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[54] CONTROL MEANS FOR PNEUMATICALLY OPERATED HIGH VOLTAGE SWITCHING DEVICE

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[51] **Int. Cl.** **H01h 33/54**

[58] **Field of Search**.....200/148, 148.6, 148.2, 148.4, 200/145

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[57] **ABSTRACT**

A high voltage switching device is operated by a compressed gas valve having an electrodynamic operating means. The operating means comprises a stationary coil which is inductively connected to a short-circuit winding supported by the movable member of said valve. To operate the switching device a capacitor located at high potential is connected to said coil through a photo-electric switching member.

4 Claims, 5 Drawing Figures

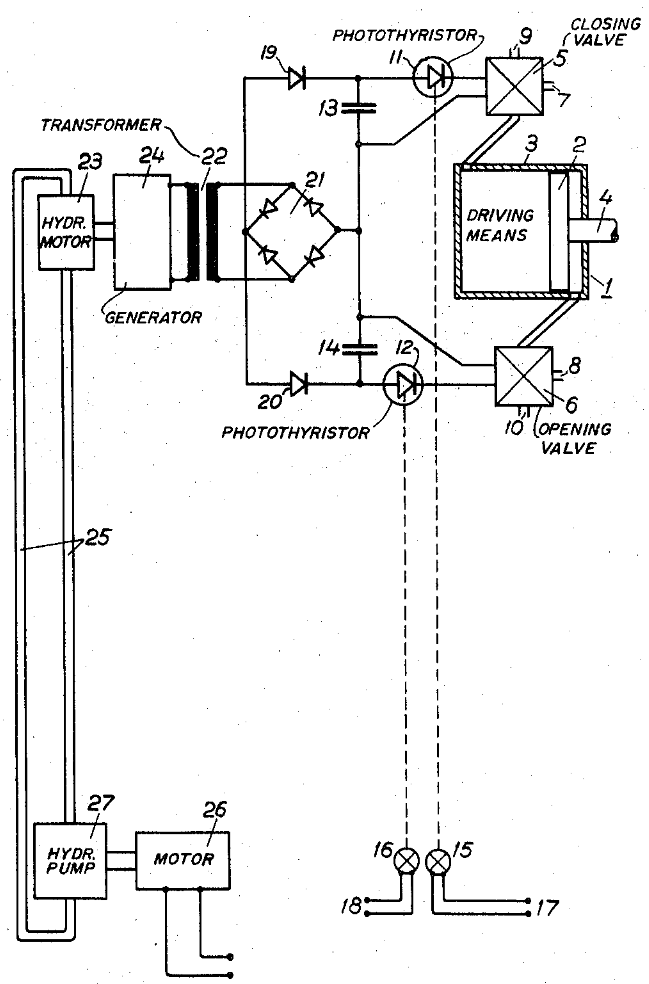

Fig. 1

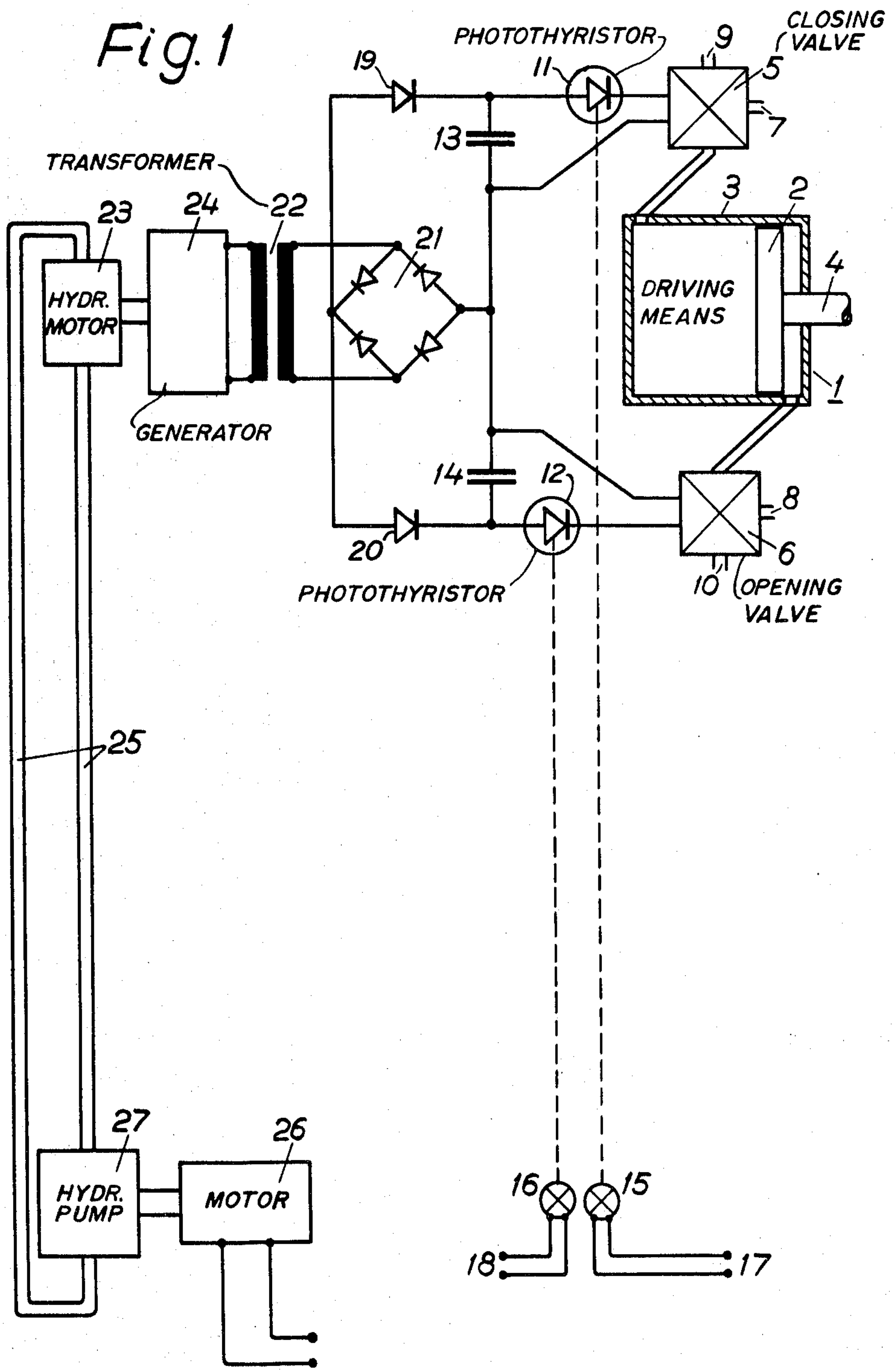

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Fig. 2

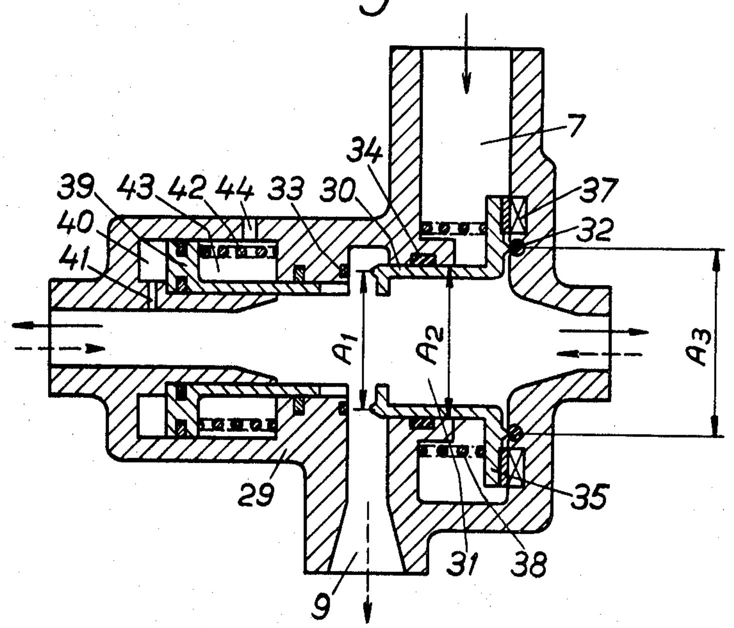

Fig. 4

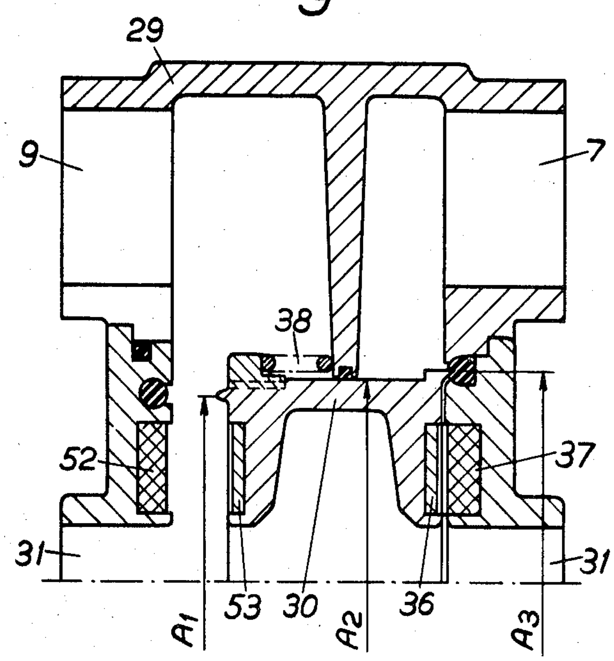

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Fig. 3

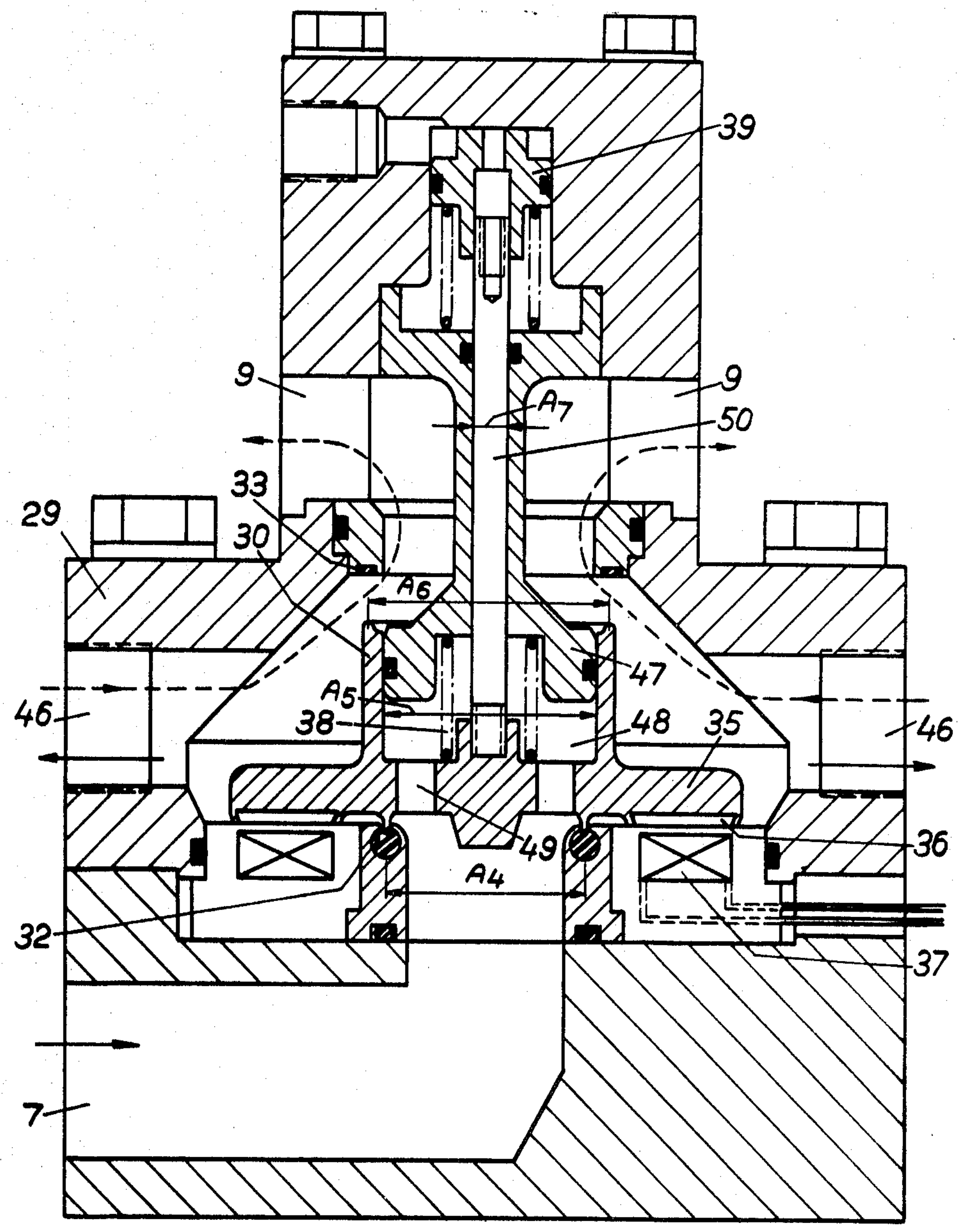

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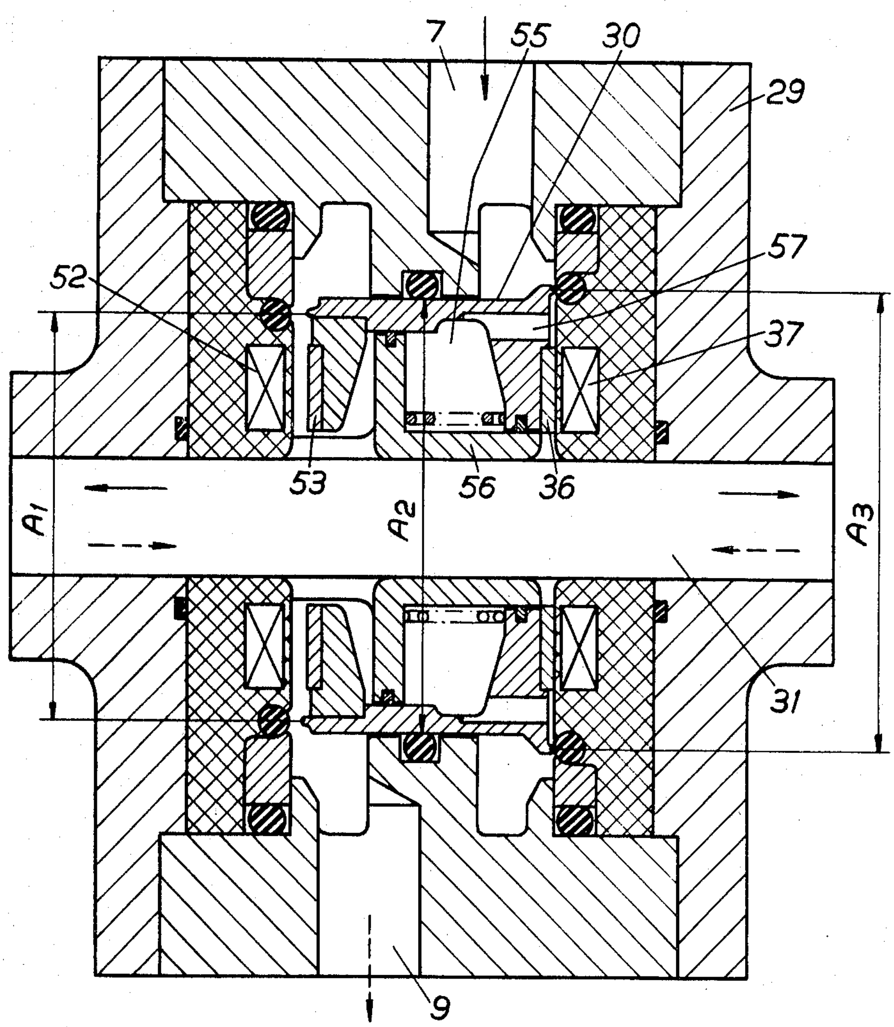
Fig. 5



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CONTROL MEANS FOR PNEUMATICALLY OPERATED HIGH VOLTAGE SWITCHING DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an electric switching device of the type comprising a container arranged at high potential and permanently filled with compressed gas and having at least one movable contact and possibly a blast valve, an operating mechanism activated by compressed gas being arranged to operate the contact and/or blast valve. The operating mechanism, which usually consists of a piston displaceable in a cylinder, communicates with the compressed air container through a compressed gas valve comprising a valve member which is movable in a valve housing. The switching device may be, for example, a compressed gas circuit breaker, a load switch, a short-circuiter or a high speed isolator.

2. The Prior Art

Gas blast circuit breakers of the type mentioned are well known in the art. During the last few years these circuit breakers have undergone a continuous development aiming at shorter operating times. This is due to the expansion of the electric power transmission systems and the resultant increased short-circuit powers which continually increase the demands for breaking capacity and speed of the circuit breakers used for breaking the short-circuit current. These demands are difficult to fulfil, particularly in circuit breakers for the highest operating voltages. These circuit breakers are extremely high so that the transmission path for the operating impulses from earth to high potential is rather long. A known principle for remote operation of such circuit breakers is that the operating impulses are transmitted from earth potential to the rectifier positioned at high potential by means of an operating rod which is permanently tensioned before the release. Relatively short operating times have been achieved by this operation principle. However, for circuit breakers for very high voltages it is desirable to reduce the operating times still further.

SUMMARY OF THE INVENTION

A considerable decrease in operating time is achieved with the switching device according to the present invention, which is characterized in that an electrodynamic operating means is arranged inside the valve housing to operate the compressed gas valve, the operating means consisting of at least one stationary coil which, upon operation, is arranged to be fed with current from an energy accumulator situated at high potential and a short-circuit winding connected inductively to the coil and being supported by or forming at least part of the movable valve member. By operating the valve arranged immediately adjacent to the switching device contact and blast valve piston, if any, in this way, an apparatus is obtained which has extremely short and precise functioning times.

It is previously known to use an electrodynamic operating means of the above-mentioned type for operating gas blast circuit breakers. However, the electrodynamic means has been arranged to directly influence the movable contact of the circuit breaker and the blast valve arranged in connection with the contact.

Since, therefore, a relatively large mass must be put in motion, a great amount of operating energy is required in the electrodynamic system. The energy accumulator required to store the operating energy, usually a capacitor battery, is therefore very large and bulky and is unreasonably expensive. By introducing, according to the present invention, an electrodynamically controlled, pneumatic valve in close contact with the contact member of the breaker at high potential, this drawback is alleviated. Such a valve can be operated in an extremely short time (some milliseconds) and, since the mass of the movable valve member is small compared with the mass of the breaker's contact and blast valve, the amount of operating energy required, and thus the size of the capacitor battery, will be considerably less than in previously known constructions. Since, furthermore, the movable valve member, as opposed to the movable contact of the breaker, need not be dimensioned with any consideration of, for example, the current load capacity, it is easier to give a valve member a suitable shape from the pneumatic point of view so that the necessary operating pressure is extremely slight.

An especially easily moved valve member is obtained by designing the member and arranging it in the valve housing in such a way that the force with which the compressed gas actuates the valve member is directed substantially perpendicular to the direction of movement of the valve member. Alternatively, the valve member may be designed so that it is subjected on both sides to the influence of the compressed gas. To operate the valve it is then unnecessary to counteract the entire force of the compressed gas activating the valve member, but only the sealing pressure and the pressure required for acceleration of the valve member. It is thus sufficient to provide a relatively small and inexpensive capacitor battery and in spite of this achieve an extremely rapid operation.

Depending on the function of the switching device, the valve may be used only for rapid opening or rapid closing of the device or for both functions. In the first case the valve member is operated electrodynamically in only one direction and is returned to its initial position pneumatically. In the second case the valve member is operated electrodynamically in both directions. In the latter case, in order to facilitate the return of the valve member from open to closed position, a storage space for compressed gas may be arranged near the valve member, in which the compressed gas remains during the closing operation and thus influences the valve member with a certain pressure in addition to the closing pressure from the electrodynamic operation system.

Release and operation of the valve takes place preferably by means of light impulses which influence a light-sensitive member at high potential, so that the energy accumulator (capacitor battery) is discharged over the induction coil of the electrodynamic system, which moves the valve member into the desired position.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be further described with reference to the accompanying drawings in which

FIG. 1 shows schematically how an operating system for a circuit breaker according to the invention may be constructed, while

FIGS. 2–5 show four different embodiments of compressed gas valves for such operating systems.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 shows a compressed gas operated driving means **1** consisting of a piston **2** which is displaceable in a cylinder **3**. The piston **2** is connected through a piston rod **4** to a movable contact and/or blast valve in a gas blast circuit breaker of the type provided with a container arranged at high potential and permanently filled with compressed gas. The piston **2** is operated, and thus also the movable contact of the breaker, by placing the cylinder spaces on the two sides of the piston **2** under pressure or evacuating them. This is effected with the help of two valves, a closing valve **5** and an opening valve **6**, which may be designed as shown in FIGS. **2** or **3**, for example. The valves **5** and **6** are provided with valve openings **7** and **8**, respectively, which are connected to the container filled with compressed gas, and valve openings **9** and **10**, respectively, which communicate with the free air. By operation of the valves **5**, **6**, the cylinder space of the driving means **1** may be connected to one or the other of these openings. The valves **5**, **6** are operated with the help of an electrodynamic operating means which is further described with reference to FIGS. 2–5. This operation means comprises an induction coil permanently arranged in each valve housing and connected to capacitors **13**, **14**, respectively, through photothyristors **11**, **12**, respectively. The photo-thyristors are controlled by means of light impulses from flash lamps **15**, **16**, respectively, arranged at earth potential. When the circuit breaker is to be closed, a closing impulse is sent through the conduits **17** to the flash lamp **15** which, by means of a light impulse, ignites the photo-thyristor **11**. The precharged capacitor **13** is discharged over the induction coil arranged in the closing valve **5** and the coil moves the valve member into the desired position. The breaker is opened in a similar manner by an opening impulse being sent through conduits **18** to the flash lamp **16**.

The capacitors **13** and **14** are charged by means of diodes **19**, **20**, respectively and a rectifier bridge **21** fed by a generator **24** driven by a hydraulic motor **23**, by way of a transformer **22**. All these members are placed at high potential. The hydraulic motor **23** is driven by hydraulic oil which is supplied through insulating conduits **25** from a hydraulic pump **27** arranged at earth potential and driven by a motor **26**. FIG. **2** shows a first embodiment of a valve for a gas blast circuit breaker according to the present invention. The valve consists of a valve housing **29** in which a movable valve member **30** is arranged. The valve member **30** is shaped substantially as a sheath with an axial through-channel **31**, the end openings of the sheath being in permanent communication with one or more driving means for the movable contacts of the breaker. The valve member **30** is axially displaceable between two valve seats **32** and **33** cooperating with the two ends of the sheath, the sheath sliding in a sealing ring **34** arranged about its central part. On either side of the sealing ring **34** are the other two openings **7** and **9** of the valve which are directed radially, the opening **7** being connected to a compressed gas container at high potential and the opening **9** communicating with free air. The valve member **30** is provided with a flange **35** which supports a short-circuit winding **36** in the form of a copper ring. In the valve position shown in the drawings this winding **36** is adjacent an induction coil **37** permanently arranged in the wall of the valve housing and connected to a capacitor, as shown in FIG. **1**. Furthermore, it can be observed that the valve seat **33** covers an area A_1, the sealing ring **34** an area A_2 and the valve seat **32** an area A_3.

In the embodiment shown in FIG. **2** the area A_3 is so much greater than the area A_2 that the required sealing pressure is obtained against the righthand valve seat **32**. A spring **38** arranged in the valve housing also contributes somewhat to the contact pressure, but this is not absolutely necessary. The valve is operated, as mentioned before, by the capacitor battery being discharged over the induction coil **37** so that the valve member **30** is moved to its lefthand end position, where the required contact pressure is effected by the gas pressure on the surface $(A_2 - A_1)$. The central channel **31** of the valve and the driving means connected to this channel for the breaker contacts are thus placed under pressure so that the breaker is closed or opened. After a certain interval the valve member **30** is returned to its righthand end position with the help of a return piston **39** in the valve housing. This piston is operated by compressed gas being supplied to a space **40** to the left of the piston, through a throttled opening **41**, so that the piston is moved to the right. When the valve member **39** has been returned to its righthand end position, the central channel **31** is emptied and thus also the space **40**, through the valve opening **9**. The return piston **39** is then returned to its rest position by a spring **42** which is arranged in a space **43** to the right of the piston, this space communicating permanently with the free air through an opening **44**.

FIG. **3** shows another embodiment of an electrodynamically operated valve for gas blast circuit breakers. The valve consists of a valve housing **29** in which a valve member **30** is movable. The connection opening **7** of the valve is connected to a container (not shown) permanently filled with compressed gas and arranged at high potential, whereas the valves openings **46** are connected to at least one pneumatic driving means for the breaker contacts. Through exhaust openings **9** the openings **46** can be connected to the free air. The valve member **30** is displaceable between two end positions where it seals against a lower valve seat **32** enclosing an area A_4 or an upper valve seat **33** enclosing an area A_6, respectively. On the side facing away from the connection opening **7**, the valve member **30** is designed as a cylindrical cup projecting in the operating direction, the internal cylindrical surface of which surrounds an area A_5 sealing against a piston **47** provided with a collar and directed axially in the valve housing. The space **48** which is thus limited by the lower end surface of the piston **47** and the valve member **30** is in permanent communication with the container filled with compressed gas through openings **49**. The valve member is provided at the bottom with a flange **35** which supports a short-circuit winding **36** cooperating with an induction coil 37 to operate the valve.

In the middle of the valve member 30 an axially directed pin 50 is firmly screwed which has a cross-sectional area designated A_7. The pin 50 slides in a central hole in the piston 47 and its upper end projects into a central recess in a return piston 39, by means of which the valve member 30 can be returned from its upper to its lower end position by the space on the upper side of the piston 39 being put under pressure.

In the lower end position of the valve the sealing pressure against the valve seat 32 is effected by the pressure on the surface $(A_5 - A_4 - A_7)$ and by a spring 38. The valve member 30 is operated by a capacitor being discharged over the induction coil 37 so that the valve member 30 is moved to its upper end position where the sealing pressure is determined by the pressure on the surface $(A_6 - A_5 + A_7)$ minus the pressure of the spring 38. Since in this way the movable valve member is designed to be biassed by the compressed gas on both sides of the member, the energy required to operate the valve can be reduced to a minimum.

FIG. 4 shows one half of a central section through a third embodiment of an operating valve for a gas blast circuit breaker according to the invention. This valve differs from the valves shown in FIGS. 2 and 3 in that it can be electrodynamically operated in both directions. For this purpose two induction coils 37 and 52 have been arranged in the valve housing 29, these coils cooperating in the end positions of the valve member 30 with one each of two short-circuit rings 36 and 53 arranged at the end surfaces of the valve member. The connection opening 7 of the valve is connected to the compressed gas container of the breaker, the channel 31 to the driving member for the breaker contacts and the opening 9 to the free air. A spring 38 has the task of giving the valve member 30 a certain bias force. Apart from this force, the sealing pressure is determined in the righthand end position of the valve member by the pressure on the surface $(A_3 - A_2)$ and in the lefthand end position by the pressure on the surface $(A_2 - A_1)$, where the areas $A_1 A_2$ and A_3 are equivalent to the corresponding areas in FIG. 2.

The fourth embodiment of an electrodynamically controlled compressed gas valve shown in FIG. 5 differs from that shown in FIG. 4 in that a compressed gas storage space 55 has been arranged which ensures a definite return of the valve member 30 from the lefthand to the righthand end position. This space 55, which is limited by the righthand, flange-shaped end part of the valve member 30 and a stationary wall 56 of the valve housing 29, communicates with the central channel 31 of the valve through openings 57 having limited through-flow area. When the valve member is operated from the left to the right end position, in addition to the pressure generated by the electrodynamic means 52, 53, the pressure remaining for a certain time in the space 55 will also contribute to the movement of the valve member.

Valves of the type show are primarily intended to operate the main contacts of gas blast circuit breakers, high speed load switches, high speed short-circuiters or high speed isolators, but they may also be used to operate auxiliary breaking contacts, for example for switching-in and breaking resistors. The valves are then released by the same light impulses which bring about the closing and opening of the main contacts but with suitable time delay in relation to these. The energy to operate the valves is stored in individual capacitors which, however, are charged from the common charging unit shown in FIG. 1.

It is clear from the examples shown that the valves intended to operate a switching device according to the invention can be relatively simple but in spite of this enable an extremely rapid operation with only a small amount of operating energy.

We claim:

1. A control device for a pneumatically operated high voltage switching device, said control device comprising an operating mechanism (1) activated by compressed gas, at least one compressed gas valve (5 or 6) separated from current-carrying parts of said switching device, said valve comprising a valve housing having an inlet opening (7) for compressed gas and a valve member (30) movable in said valve housing, said movable valve member being shaped substantially as a sheath having an axial through-channel (31), said through-channel permanently communicating with said operating mechanism (1), said valve housing including two valve seats (32,33), said valve member being axially displaceable between said two valve seats, said seats cooperating with both ends of said sheath, a sealing ring (34) arranged around the central part of said sheath, said sheath being slidable in said sealing ring, said valve housing having a second opening to the open air, said sheath including means for selectively closing said two valve openings (7,9), said operating mechanism including an inlet for compressed gas connected to said compressed gas valve housing, an electrodynamic operating means (36,37) in said valve housing for operating said valve member, said operating means comprising at least one stationary coil (37), said movable valve member including short-circuit means (36) movable therewith and inductively connected to said coil, an energy accumulator (13,14) at high potential, and means for connecting said coil to said energy accumulator.

2. A control device according to claim 1, in which said electrodynamic operating means comprises two windings (37,52) with short-circuit windings (36,53) to operate said valve member in opposite directions.

3. A control device according to claim 2, in which one end part of said movable valve member situated nearest said inlet opening is provided with a flange, a wall (56) in the valve housing (29) within said sheath which limits therewith a space (55) which through a narrow channel (57) is in communication with said through-channel (31) inside the valve member.

4. A control device for pneumatically operated high voltage switching device, said control device comprising an operating mechanism (1) activated by compressed gas, at least one compressed gas valve (5 or 6) separated from current-carrying parts of said switching device, said valve comprising a valve housing having an inlet opening (7) for compressed gas and a valve member (30) movable in said valve housing, said valve housing including first (32) and second (33) valve seats, the first valve seat being around said inlet opening, said movable valve member in its end positions sealing against said first and second valve seats, said

housing having an exhaust outlet (**9**) for compressed gas, said second valve seat surrounding said exhaust outlet, said operating mechanism including an inlet (**7**) for compressed gas connected to the space within said compressed gas valve housing between said valve seats, said valve member having a cross-sectional area substantially larger than said first valve seat, a piston (**47**) fixed in the valve housing, said valve member having a cylindrical extension (**30**) towards the second valve seat slidable on said piston, the space within said cylindrical extension being in permanent communication with said inlet opening, an electrodynamic operating means (**36,37**) in said valve housing for operating said valve member, said operating means comprising at least one stationary coil (**37**), said movable valve member including short-circuit means (**36**) movable therewith and inductively connected to said coil, an energy accumulator (**13,14**) at high potential, and means for connecting said coil to said energy accumulator.

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