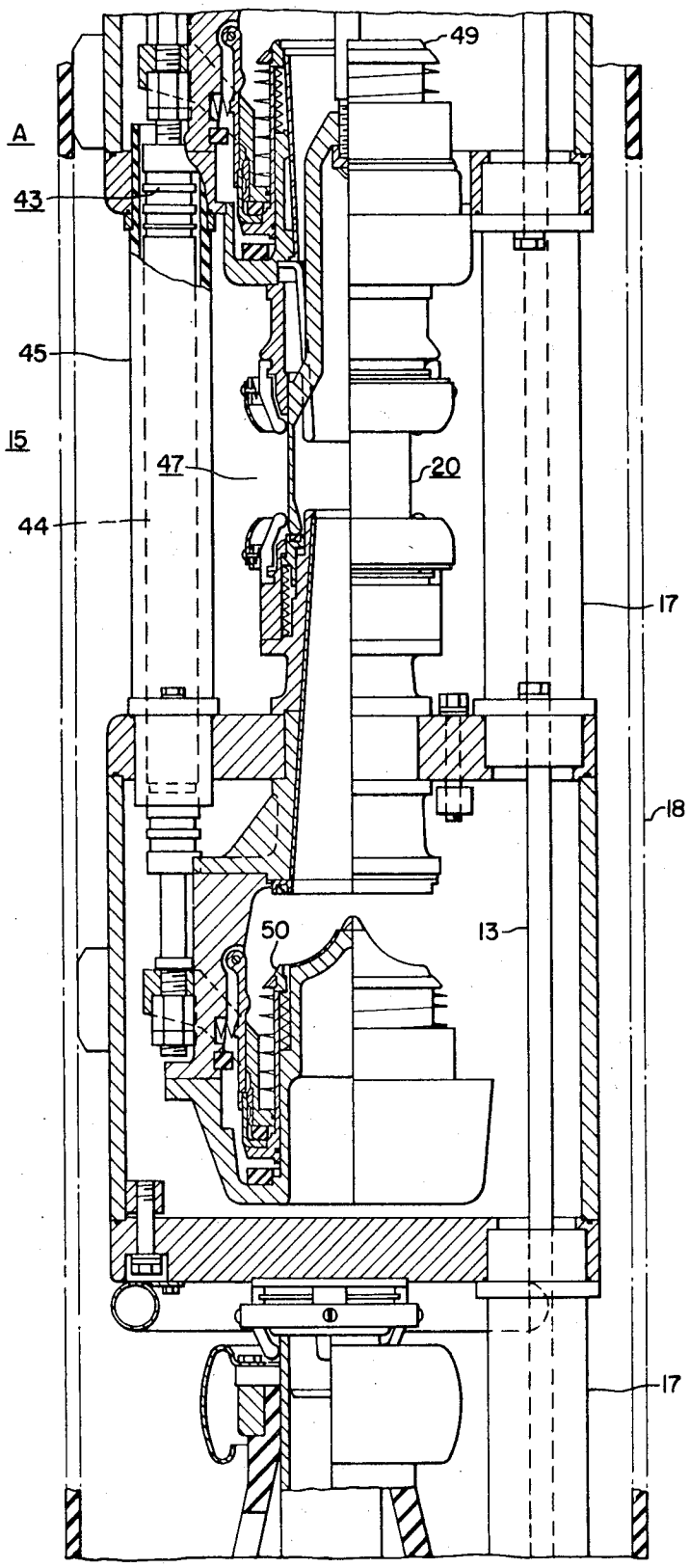
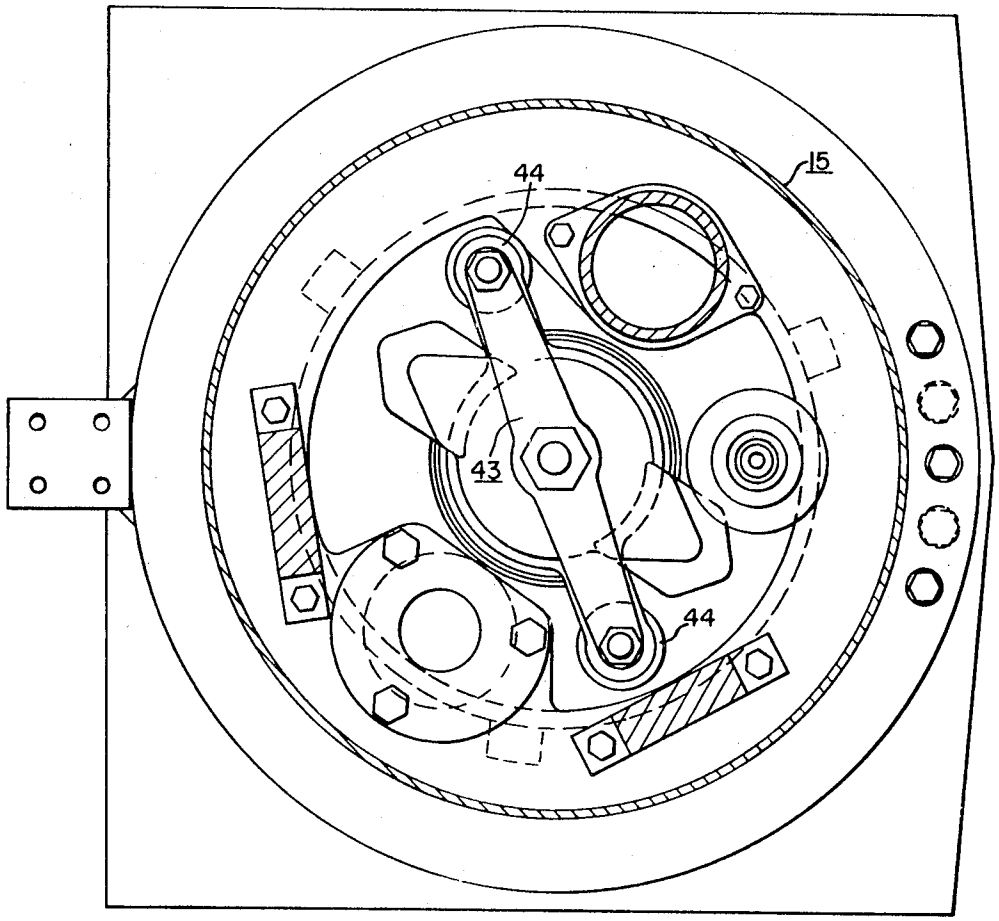


FIG. 8.

FIG. 9.



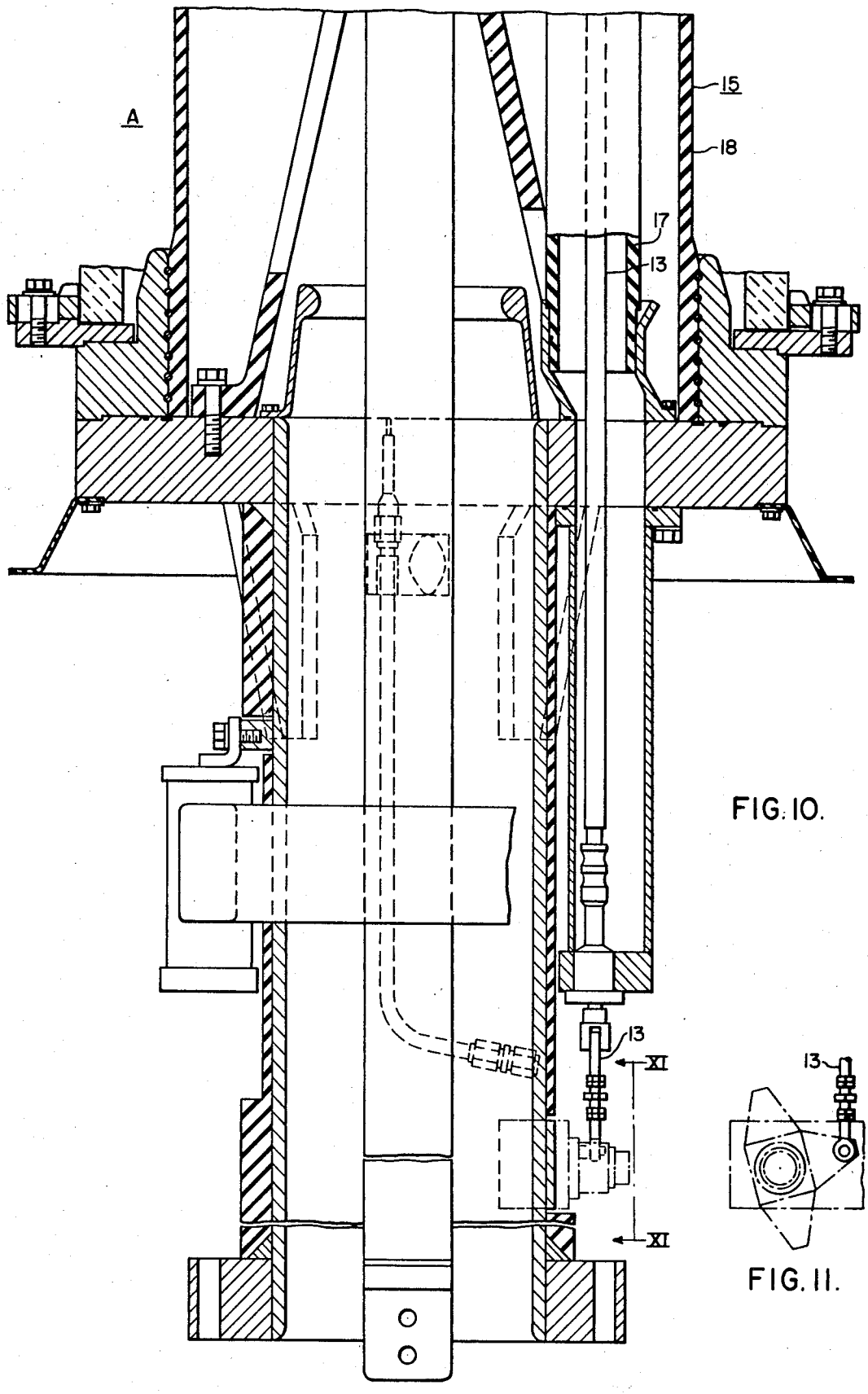


FIG. 10.

FIG. 11.

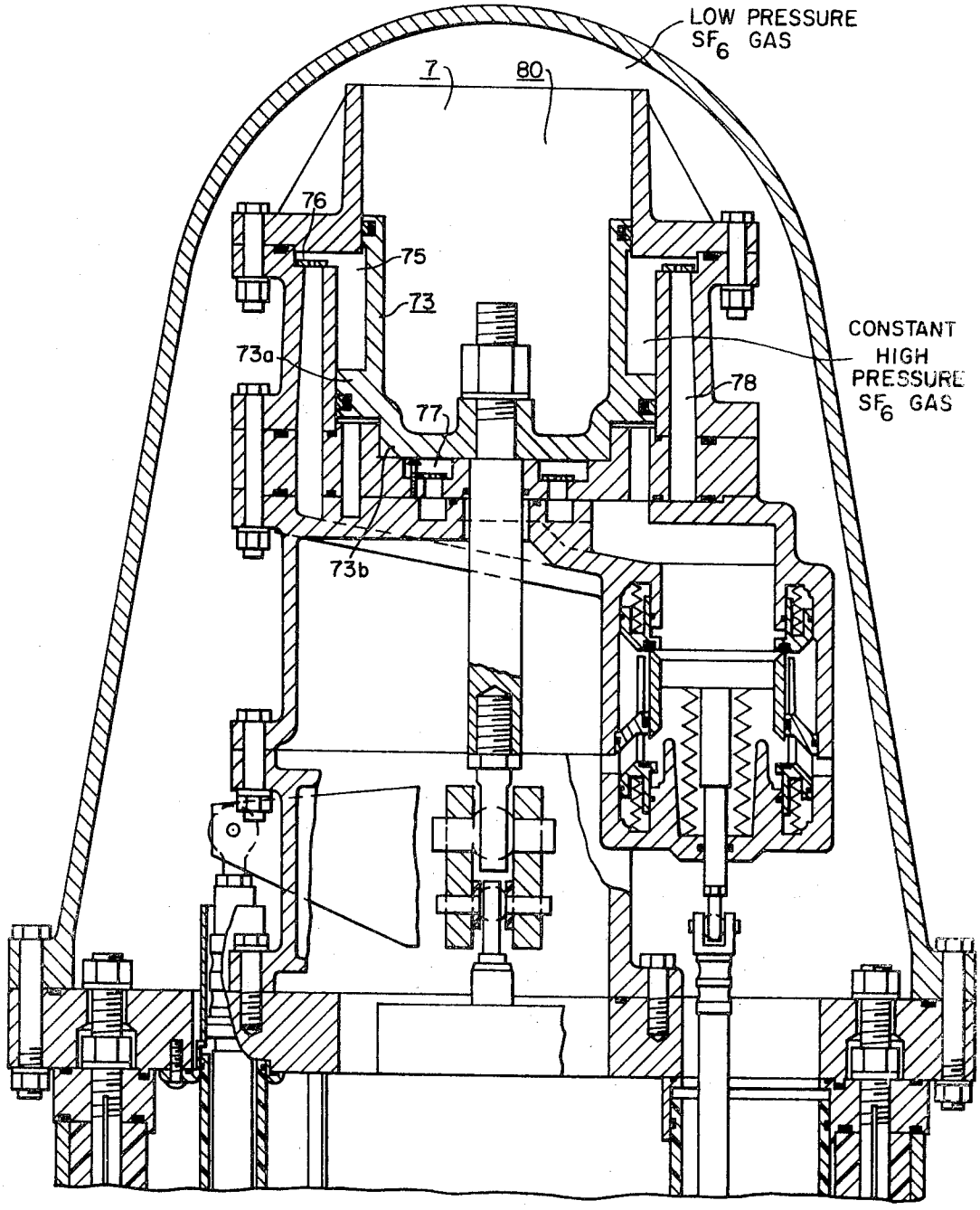

LOW PRESSURE
SF_6 GAS
7
80
76
75
73
73a
CONSTANT
HIGH
PRESSURE
SF_6 GAS
78
77
73b

FIG. 12.

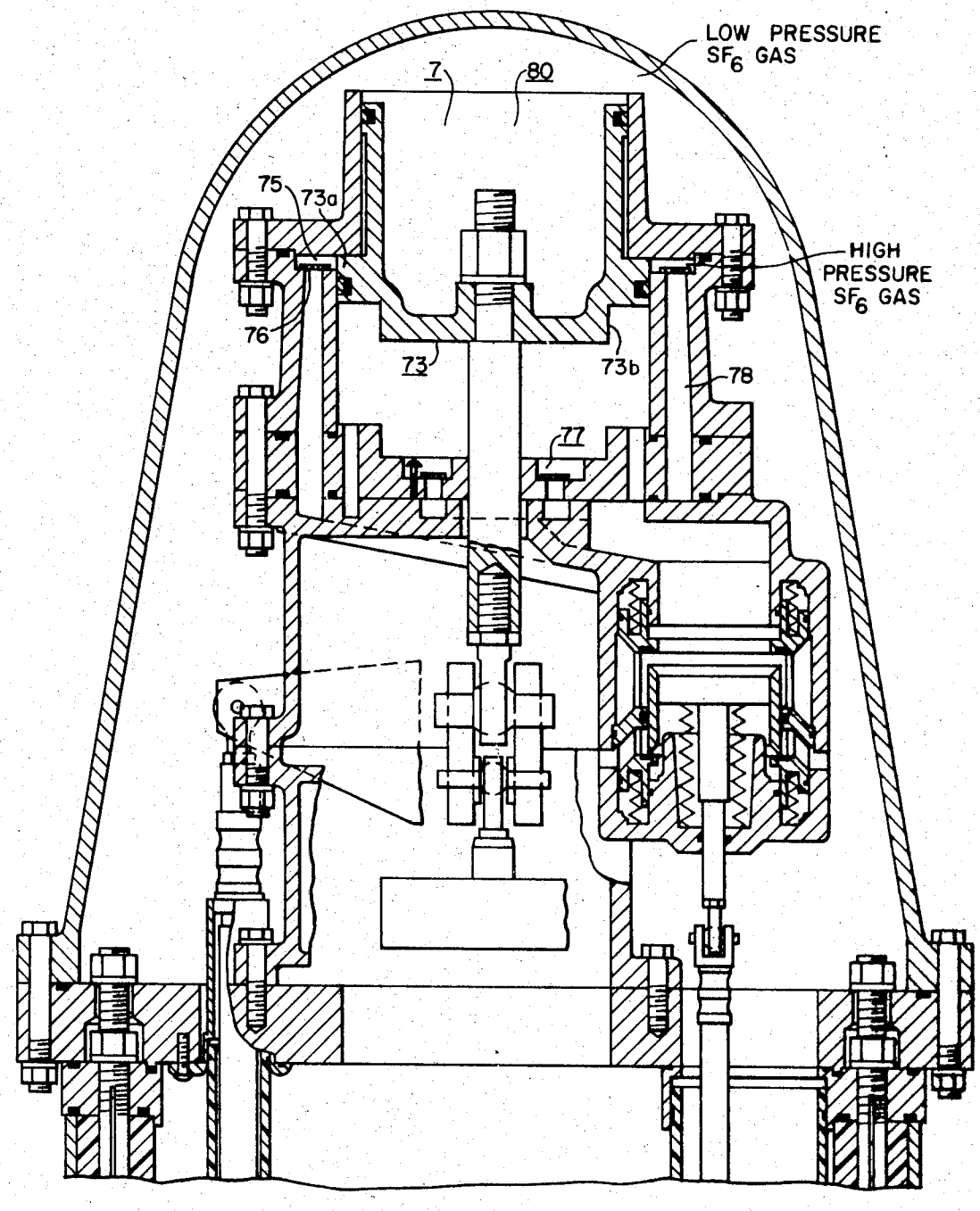

LOW PRESSURE
SF_6 GAS
7
80
75
73a
HIGH
PRESSURE
SF_6 GAS
76
73
73b
78
77

FIG. 13.

OPERATING MECHANISM FOR A CIRCUIT INTERRUPTER

CROSS-REFERENCE TO RELATED APPLICATIONS

In U.S. Pat. application filed Sept. 25, 1969 Ser. No. 762,479, now U.S. Pat. No. 3,590,189, issued June 29, 1971 to William H. Fischer and Wayne S. Aspey there is described a pneumatic piston structure for operating the movable contacts of a circuit interrupter including an opening piston and a closing piston, both fixedly secured to, and movabe with the piston rod operating the contacts. In this application, a separate shock absorber was utilized to eliminate shock during the opening and closing operations of the interrupter.

BACKGROUND OF THE INVENTION

It is desirable, in providing a circuit breaker, particularly of the high-voltage and high-rating type, to provide an operating mechanism, which is reliable and efficient bringing about, at desired times, a quick-opening and a quick-closing operation of the contact structure. In addition, as well known by those skilled in the art, it is desirable to provide means for cushioning the movable parts near the ends of their opening and closing strokes. On the other hand, the provision for the shock-absorbing function must not interfere with a rapid opening and closing movement of the piston structure itself, which during a major portion of such opening and closing strokes, must move unhindered by the action of shock-absorbing elements.

Also, it is desirable to provide a mechanism of relatively few parts and taking up little space. Finally, it is desirable to associate positively with the moving contact structure an indicator indicating, with positive assurance, the open and closed circuit positions of the circuitinterrupter contacts. This is highly essential to prevent danger to operating personnel during maintenance.

SUMMARY OF THE INVENTION

In accordance with a preferred embodiment of the invention, there is provided a dual-acting piston structure positively tied to the movable contacts of a circuit breaker, which, by a suitable configuration thereof, not only provides a structure which is biased to the closed circuit position, but, additionally, has portions performing shock-absorbing functions during the opening and closing operations of the interrupter. In the instant invention, a piston structure has a stepped portion, which moves within a high-pressure chamber and operates to bias the contact structure to the closed position, and also serves as a shock absorber during the opening operation of the interrupter. Preferably, another portion of the piston structure moves within a recess during the closing operation, trapping therein additional gas to serve as a shock absorber during the closing stroke of the interrupter.

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

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an end elevational view of a three-phase circuit breaker embodying the principles of the present invention;

FIG. 2 is a side elevational view of the three-phase circuit breaker of FIG. 1;

FIG. 3 is a top plan view of the circuit breaker of FIGS. 1 and 2;

FIG. 4 diagrammatically indicates the interconnecting linkage between the ground potential operator and the valve control rods for the several interrupting assemblies;

FIGS. 5A, 5B and 5C collectively illustrate a cross-sectional view taken through the circuit breaker of FIGS. 1–3 illustrating the contact structure in the closed circuit position;

FIG. 6 is a vertical sectional view taken through the high-potential operator illustrating the improved operating mechanism of the present invention, the contact structure being illustrated in the closed circuit position;

FIG. 6A is a diagrammatic view of the differential piston areas of the piston of FIG. 6;

FIG. 7 is a vertical sectional view of a portion of the contact structure for the circuit breaker, the contacts being illustrated in the fully open circuit position;

FIG. 8 is a view somewhat similar to that of FIG. 7, but illustrating the contact structure in the closed circuit position thereof;

FIG. 9 is a plan view, in section, taken substantially along the line IX—IX of FIG. 6;

FIG. 10 is a vertical sectional view taken through the lower portion of the circuit breaker structure indicating the extension of the valve control rods;

FIG. 11 is a detailed view taken in the direction of the arrows of FIG. 10;

FIG. 12 illustrates a modified form of the invention, the piston structure being illustrated in the closed circuit position of the interrupter; and,

FIG. 13 is a view similar to that of FIG. 12, but illustrating the position of the piston structure of FIG. 12 in the fully open circuit position.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, and more particularly to FIGS. 1–3 thereof, the reference numeral 1 generally designates a three-phase circuit breaker. As shown in FIGS. 1–3, it will be apparent that the circuit breaker structure 1 is supported by a metallic framework 2, which may be composed of heavy angle iron braces 3 and struts 4. The circuit breaker structure 1 is generally of the dual-pressure type involving the use of a suitable arc-extinguishing gas 5 at two different pressures, namely a high pressure say 230 p.s.i. suitable for use for injecting into the arc 6 (FIG. 7) to effect the extinction thereof, and, additionally, being used in the operating mechanism 7 (FIG. 6) to effect actuation of the piston structure 8 associated therewith.

Generally, as shown in FIGS. 2 and 3, the several pole units, A, B, and C are spaced laterally apart upon the grounded supporting framework 2, and are mechanically interconnected to a common mechanism 10 at ground potential, diagrammatically indicated in FIG. 4 of the drawings.

Briefly, the manner of operation of the circuitbreaker structure 1 is such as to cause the actuation of the ground potential operator 10 to effect motion of a mechanical linkage 11, which interconnects the several three-way valve control rods 13 extending upwardly individually within the three arc-extinguishing assemblages 15, more clearly shown in FIGS. 2 and 3 of the drawings. As illustrated diagrammatically in FIG. 5A of the drawings, the valve control rod 13, moving only a short distance, extends upwardly within insulating supporting tubes 17 disposed interiorly of an insulating inner tension tube 18 serving to spacially relate the one or more pairs of contact structures 20, which may be employed. As shown in FIG. 5A, only a single pair of separable contact structures 20 is utilized; however, for the higher voltages and higher ratings, a plurality of pairs of contact structures 20 may be utilized, if desired.

Generally, the arc-extinguishing assemblage 15 comprises an outer insulating weatherproof insulating casing 22, which maybe formed either of porcelain, or of a suitable resinous material serving to enclose the arc-extinguishing structure 24 of the interrupter 1. The arc-extinguishing structure, or assemblage 15 is supported upon the grounded housing 26 and is slanted, or canted away from a terminal-bushing structure 28, which serves to cause the current path to be conducted in a generally U-shape as shown in FIG. 1. The terminal-bushing structure 28 generally has a terminal rod 29 at high voltage extending therethrough, and is spaced within an outer weatherproof casing 30, composed of a suitable insulating material, such as porcelain, as shown in FIG. 5C. A suitable arc-extinguishing gas, which has high insulating qualities, may be enclosed within the terminal-bushing structure 28 at a relatively low pressure, say of 60 p.s.i. This gas may be the same gas 5 as described heretofore.

FIGS. 5A, 5B, 5C collectively show a vertical cross-sectional view taken through a single pole unit A of the three-phase circuit interrupter 1. As well known by those skilled in the art, there are three such structures A, B and C to control the three phases of a transmission system.

In the circuit breaker structure 1 under consideration a suitable highly effective arc-extinguishing gas 5, such as sulfur hexafluoride (SF_6) gas, may be used as the arc-extinguishing gas, and also as an insulating gas to enable a close spacing of the live parts. It is also used as the insulating gas within the terminal-bushing structure 28. U.S. Pat. No. 2,757,261 describes the arc-extinguishing characteristics of this particular gas 5.

As mentioned hereinbefore, generally, the manner of operation is the simultaneous actuation of the three valve control rods 13, which extend upwardly into the tops of the arc-extinguishing assemblages 15. Here, as is shown more clearly in FIG. 6 of the drawings, the upper ends of the valve control rods 13 are biased upwardly by a battery of compression springs 31 seating upon a movable spring seat 32 affixed to the valve control rod 13, as at 34, and serving to bias the pressure-balanced three-way control valve 36 to its upper closed position. To effect an opening operation of the circuit breaker 1, the valve control rod 13 is moved upwardly say three-quarters of an inch, so as to permit the admission of high-pressure gas 5, existing within the region 37, upwardly through a conduit 39 and across the entire lower surface 8C of a dual-acting piston structure 8, which is connected, by means of a piston rod 41, to the movable contact structure 20 of the interrupter 1.

As shown more clearly in FIG. 6, taken in conjunction with FIG. 7, it will be observed that the piston structure 8 is mechanically tied, by means of the piston rod 41, to a generally ladder-shaped structure 43, which comprises a pair of laterally spaced insulating operating rods 44, which extend axially of the arc-extinguishing assemblages 15 through a pair of hollow supporting tubes 45.

The region 47, immediately adjacent the contact structure 20, and externally thereof in the closed circuit position thereof, as illustrated in FIG. 8, is at a relatively high pressure, say 230 p.s.i., as more clearly described in the U.S. Pat. application filed Sept. 16, 1968, Ser. No. 759,992 by Berkabile, the arc-extinguishing structure 24 being of the so-called downstream type, in which the high-pressure gas 5 moves into and through the separated contact structure 20 during the opening operation until the flow of gas is halted by the closing operation of a pair of downstream blast valves indicated by the reference numerals 49 and 50 in FIG. 8 of the drawings.

With reference to FIGS. 6 and 6A of the drawings, it will be observed that the dual-acting piston 8 has a differential annular area 8*x* equal to the difference of area of 8*a*–8*d*, herein termed the effective closing area portion of the piston 8*x*. This effective closing area 8 is constantly subjected to a high-pressure gas within the region 51. In addition, the piston structure 8 has the upper closing face portion 8*b* thereof constantly subjected to gas at a relatively low pressure, which tends to effect closing operation of the piston 8, and hence the movable contact structure 20. The annular area, which is effective in opening the mechanism is 8*c*–8*x*. The area that is effective in closing is 8*a*–8*d* or 8*x*. The area, which is effective for the opening shock absorber is 8*a*. The area that is effective for the close shock absorber is 8*d* as shown in FIG. 6A.

To effect an opening operation of the interrupter 1, actuation of the three-way valve 36 is brought about by upward movement of the valve control rod 13 to admit gas upon the entire lower face 8*c* of the piston structure 8 causing opening upward motion of the contact structure 20, and, additionally, trapping high-pressure gas within the space 51 and causing its slow leakage through the ports 53 provided in the annular check valve 54. During the closing operation, upon downward movement of the piston structure 8, the check valve 54 raises and permits high-pressure gas, which is constantly present within the region 56 to flow past the ring-shaped check valve 54 and into the region 51.

During the closing operation, the downward movement of the piston structure 8 effects the downward movement of a stepped portion 8*d* thereof into the space 58, which contains gas at relatively high pressure at all times. This performs a shock-absorbing function during the closing stroke, the gas leaking through perforations 59 provided in a ring-shaped check valve 60.

Fixedly attached to the piston structure 8 and in effect constituting an extension of the piston rod 41 is an indicator stem 62, which carries a green flag 63, which projects upwardly into a transparent cap 64 provided at the upper end of the interrupter, as shown in FIG. 6. This clearly indicates to maintenance people, in a positive manner, the fact that the circuit breaker has its contact structure in the fully open circuit position, and that it is then safe to work upon the breaker, if desired. This structure is set forth and claimed in U.S. Pat. application (W.E.40,612) filed Dec. 31, 1969, Ser. No. 889,635, by Richard E. Kane and Wm. H. Fischer and assigned to the assignee of the instant application.

The three-way valve structure 36 comprises movable valve seats 66, 67, which take care of any misalignment or elongation or contraction of the valve control rods 13, which may be of considerable length. In addition, the valve seats 66, 67 are spring biased in a direction to effect following travel, once the lips 36*a*, 36*b* of the valve have separated therefrom.

To take care of the situation where a low ambient temperature may be encountered, and liquefaction of the sulfur-hexafluoride gas is encountered, liquid pipes may be provided, as indicated by the reference numerals 69 and 70.

The liquefaction pipe 70 communicates with the space below the piston structure 8, which may be at alternately low and high pressure. The liquefaction pipe 69 communicates with the space 37 which is constantly at high pressure. Preferably, ball check valves 71, 72 are provided to prevent the leakage of high-pressure gas admitted from the high-pressure reservoir leaking into the space 39 during low-pressure conditions therein. When the pressure is equalized at the ball valves, the liquid will flow downwardly by gravity down the pipes 69*a*, 70 and eventually leads into the high-pressure reservoir 24 within the arc-extinguishing chamber, and also within the lower U-bend, where suitably provided heaters may be located to vaporize the liquefied gas.

FIGS. 12 and 13 illustrate a modified form of the invention in which the piston structure 73 has a stepped portion 73*a*, which moves within a space 75 constantly at high pressure. Again it will be observed that the ring-shaped check valve 76 is provided to bring about a shock-absorbing function during the opening operation of the interrupter. Additionally, a space 77 is provided below a stepped portion 73*b* of the piston structure 73 to provide a shock-absorbing action during the closing operation. High-pressure gas is constantly fed into the region, 78. Relatively low-pressure gas exists in the space 80 above the piston structure 73. Generally, the operation of the piston structure 73 of FIGS. 12 and 13 is similarly to that previously described in connection with the piston structure of FIG. 6 of the drawings.

From the foregoing description, it will be apparent that there has been provided an improved operating mechanism 7 for a circuit breaker in which, by a suitable configuration of the piston structure, 8, 73 a shock-absorbing function is built in to cushion the opening and closing strokes of the interrupter. There results a simplification of parts and highly reliable operation is achieved by the resulting simplicity. In addition, means has been provided for accommodating liquefaction of the arc-extinguishing gas during relatively low ambient operating conditions.

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

We claim as our invention:

1. A gas-operating mechanism for a circuit interrupter including, in combination:

a. a piston rod adaptable for connection to the separable contact structure of the circuit interrupter;

b. a dual-acting stepped piston structure secured to said piston rod and having a first stepped portion (*8a*) movable within a shock-absorbing chamber (**51**) constantly filled with high-pressure operating fluid partially tending to bias said piston structure to the closed circuit position at all times;

c. said piston having one side thereof (*8b*) constituting the major closing face portion thereof acted upon by low-pressure operating fluid at all times tending to close the contact structure, and,

d. means for alternating the pressure upon the opposite opening face (*8c*) of the piston structure for producing opening and closing operations of the circuit interrupter.

2. The combination according to claim **1**, wherein the dual-acting piston structure is generally cup-shaped and has an outer annular flange portion constituting said first portion (*8a*) of the piston structure movable within said shock-absorbing chamber.

3. The combination according to claim **1**, wherein a portion (*8d*) of the piston structure moves within a second shock-absorbing chamber (**58**) constantly filled with high-pressure operating fluid at all times and tending to bias the piston structure to the open position.

4. The combination of claim **1**, wherein an indicator rod is affixed to the piston structure and is visible externally of the circuit interrupter so as to be visible to maintenance personnel.

5. The combination of claim **1**, wherein a three-way control valve controls the admission or exhausting of high-pressure fluid on the opening face (*8c*) of the piston structure.

6. The combination of claim **1**, wherein a liquefaction duct connects to the shock-absorbing chamber (**51**).

7. In combination, a pneumatic operating mechanism for a circuit interrupter including a cup-shaped stepped operating piston having an enlarged piston head flange portion (*8a*) at one end movable within an enlarged high-pressure shock-absorbing chamber (**51**) at all times, said piston having low-pressure fluid constantly acting on a portion (*8b*) of the closing face thereof, and means for alternating the high- and low-pressure fluid acting on the opposite enlarged piston head flange portion (*8c*) to effect the opening and closing operations of the circuit interrupter.

8. The combination according to claim **7**, wherein the cup-shaped operating piston (*8d*) has an enlarged guide portion at the other end thereof of smaller diameter than the diameter of said enlarged piston head flange portion (*8a*), and a radially inwardly extending operating cylinder portion bearing against the smallest diameter of the piston.

9. The combination according to claim **1**, wherein the head of the piston has a reduced protruding portion extending into a shock-absorbing chamber to cushion the closing stroke of the interrupter.

10. The combination of claim **9**, wherein a check valve is associated with the last-mentioned shock-absorbing chamber.

11. The combination according to claim **1**, wherein a check valve is associated with said shock-absorbing chamber.

12. The combination according to claim **3**, wherein a check valve is associated with the second shock-absorbing chamber.

13. The combination according to claim **12**, wherein a check valve is associated with the first-mentioned shock-absorbing chamber.

* * * * *