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Rostron et al.

[11] **3,930,134**

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[54] **PNEUMATIC POWER-UNIT HAVING A DRIVING PISTON AND AN EXHAUST VALVE**

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[52] **U.S. Cl.** ..... **200/82 B;** 200/83 A; 200/148 F; 91/416; 137/625.64

[51] **Int. Cl.²** **H01H 35/38**

[58] **Field of Search**..... 335/174, 191; 200/82 R, 200/82 B, 82 C, 169 R, 145, 153 G, 153 V, 153 H, 148 E, 148 F, 83 A, 83 C, 83 J; 137/625.64; 91/416

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[57] **ABSTRACT**

An improved pneumatic power unit is provided including a penumatic piston reciprocally operable within an operating cylinder housing, which, in one conceivable application, operates the contact structure of a power circuit-breaker, and uses a normally-open three-way valve, which normally provides high-pressure gas on both sides of the driving piston within the operating cylinder housing. During the closing operation of the circuit-breaker, when the pneumatic power unit of the instant invention is applied to this particular application, the three-way normally-open valve is operated to exhaust one side of the driving piston, and the high-pressure gas already present on the other side of the piston provides the required closing force to close the contacts of the circuit-breaker against the usually-provided accelerating spring pressure tending to open the breaker.

The de-energization of the normally-open three-way valve returns the closing or driving piston to its normal reset position, in such a particular application, thus not requiring a return spring, since the cross-sectional area of the piston-shaft is acted upon by the internal high-pressure gas present on the return or non-working side of the piston assembly in the cylinder housing, and since normal atmospheric air pressure obviously exists on the outside or externally of the operating-cylinder housing thereby exerting relatively little inward force on the cross-sectional area of the piston rod.

16 Claims, 4 Drawing Figures

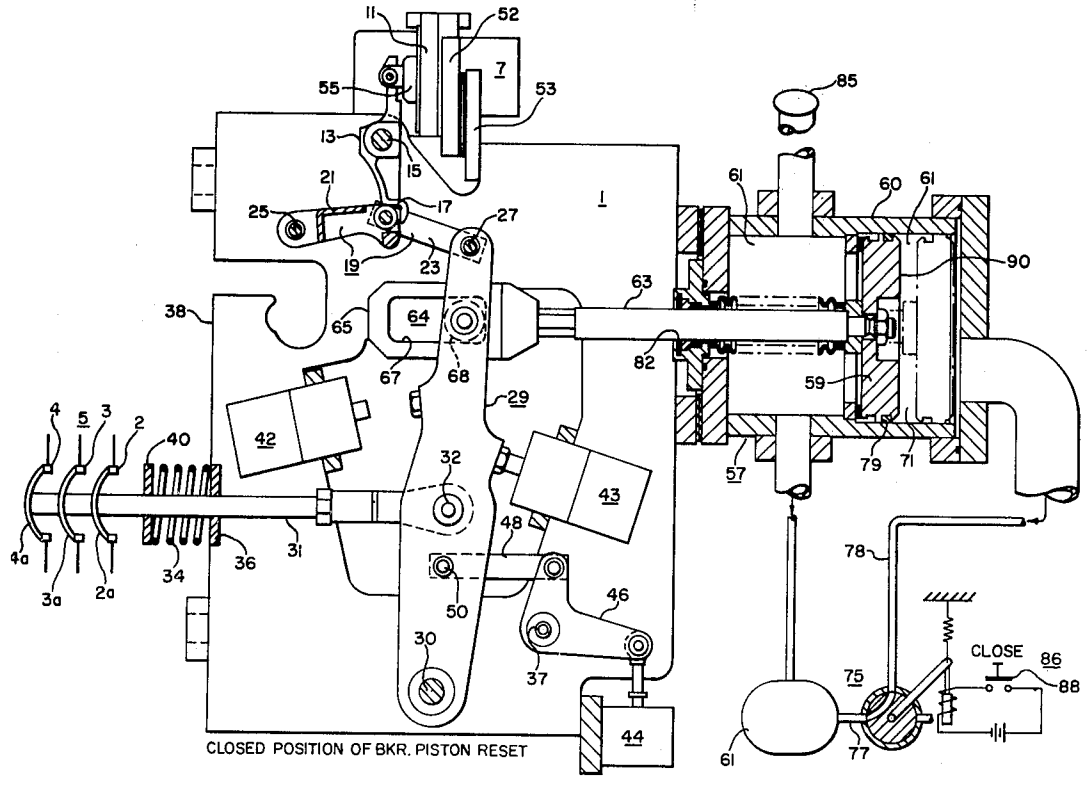


FIG. 1.

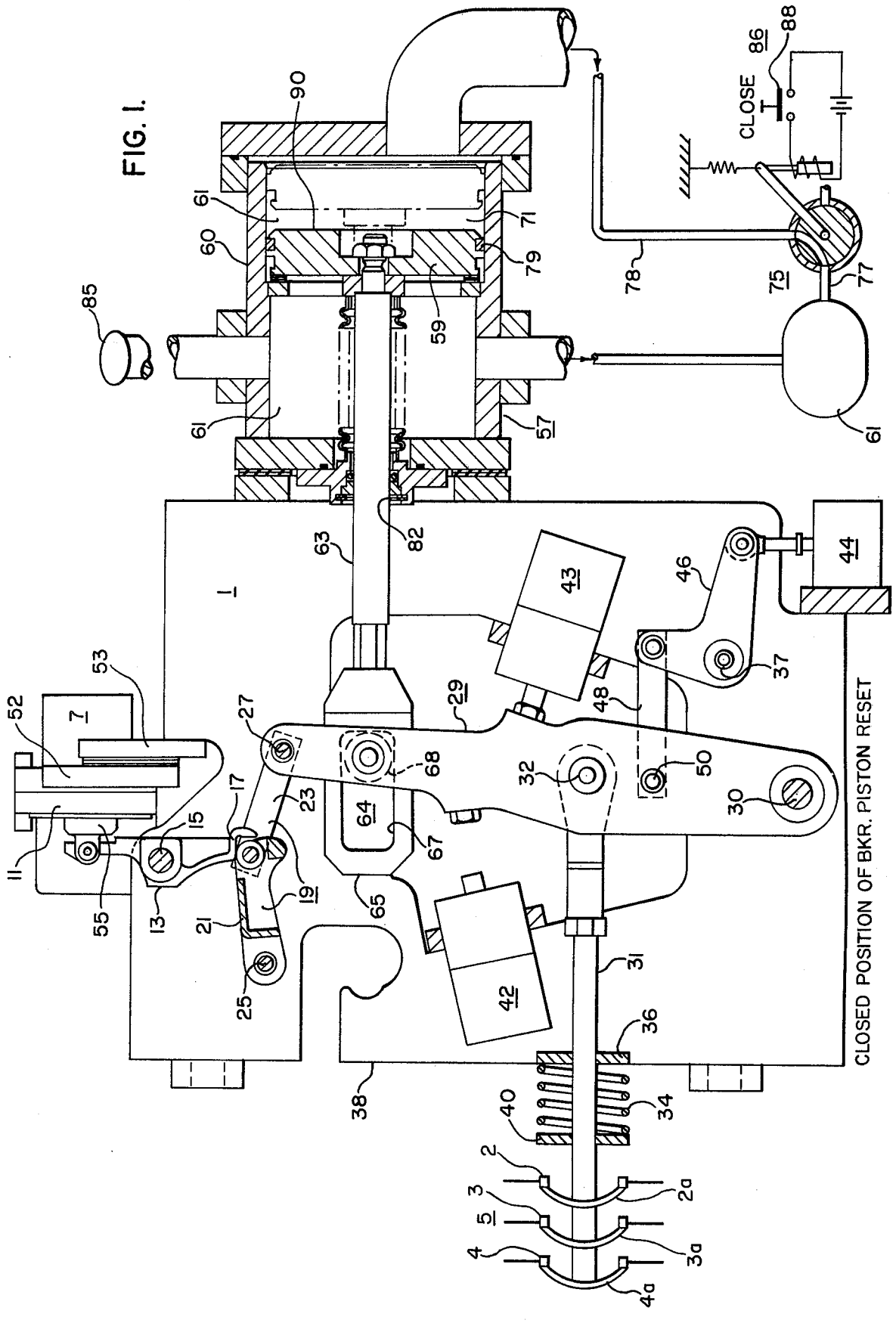


FIG. 2.

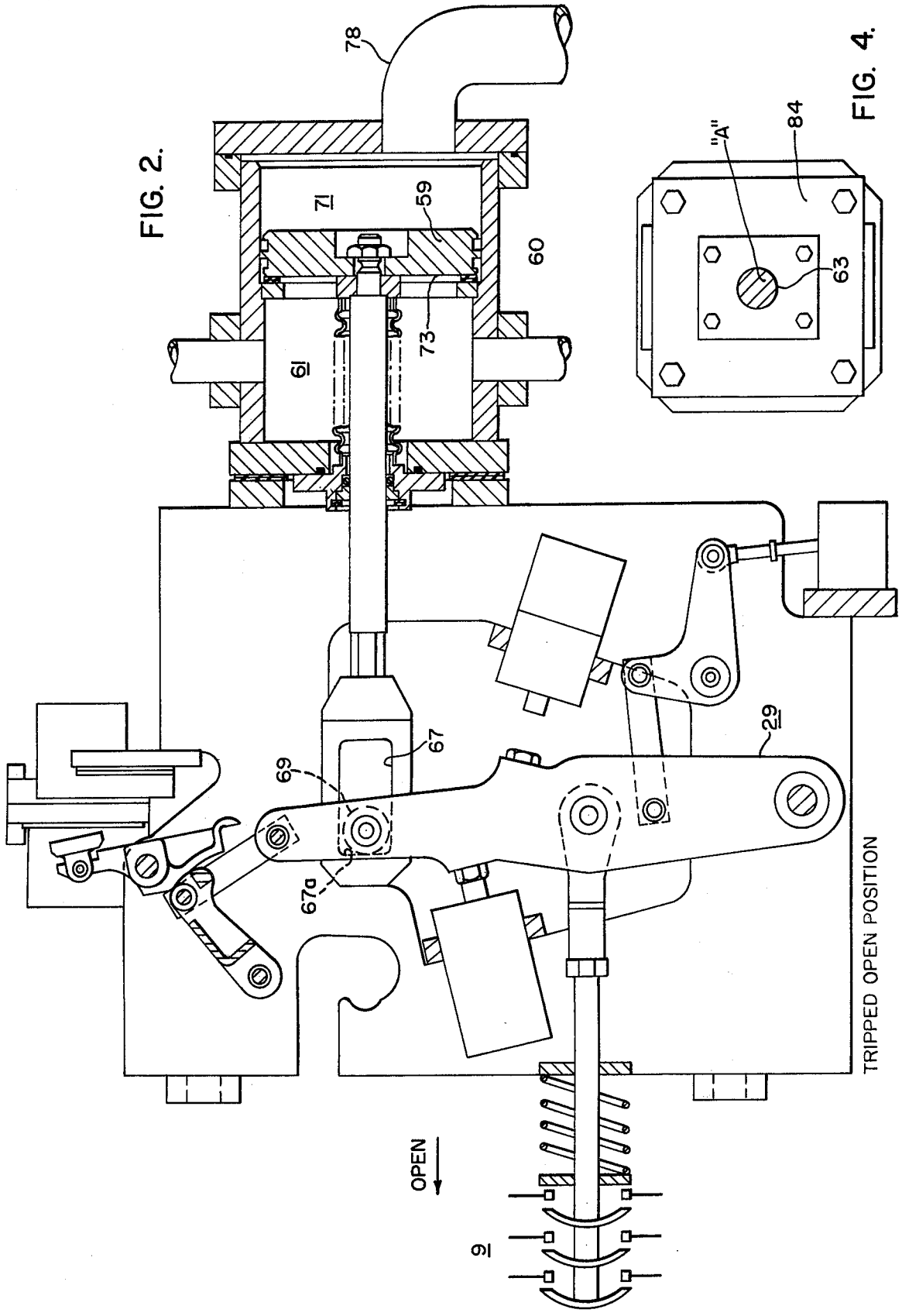
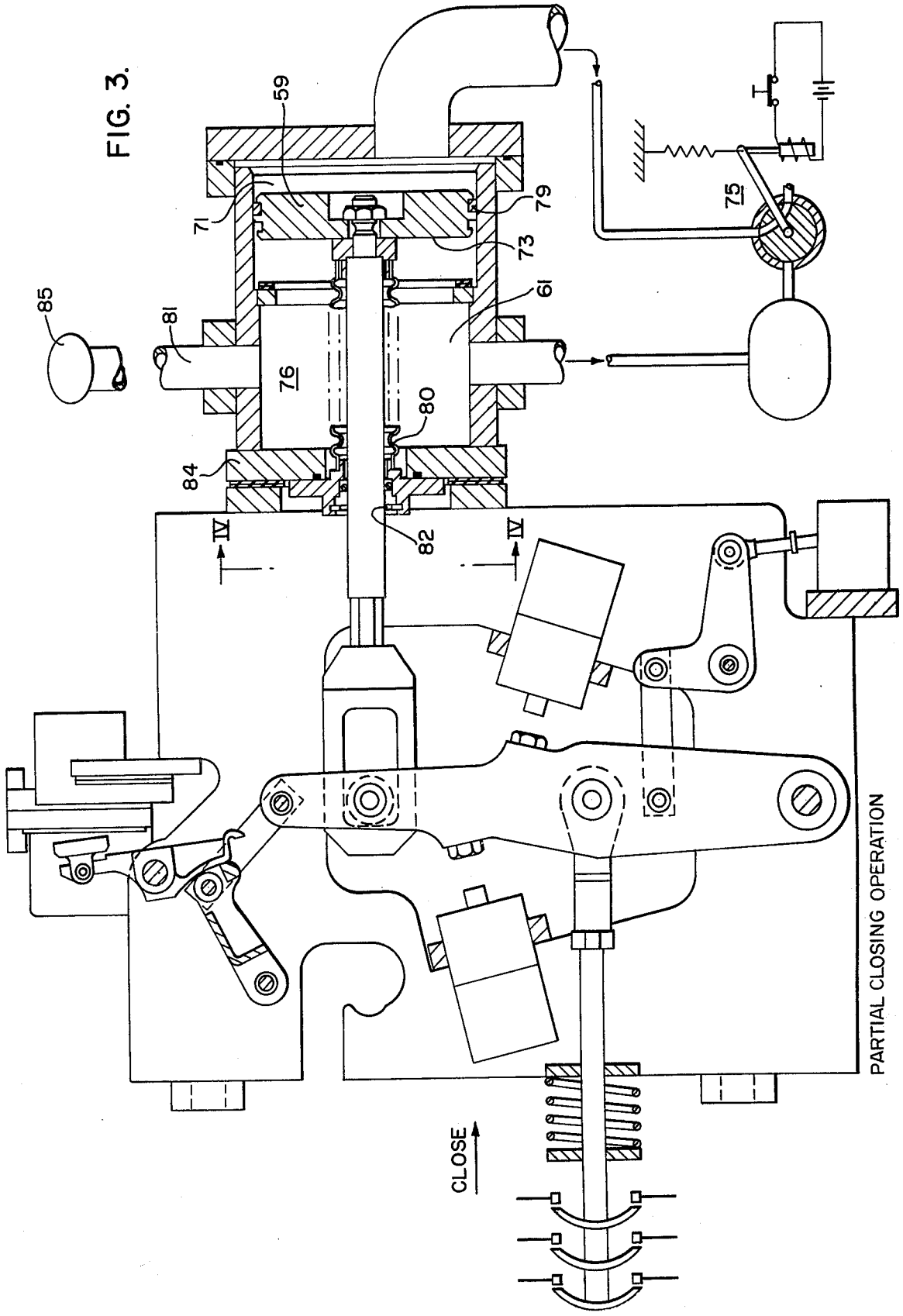

78
71
59
60
61
73
67
69
67a
29
OPEN
9
TRIPPED OPEN POSITION

FIG. 4.

"A"
84
63

FIG. 3.


59
71
79
73
61
75
85
81
76
80
84
82
IV
IV
CLOSE
PARTIAL CLOSING OPERATION

PNEUMATIC POWER-UNIT HAVING A DRIVING PISTON AND AN EXHAUST VALVE

CROSS-REFERENCES TO RELATED APPLICATIONS

Applicants are not aware of any related patent applications pertinent to the present invention.

BACKGROUND OF THE INVENTION

In U.S. Pat. No. 3,624,329, issued Nov. 30, 1971 to William H. Fischer et al, and assigned to the assignee of the instant application, there is illustrated and described a pneumatic operating mechanism for a circuit-interrupter in which a spring-retrieved closing piston is pneumatically operated to rotate a circuit-breaker closing lever and thereby to close the breaker contacts. Upon the removal of pressure from the closing piston, a compression spring, located within the operating cylinder, retrieved the closing or driving piston to thereby disengage the piston-rod from a roller associated with the rotatable operating lever. The closing piston utilized a normally-closed three-way valve, and the valve provided the piston with low pressure on the working side of the closing piston in its reset position. The working side of the piston was pressurized by operation of the three-way valve to provide the requisite closing force on the piston to close the breaker. In addition, there was a compression spring provided in the closing cylinder on the non-working side of the piston to return the piston to its reset position, so that the piston did not interfere with the tripping operation of the breaker after a closing operation had been accomplished. Also, a latch-check switch de-energized the solenoid valve after the mechanism was completely closed, and, in addition, a switch was required to prevent tripping of the circuit-breaker until the driving piston had been returned to its original reset position.

The present invention is particularly concerned with an improved pneumatic power unit having wide application, with one particular application concerned with a circuit-breaker operating mechanism operable to effect the closing operation of a power circuit-breaker against heavy accelerating opening spring pressures tending to open the breaker contacts, and yet having the piston in a position out of the way during a subsequent tripping operation in the normal latched-closed position of the breaker. The invention is particularly suitable for the operating mechanisms of power circuit-breakers of relatively high-voltage and high-current carrying capacity.

SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided an improved pneumatic power unit having wide application, one particular application being its use with an operating mechanism assembly operable to close the circuit-breaker contacts of a power circuit-breaker by piston action, which involves a normally-open three-way control valve which exhausts one side of the driving piston to provide the power-closing stroke for the mechanism.

To effect a retrieving action of the piston, the three-way control valve is de-activated or de-energized, and thus provides high pressure on both sides of the driving piston. Due to the differential pressure acting across the cross-sectional area of the piston-shaft extending out of the operating cylinder, with high-pressure gas existing on the non-working side of the piston, and normal atmospheric air pressure existing on the outside of the piston-operating cylinder, there is provided the requisite differential pressure force across the piston-rod cross-sectional area to effect the return of the piston to its normal de-activated reset position with pressure existing on both sides of the driving piston. At this time, the normally-open three-way control valve is in its de-energized position.

Further advantages will be apparent upon reading the following specification taken in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a sectional view illustrating the improved pneumatic power unit of the circuit-breaker in the contact-closed position with the piston assembly in its retrieved reset position;

FIG. **2** is a view similar to that of FIG. **1**, but illustrating the circuit-breaker in its tripped open position;

FIG. **3** illustrates the position of the several parts during a power-closing stroke of the circuit-breaker mechanism; and,

FIG. **4** is an end sectional view taken substantially along the line IV—IV of FIG. **3**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, and more particularly to FIG. **1**, it will be observed that there is provided an operating mechanism, generally designated by the reference numeral **1**, operable to effect the closing and opening operations of the circuit-breaker contacts **2, 3** and **4** of a power circuit-breaker **5**. The three sets of circuit-breaker contacts **2, 3** and **4** are diagrammatically illustrated in FIG. **1**, inasmuch as the present invention is particularly concerned with the circuit-breaker operating mechanism **1**. The particular operating mechanism **1** is associated, for example, with a power circuit-breaker **5** of the type set forth in U.S. Pat. No. 3,624,329, issued Nov. 30, 1971, to William H. Fischer et al, and assigned to the assignee of the instant application. Although the view in FIG. **1** shows a direct mechanical connection to the contacts, the mechanism may alternatively operate control valves, the latter in turn controlling gas flow to pistons which are linked to the contacts as in U.S. Pat. No. 3,624,329. Reference may be made to this patent for background information regarding certain structural component parts of the power circuit-breaker, if desired. Since the present invention is particularly concerned with the operating mechanism **1**, however, the contact structure has been simplified, and is, as shown, diagrammatically illustrated in FIG. **1** of the drawings.

A trip-magnet assembly **7** is provided for releasably magnetically latching the circuit-breaker **5** in the closed position. As set forth in the aforesaid patent, generally, the trip-magnet assembly **7** comprises a holding-magnet **11** and a trip-lever **13**, pivotally mounted upon a stationary pivot **15**, and having its tail portion **17** maintain a toggle-linkage **19** in a slightly underset condition. As shown in FIG. **1**, the toggle-linkage **19** comprises a pair of toggle-links **21, 23** one toggle link **21** being pivotally mounted upon a stationary pivot **25**, and the other toggle link **23** being pivotally connected to a moving pivot **27** at the outer free end of a main operating lever assembly, generally designated by the reference numeral **29**, and pivotally mounted upon a

stationary pivot **30.**

An operating rod **31** is pivotally connected intermediate the ends of the main operating lever-assembly, as at **32,** and is also connected to the movable contacts **2***a*, **3***a*, **4***a* of the circuit-breaker **5,** diagrammatically illustrated, which are under heavy spring pressure **34** in the closed-circuit position of the interrupter tending to effect their opening operation, as shown in FIG. **1.** In more detail one or more accelerating springs **34** are interposed between a stationary cross-plate **36** extending across and affixed, as by welding, for example, to two heavy side support plates **38,** which journal the various stationary pivot pins **25, 30,** and **37** of the mechanism **1.** The other end of the compression spring **34** bears upon a movable spring-plate **40** affixed to and movable with the contact operating rod **31.**

A pair of bumpter assemblies **42** and **43** are provided to cushion the ends of the opening and closing movements of the main operating lever-assembly **29;** and an auxiliary switch assembly **44** is provided, being connected through a bell-crank lever **46** and a link **48** to a portion **50** of the main operating lever-assembly **29** to provide the desired actuation of the auxiliary switch **44.** As well known by those skilled in the art, the auxiliary switch **44** controls electrical circuits (not shown), which are responsive to the open and closed-circuit positions of the interrupter **5.**

As illustrated in FIG. **1,** the main operating lever-assembly **29** is under spring pressure **34** to open the contacts **2, 3 4,** but is maintained in its closed position, as shown in FIG. **1,** under such spring pressure **34** by the latching action of the trip-magnet assembly **7.** Trip coils **52, 53** are associated with the magnet assembly **7,** and when energized, divert the magnetic flux within the holding magnet **11** and thereby effect the release of the armature, or keeper **55,** which in turn, will permit collapse of the toggle-linkage **19** and thereby allow spring-opening operation of the contacts **2***a*, **3***a*, **4***a* of the cirucit-breaker **5.**

To effect the closing operation of the circuit-breaker **5,** there is provided an improved closing-piston assembly **57,** including a driving piston **59** reciprocally operable interiorly of a pneumatic operating cylinder **60** normally having high-pressure air, or gas **61** on both sides thereof. The fluid **61** may, of course, be other than air, and, in fact, may be any suitable gas, even a gas suitable for arc-extinguishing purposes in the breaker **5.** This is particularly true where the circuit-breaker **5** is one of the sulfur-hexafluoride (SF_6) type, in which it is not desired to utilize two separate gases, such as SF_6 gas and compressed air, in the same breaker installation **5.** Thus, the sulfurhexafluoride gas **61** may not only be used for arc-extinguishing purposes at the contacts **2, 3, 4,** but in fact is used for the pneumatic operation of the driving piston-assembly **57.**

It will be observed that the driving piston **59** is interconnected with a piston rod **63,** which has an actuating-end portion **65** with a longitudinal slot **67** provided therein. This provides a lost-motion connection **64** between the rod **63** and the roller **68** carried by the lever **29.** When the circuit-breaker **5** is in the open-circuit position, as illustrated in FIG. **2,** it will be observed that the roller **68,** movable with the main operating lever assembly **29,** is in a position close to the end **67a** of the elongated slot **67.** In this event, exhausting of gas **61** from the righthand end **71** of the piston cylinder **60** will permit the high-pressure gas **61** on the left-hand working face **73** of the drivinging piston **59** to effect a rightward closing operation of the driving piston **59,** and thereby forcibly carry the roller **68** and hence the main operating lever-assembly **29,** in a clockwise direction, as viewed in FIGS. **2** and **3,** to thereby effect a closing operation of the interrupter **5.** FIG. **3** shows such a power-closing operation of the circuit breaker **5** in a more detailed manner.

The present invention is suitable for use with any conventional, normally-open, three-way control valve **75,** which when operated, will exhaust the region **71** on the right-hand non-working face of the driving piston **59.** Deenergization of the normally-open three-way control valve **75,** high-pressure gas **61** is again permitted to flow through the piping **77, 78** and into the right-hand chamber **71** of the operating cylinder **60** and the consequent equalization of gas pressure on both sides of the piston **59** will drive the piston assembly **59** to its leftward end reset position, as shown in FIG. **1,** by virtue of the differential pressure existing on the piston assembly **59.** As well known by those skilled in the art, this differential pressure exists because of the cross-sectional area "A" (FIG. **4**) of the piston-rod **63** itself. Thus, with reference to the cross-sectional area "A" (FIG. **4**) of the piston-rod **63,** it will be observed that there is high-pressure gas **61** acting to force the piston-rod **63** leftwardly out of the operating cylinder **60,** as viewed in FIG. **1,** whereas there is merely atmospheric pressure, or low-pressure gas, externally of the operating cylinder **60.** An unbalanced pressure force upon the piston rod **63** of the piston-assembly **59** consequently exists.

The equalization of gas pressure on both sides of the piston **59** will, as mentioned, force the piston **59** to the left to be ultimately arrested at an annular stop designated by the reference numeral **72.**

High-pressure gas **61** is constantly supplied to the operating cylinder space **76** by a high-pressure supply pipe **81** fed from a suitable high-pressure reservoir **85.**

To prevent leakage of gas **61** out of the pneumatic operating cylinder **60,** there is provided a sylphon-bellows **80,** for example, to prevent leakage of gas along the opening **82** provided in the end plate **84** of the operating cylinder **60.** The present invention, of course, is not limited to the use of a sylphon-bellows **80,** but any good seal may be provided, as desired. The use of a sylphon-bellows **80,** of course, assures that long operational life will be obtained with no leakage occurring along the opening **82** in the end head-plate **84** of the operating cylinder **60.**

The electrical control **86** for the actuation of the three-way pneumatic control valve **75** is illustrated in FIG. **1,** and it will be observed that upon pressing or closing the "close" button **88,** the control valve **75** will be actuated, and will thereby exhaust the region **71** on the right-hand non-working face **90** of the driving piston **59.** This will, of course, permit the normally-present high-pressure gas **61** in the region **76** on the left-hand working face **73** of the driving piston **59** to drive the piston-rod **63** to the right, and thereby effect closing of the circuit breaker **5.** The closed position of the contacts **2, 3, 4** of the circuit-breaker **5,** of course, is resisted by accelerating springs **34** normally provided in circuit-breaker structures to assist in a subsequent quick-opening operation of the contacts.

From the foregoing description, it will be apparent that there has been provided an improved closing-piston assembly **57** for a circuit-breaker mechanism **1,** which utilizes a normally-open three-way valve **75.** The

normally-open three-way valve **75** provides high-pressure gas on both sides of the driving piston **59**. The valve **75** exhausts one side **71** of the driving piston **59**, and the high-pressure gas **61** on the other side **76** of the driving piston **59** provides the required closing force to close the breaker. The return of the drivng piston **59** to its normal reset position, as shown in FIG. **1**, does not require a spring. As mentioned, the area "A" (FIG. **4**) of the piston-shaft **63** with high-pressure gas existing on the inside of the piston assembly **61** in the region **71**, and normal atmospheric air pressure existing on the outside of the operating cylinder **60**, provides the required force to return the driving piston **59** to its end leftward reset position, as shown in FIGS. **1** and **2**.

The valving arrangement is calculated and has been observed to be very consistent in its operation over a wide range of pressures. This consistency allows the usual latch-check switch to be deleted, and the valve to be deenergized by the auxiliary contacts that are required for other functions as well. The switch formerly used to assure that the driving piston **59** is fully returned prior to a trip operation is also eliminated, due to the consistency of operation of the mechanism **1**. The full return stroke of the driving piston **59** prior to a trip operation can be assured without the use of this switch.

Although there has been illustrated and described a specific 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:

1. An operating mechanism for a circuit-interrupter including in combination:

a. means defining separable contact means;

b. a movable member;

c. means rendering opening and closing motions of said separable contact means responsive to the movement of said movable member (**29**);

d. a pneumatic operator including a driving-piston operable within a pneumatic operating cylinder and having a piston-rod extending externally out of said pneumatic operating cylinder;

e. said piston rod being connected with said movable member (**29**) to cause the actuation thereof;

f. said piston-rod extending only out of one end of the operating cylinder on one working side of the driving piston;

g. the other end of the operating cylinder on the nonworking side of the piston being closed with respect to the piston-rod;

h. valve means normally maintaining high-pressure gas within said pneumatic operating cylinder on both the driving and non-driving sides of the driving-piston to thereby extend the piston-rod outwardly by differential piston action; and,

i. means for operating said valve means and exhausting gas from the non-driving side of the driving-piston at said other end of the cylinder to thereby move the driving-piston toward the closed end of the operating cylinder and the movable member (**29**) to close the breaker contacts.

2. The combination according to claim **1**, wherein the movable member is a rotatable main operating lever pivotally mounted upon a stationary pivot and connected to said piston-rod.

3. The combination according to claim **2**, wherein the connection between the piston-rod and the rotatable main operating lever is a lost-motion connection, whereby the driving-piston may assume its reset position without interference with the rotatable main operating lever.

4. The combination according to claim **1**, wherein a collapsible toggle-linkage releasably maintains the movable member in its closed position.

5. The combination according to claim **4**, wherein a holding means including a magnetically-actuated trigger-arm maintains the collapsible toggle-linkage in an underset condition.

6. The combination according to claim **1**, wherein opening accelerating spring means tends to bias the movable contacts of the circuit-interrupter in the opening direction, and a lost-motion connection is provided between the movable member and the piston-rod of the pneumatic operator.

7. The combination according to claim **1**, wherein the valve means includes a normally-open three-way control valve, and the movable member comprises a rotatable operating lever pivotally mounted upon a stationary pivot and having a lost-motion connection with the piston-rod of the pneumatic operator.

8. The combination according to claim **3**, wherein the lost-motion connection is an elongated slot provided in the piston-rod.

9. The combination according to claim **1**, wherein the normal reset position of the driving-piston with high-pressure gas existing on both sides thereof is intermediate the ends of the pneumatic operating cylinder and against a stop portion provided on the pneumatic operating cylinder.

10. A pneumatic power-unit including, in combination:

a. means defining an operating cylinder;

b. a driving piston operable within said operating cylinder and responsive to the gas-pressure conditions existing therewithin;

c. a piston-rod fixedly secured to and movable with said driving piston and responsive to the movement thereof;

d. said piston-rod projecting externally of said operating cylinder at one end thereof through a first open cylinder-head and having an effective cross-sectional area of "A";

e. a first pneumatic region (**76**) defined by said driving piston, the inner side walls of the operating cylinder and said first open cylinder-head of the operating cylinder at said one end of the operating cylinder;

f. a second pneumatic region (**61**) disposed on the other side of said operating piston from said first pneumatic region;

g. high-pressure gas conditions existing in said first pneumatic region at all times during operation of the pneumatic power unit;

h. operating means including a three-way control valve for alternately pressurizing or exhausting said second pneumatic region;

i. the pressurization level of said second pneumatic region being substantially at the same gas-pressure level as said constant-pressure gas-level of the first pneumatic region; and,

j. the cross-sectional area "A" of said piston-rod being of sufficient adequate cross-sectional area to rapidly retract, by differential piston action, the

operating movement of the operating piston toward said one end of the operating cylinder, whereby pressurization of the second pneumatic region will operatively move the piston-rod toward said first open cylinder-head of the operating cylinder, and exhausting of the second pneumatic region by operation of said control-valve will correspondingly effect driving inward motion of the operating piston and the piston-rod toward the other or closed second cylinder-head for retracting purposes of the operating piston.

11. The combination of claim **10,** wherein stop means for the operating piston is provided along the inner side wall of the operating cylinder.

12. The combination in a circuit-breaker of separable contacts separable to establish arcing, means biasing said separable contacts to the open-circuit position, a closing mechanism for effecting the closing of said separable contacts including a pneumatic operator, said pneumatic operator including a driving-piston operable within a pneumatic operating cylinder, a rotatable main lever pivotally mounted upon a stationary pivot, a piston-rod connected to said driving-piston and having a lost-motion mechanical connection with said rotatable main lever, said piston-rod projecting externally of said operating cylinder at one end thereof through a first open cylinder-head and having an effective cross-sectional area of "A", a first pneumatic region (**76**) defined by said driving-piston, the inner sidewalls of the operating cylinder and said first open cylinder-head of the operating cylinder at said one end of the operating cylinder, a second pneumatic region (**61**) disposed on the other side of said operating piston from said first pneumatic region, high-pressure gas conditions existing in said first pneumatic region at all times during operation of the pneumatic operator, operating means including a three-way control-valve for alternately pressurizing or exhausting said second pneumatic region, the pressurization level of said second pneumatic region being substantially at the same gas-pressure level as said constant-pressure gas-level of the first pneumatic region, the cross-sectional area "A" of said piston-rod being of sufficient adequate cross-sectional area to rapidly retract by differential pressure-action the operating movement of the operating piston toward said one end of the operating cylinder, whereby pressurization of the second pneumatic region will operatively move the piston-rod toward said first open cylinder-head of the operating cylinder, and exhausting of the second pneumatic region by operation of said three-way control-valve will correspondingly effect inward driving motion of the operating piston and the piston rod toward the other or closed second cylinder-head for retracting purposes of the driving-piston, and said retracting movement of the driving-piston and said lost-motion connection will locate the piston-rod in a non-interfering position relevant to the rotatable main lever.

13. The combination according to claim **12,** wherein the valve means comprises a three-way pneumatic control valve, said rotatable main lever is releasably maintained in its closed position by a collapsible toggle-linkage, and said collapsible toggle-linkage is maintained in an underset condition by a releasable holding means.

14. The combination according to claim **12,** wherein the valve means comprises a three-way pneumatic control valve, said rotatable main lever is releasably maintained in its closed position by a collapsible toggle-linkage, and said collapsible toggle-linkage is maintained in an underset condition by a releasable holding means.

15. The combination according to claim **14,** wherein the releasable holding means comprises a magnetically-actuated trigger-arm.

16. The combination according to claim **15,** wherein a pair of shock-absorbers cushion the opening and closing motions of the rotatable main operating lever.

* * * * *