# United States Patent [19]

**Kawasaki**

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[54] **TANK-TYPE GAS-BREAK CIRCUIT BREAKER**


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Dec. 29, 1970 Japan .............................. 45-127254

[52] **U.S. Cl.** ......................... **200/148 J,** 200/148 BV
[51] **Int. Cl.** ........................................... **H01h 33/86**
[58] **Field of Search**......200/148 J, 148 BV, 148 A, 200/148 B, 148 D, 148 R



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[57] **ABSTRACT**

The break contacts in a tank-type gas-break circuit breaker are disposed in a high-pressure gas chamber formed in a sectionalized state within a tank constituting a low-pressure gas chamber and are coupled via an operating rod of insulative material passing through the low-pressure gas chamber to a piston of a piston mechanism disposed outside of the tank, a driving device operating in response to a tripping command to impart an initial impulsive driving force for opening the break points to the piston.


**7 Claims, 6 Drawing Figures**

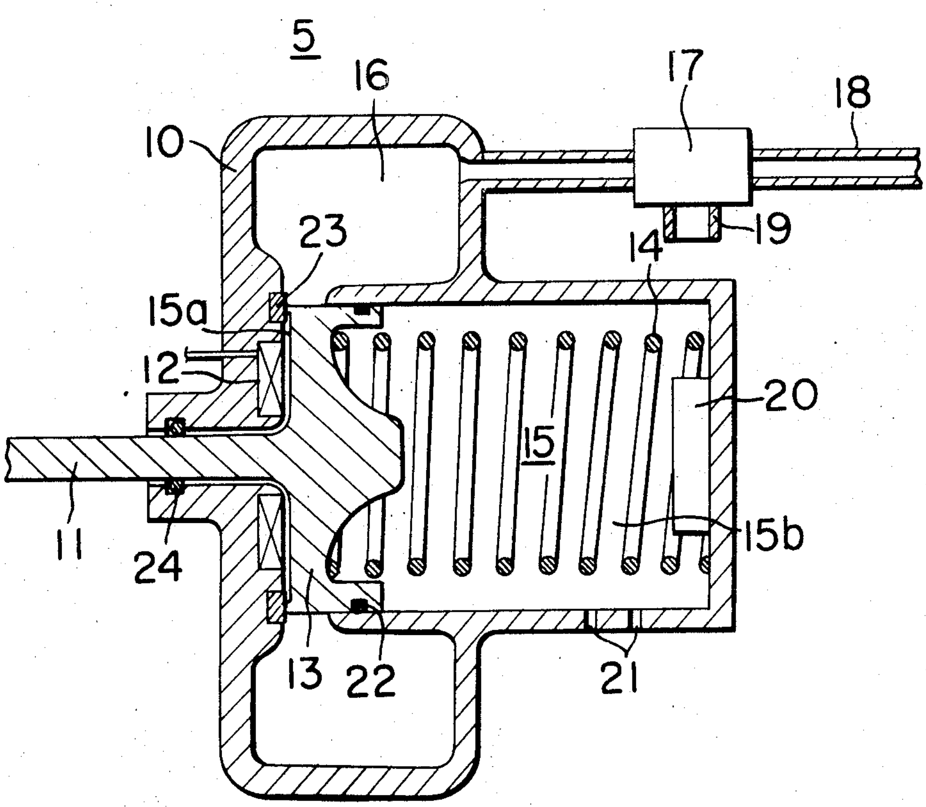


FIG. 1

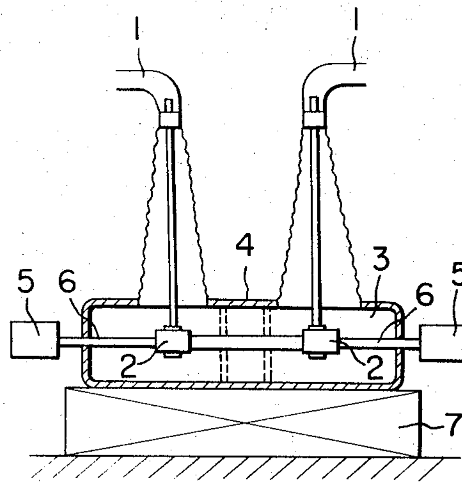



FIG. 2

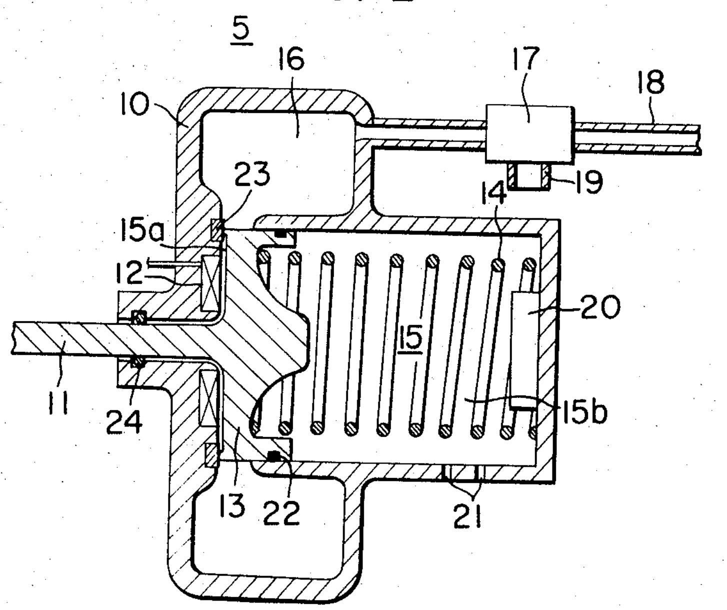


FIG. 3

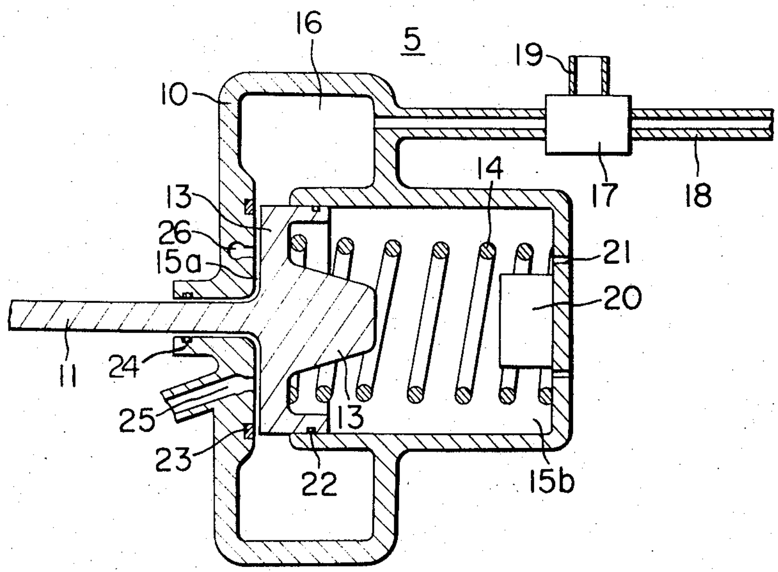
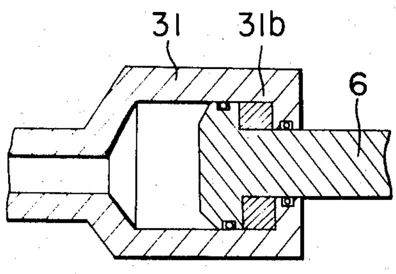



FIG. 6



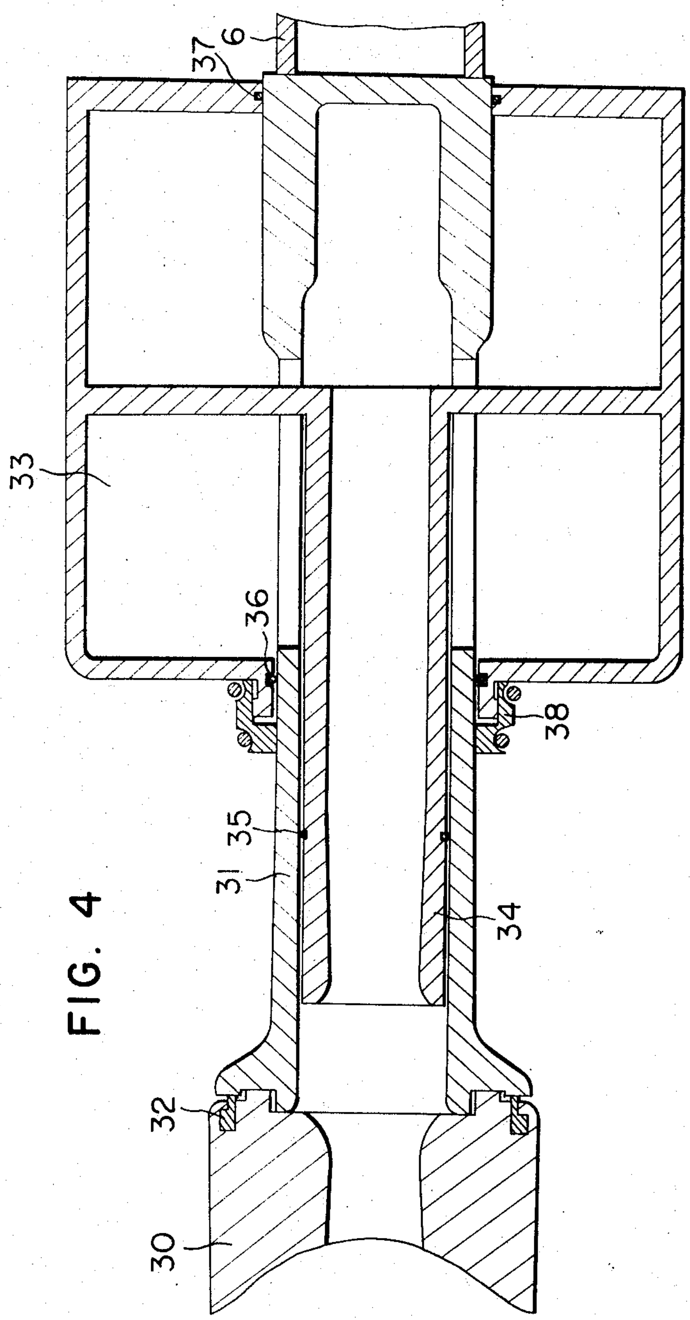



FIG. 4

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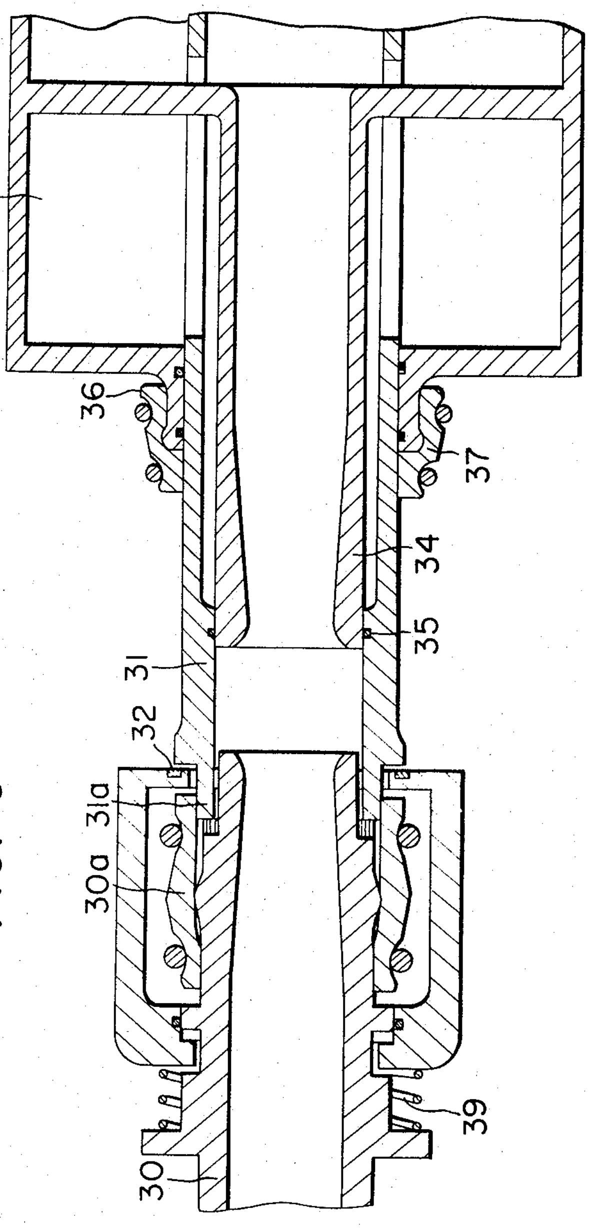


FIG. 5

# TANK-TYPE GAS-BREAK CIRCUIT BREAKER

## BACKGROUND OF THE INVENTION

This invention relates to tank-type gas-break circuit breakers.

With the recently built circuit breakers for use in power transmission systems, there has been a tendency toward the contraction of interruption times and the use of $SF_6$ gas as an arc-suppressing and insulating medium. Among features of circuit breakers employing $SF_6$ gas as an arc-suppressing and insulating medium are high interruption performance afforded by the high arc-suppressing capability of $SF_6$ gas and the contraction of insulator dimensions due to high insulation and breakdown performance, that is, the attainment of compactness of equipment size. The contraction of insulator dimensions can be attained, for example, by the contraction of the interpole insulation distance between the main breaker contacts or the insulation distance between the main circuit and ground.

With respect to the contraction of the interruption time, there has been proposed an electromagnetic repulsive driving system in which the contacts are rapidly opened by the electromagnetic repulsive force produced between a driving coil and a secondary short-circuit ring disposed adjacent to a driving coil when a capacitor is suddenly discharged.

Circuit breakers employing this system can realize interruption as short as one-cycle presently considered a technical limitation, by causing interruption in synchronism with a particular phase of the main circuit current.

In spite of the advantage of circuit breakers of this electromagnetic repulsive driving system, the advantage is offset by certain structural defects as follows.

1. The interruption or break unit is disposed in a high-voltage section mounted on insulators. This necessitates installation of a comparatively large-capacity, expensive transformer for insulating the capacitor from the ground.

2. A device for conveying a directive for tripping from the ground side to the high-voltage break unit becomes necessary.

3. Security of equipment reliability is greatly sacrificed with an increase in the number of component parts of this directive conveying device.

Such deficiencies of circuit breakers of the electromagnetic repulsive driving type using capacitors is due partly to the fact that the required insulation distance along the ground surface is too long to drive directly the break unit at high voltage through an insulating rod from the ground side.

Although the use of a long insulating rod for securing the insulation distance is quite conceivable, this tends to cause a delay in the transmission speed of the force of the insulating rod. Among other inconveniences are the elongation of the rod which brings about an incidental transmission delay, poor response with respect to the elongation or contraction of insulating material accompanying temperature variations, and difficulties encountered in the procurement of a material of high strength capable of withstanding large operating forces required for long operating rods.

## SUMMARY OF THE INVENTION

It is an object of this invention to provide a high-speed tank-type gas-break circuit breaker that can be constructed as inexpensively as possible.

It is another object of this invention to provide such a circuit breaker capable of driving a moving contact at high voltage at high speed from the ground side through an operating rod of insulation material.

It is still another object of this invention to provide a novel circuit breaker capable of actuating a piston for driving the operating rod at high speed by the energy of explosion of an explosive.

According to this invention, briefly summarized, there is provided a tank-type circuit breaker characterized in that the interruption or break contacts are disposed in a HV gas chamber sectionalized in a tank constituting a low-pressure gas chamber and are coupled, directly or indirectly, to an operating rod of insulating material passing through said low-pressure gas chamber and that the initial driving power is imparted to a piston in a piston mechanism, in response to a tripping command issued, by using an impulsive driving power for the separation of the break contacts.

## BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. **1** is a diagrammatic longitudinal section showing the overall construction of a circuit breaker according to this invention;

FIGS. **2** and **3** are longitudinal sections respectively showing two different examples of the driving device of the circuit breaker;

FIGS. **4** and **5** are respectively longitudinal sections showing two different examples of the current break unit; and

FIG. **6** is a longitudinal section of one example of a damper unit.

## DETAILED DESCRIPTION

FIG. **1** is a diagrammatic representation of a tank-type gas-break circuit breaker according to this invention. As illustrated, the symmetrically constructed high-tension main circuit is led into the circuit breaker through means such as a cable head **1**, or it may be led into another part through a cable head and placed in a high-voltage insulating gas. A high-pressure chamber **2** accommodating a break unit is filled with $SF_6$ gas and is disposed within a low-pressure chamber **3** within a tank **4**. The low-pressure chamber **3** is grounded.

In the case of a circuit interruption, the break contacts are driven by a grounded driving unit **5** disposed outside of the tank **4** through an insulating rod **6**. The tank **4** is mounted on a base **7**.

In the case of closure, the operation may be performed from the outside, similarly as in the case of interruption. Although not illustrated, in the presence of an auxiliary break unit, the closing operation of a circuit breaker is achieved as follows. The main break unit, after interruption, is automatically restored to the closing state, the disconnected state being maintained by the auxiliary break unit, and then the auxiliary break unit is closed by a command issued for closure.

FIG. **2** is a detailed representation of an example of the driving unit **5** suitable for use in the circuit breaker shown in FIG. **1**. Driving power is produced by an electromagnetic repulsive driving system, which, in itself, is well known in the art. The electromagnetic force acts effectively during only the interval in which the driving coil and the driving piston constituting the secondary short-circuit ring disposed adjacent thereto are located close to each other. According to this invention, only the initial acceleration for the break operation is acquired and thereafter, compressed air is used as a supplemental means.

IN FIG. 2, the driving unit **5** is provided with a frame **10.** A driving coil **12** of ring shape is disposed within this fame **10** on its inner side and encompasses the operating rod **11.** When the break unit is closed, a driving piston **13** integral with the operating rod **11** at its outer end approaches close to the driving coil **12** to confront the same. The piston **13** is continually urged toward the driving coil **12** by a helical spring **14** disposed in a cylinder **15** formed integrally and coaxially with the frame **10** and accommodating the piston **13** disposed slidably therewithin. The interior of the cylinder **15** is divided by the piston **13** into two sections, i.e., a section **15*a*** on the operating rod side and a section **15*b*** on the opposite side.

Within the frame **10**, there is provided an annular pressure chamber **16**, which is shut off from the interior of the cylinder **15** by the piston **13** when the piston **13** is close to the driving coil **12**, i.e., when the break unit is closed. When the piston **13** separates from the coil **12**, the pressure chamber **16** communicates with the cylinder section **15*a***, and air pressure is exerted upon the piston through the section **15*a*** to separate the piston **13** further away from the driving coil **12.** The pressure chamber **16** is communicatively connected to a compressed air supply source (not shown) through an electromagnetic valve **17** and a pipe line **18**, an exhaust pipe **19** being installed on the electromagnetic valve **17.**

Within the cylinder **15** and at its head end, there is provided a stop made of a buffer material **20** such as rubber for stopping the movement of the piston **13** when it is moving away from the driving coil **12.** Small vent holes **21** communicating with the atmosphere and functioning as an air damper is provided in the cylinder wall. The piston **13** is provided with a piston ring **22.** In order to maintain air-tightness of the pressure chamber **16** when the break contacts are closed, a packing **23** is disposed in the frame around the peripheral portion of the driving coil **12** so as to contact the piston **13** with pressure. Furthermore, a packing ring **24** is disposed between the frame **10** and the operating rod **11** so as to maintain air-tightness therebetween.

The device shown in FIG. **2** operates as follows: when a discharge current of a source capacitor (not shown) flows in the driving coil **12** in accordance with a directive for tripping in a state corresponding to the closing state of the break unit, the piston **13** operates as a short-circuiting secondary ring, generating an electromagnetic repulsive force between the driving coil **12** and the ring, whereby the piston **13** is driven suddenly in the direction of the buffer material **20** against the force of the spring **14.** Air-tightness due to the packing **23** is then broken, with the result that pressure chamber **16** communicates with the chamber **15*a*** and compressed air in the pressure chamber flows to the chamber **15*a*.** This causes the piston **13** to move toward the right direction as viewed in FIG. **2.** In this case, the adjustment vent holes **21** and the buffer material **20** operate to impart damping action, and the piston **13** and the operating rod **11** operate integrally.

It will now be supposed that a command for closing is issued when the break contacts open, and the piston **13** is on the right-hand side of the cylinder chamber **15.** Then the electromagnetic valve **17** is actuated, and air in the chamber **15**and the pressure chamber **16** is expelled from the exhaust pipe **19,** with the result that the pressure is decreased. Consequently, the piston **13** is pushed by the force of the spring **14,** and the break contacts are closed through the operating rod **11.** It is desirable, in this case, that a part of the closing force be acquired by compressed air. Operation of the operating rod **11** of this device is transmitted to the break unit through the insulating rod **6** (illustrated in FIG. **1**).

FIG. **3** illustrates another example of the dividing unit **5** shown in FIG. **1.** In FIG. **3,** parts of equivalent functions as those shown in FIG. **2** are designated by the same reference numerals. The driving coil **2** shown in FIG. **2** is not installed in the device of FIG. **3.** In lieu of this coil **12,** an inlet **25** is provided in the casing **10** for communication with the chamber **15*a*.** An impulsive pressure generated by the explosion of an explosive is introduced through this inlet into an equalizing chamber **26** of annular shape.

In the device of FIG. **3** an explosive device (not shown) initiates an explosion in response to a tripping command, whereby an impulsive high pressure caused by the explosion is introduced into the chamber **15*a*** via the inlet **25** and equalizing chamber **26,** whereupon the piston **13** is moved suddenly toward the right as viewed in FIG. **3.** As a result, air-tightness due to seal packing **23** is broken.

Although the pressure of the explosion acts on the pressure chamber **16,** the air pressure from the compressed air supply source overcomes the former pressure after reaching a pressure equilibrium within a brief time interval, whereby the piston **13** is further accelerated. The driving energy produced by the explosion is used mainly for the initial acceleration of the piston **13.** In other words, it is used for breaking rapidly air-tightness due to the seal packing **23,** and, hence, the driving force, once the piston **13** has initiated movement, is obtained mainly by the compressed air pressure from the pressure chamber **16.** The piston **13,** after being driven a predetermined distance necessary for the break of the interruption contacts, collides against the damper material **20** and stops without producing an excessive impulsive force with the aid of the actions of the chamber **15*b*** and buffer material **20.** Thus, the moving contact of the break unit is actuated rapidly through the insulating rod **6.**

The return stroke of the piston **13** takes place as follows. The electromagnetic valve **17** is switched over as in the case of the example shown in FIG. **2** to communicate the pressure chamber **16** and the exhaust pipe **19,** whereby the pressure in the pressure chamber **16,** or the chamber **15*a*,** is decreased and the spring force of the restoring **14** can be utilized. After the piston has returned to the position as illustrated, the electromagnetic valve **17** is operated to restore the pressure chamber **16** to its high-pressure state.

In the device of FIG. **3,** the pressure caused by the explosion acts directly on the piston **13.** The energy of explosion by an explosive must be set beforehand so as to produce the predetermined initial acceleration during the driving period, the weights and frictional forces of the operating rod 11, insulating rod 6, and the moving contact in the break unit, all interconnected to the piston 13 being taken into consideration.

It is desirable that the insulating rod 6 be as short as possible for the previously mentioned reasons. Since the tank is at a low potential, there is no need for taking a considerable interval as the insulation distance between the tank 4 and the driving unit. Furthermore, the insulation distance in the tank may be considerably contracted because the tank is filled with a highly insulative gas. The minimum distance of the insulating rod required within the tank is of the order of tens of centimeters for tank-type circuit breakers rated at 300 KV in view of the surface insulation characteristic.

The break or interruption unit may be composed of a main break unit of high-speed break performance and an auxiliary break unit of low-speed break performance, connected in series. Otherwise, it may be composed of the main break unit alone. By imparting a sufficient wipe to the contacts and having the stationary contact perform separation slowly, these contacts may be utilized additionally as a disconnector section. It is to be noted that the latter construction is inappropriate for high-speed interruption performance.

FIG. 4 illustrates the construction of a main break unit suitable for additionally installing an auxiliary break unit. The whole of the illustrated part is placed in a high-pressure gas chamber. A stationary contact 30 and a moving contact 31 opposed to each other are both of cylindrical nozzle shape, established airtightness at the periphery of the contact part by means of a nozzle packing 32. The moving contact 31 is coupled to the insulation rod 6 and driven by a driving unit 5 such as that shown in FIG. 2 or 3.

The moving contact 31 and the insulating rod 6, or the insulating rod 6 and the operating rod 11, are securely connected together by a combination of a mechanical coupling means such as screws or pins and a chemical coupling means such as adhesives.

Both contacts 30 and 31 are of double-flow construction as regards the flow of an arc-suppressing gas. A blowing gas from the high-pressure chamber that has passed between the contacts also passes through an internal cavity between these contacts for tentative storage in the reservoir.

An arc contact 34 is disposed within the moving contact 31 and is separated a predetermined distance from the stationary contact 30. In order to maintain airtightness between the arc contact 34 and the moving contact 31, seal packings 36 and 37 are provided in that part of reservoir through which the moving contact 31 penetrates.

A collector 38 is provided on the moving contact side and disposed at the outer periphery of the contact so as to maintain electrical contact with the contact 31.

When the moving contact 31 in the main break unit of FIG. 4 separates rapidly from the stationary contact 32, sealing due to the packing 32 is broken, and a gas for interrupting an arc formed between the two contacts is blown from the peripheral high-pressure chamber. The expected arc-suppressing action of this gas takes place as it passes between the two contacts, and after passing through the interval cavity of the contacts, it is tentatively stored in the reservoir 33. The movement of the moving contact 31, after its tip end reaches a position somewhat inset from the tip end surface of the arc contact 34, gradually stopped by the driving unit 5.

On the other hand, the auxiliary break unit (not shown) installed in series with the main break unit (FIG. 4) is adapted to initiate separation soon after the main break unit commences the break operation and completes releasing operation simultaneously with or prior to the release operation of the main break unit. The moving contact 31 of the main break unit is gradually restored to the closing state by the restoring mechanism in the above-mentioned driving unit 5. Accordingly, the break operation of the main break unit and the circuit disconnected state that follows are maintained by the auxiliary break unit.

With this arrangement therefore, the main circuit closure is accomplished by the auxiliary break unit, and the main break unit merely serves the function of mechanically closing the two contacts. For this reason, no detrimental electrical effect is caused even if a certain amount of chattering is produced in contact closure.

In the example shown in FIG. 4, so-called butt contact structure is used.

In contrast, FIG. 5 shows an example of a wipe contact structure. Except for the contact system, the principle of operation is the same as that of the structure shown in FIG. 4. The same reference numerals are used for equivalent parts in FIGS. 4 and 5. The stationary contact 30 is provided with a tulip-shaped contact unit 30*a*. The tip end contact 31*a* of the moving contact 31 fits into this contact to secure positive electrical continuity. In order to improve the sealing effect of the nozzle packing 32, a spring 39 is provided. The operation of this device of FIG. 5 is similar as that of the device shown in FIG. 4.

In the above described examples of the invention, the moving contact 31, the insulating rod 6, and the operating rod 11 are constructed as a single body. In such an arrangement, an impulsive driving force acting upon the operating rod 11 is imparted directly to the insulating rod 6 and moving contact 31.

If a considerably heavy moving contact 31 is directly coupled to the insulating rod 6 and directly driven, an impulsive load on the insulating rod 6 may become excessive and the design of rod 6 will become difficult. In such a case, a buffer unit should be interposed between the rod 6 and the moving contact 31 to provide a buffer action for the impulsive force produced by the electromagnetic repulsive force.

FIG. 6 shows an example of the buffer device. The end portion of the moving contact 31 becomes a cylinder chamber 31*a* in which the end portion of the insulating rod 6 is fitted. The cylindrical chamber 31*b* is filled with a substance which acts as a damping material such as oil when the insulating rod 6 is displaced in the rightward direction by the electromagnetic repulsive force. By this arrangement, the driving force of the driving unit 5 is transmitted to the cylindrical chamber 31*b* when the insulating rod is displaced in the leftward direction. Simultaneously, sealing due to the packing 23 is broken in the driving unit 5, and the operating rod 11 receives the driving force of compressed air from the pressure chamber 16.

Accordingly, the moving contact 31 performs the break operation, with a motion which is slightly decelerated relative to that in the case where the electromagnetic repulsive force is directly received, by an operating force which is the sum of the electromagnetic repulsive force and the air operating force, the impulsive electromagnetic repulsive force being considerably relieved. By this organization of parts, a considerably high break speed can be attained, although the break speed is somewhat retarded. In other words, an advantage of this arrangement is that the design and manufacture of the insulating rod **6** is facilitated. It will be evident that a buffer, unit using spring force can also be used.

A link mechanism of known type may be utilized for the mutual operation of the operating rod **11**, insulating rod **6**, and the moving contact **31**, whereby the direction of the operating force can be suitably changed.

As described above, the gas-break high-speed circuit breaker according to this invention is featured by simple construction, improved reliability, low operating power, compact size, and low manufacturing cost.

I claim:

**1.** A tank-type gas-break circuit breaker comprising a low-pressure gas chamber; a high-pressure gas chamber disposed within said low-pressure gas chamber; break contacts disposed within said high-pressure gas chamber; an operating rod of insulating material passing through said low-pressure gas chamber and coupled at one end to said break contacts,; driving means for driving said operating rod disposed outside said low pressure chamber, said driving means including a piston chamber having a piston one end face of which is coupled to the other end of said operating rod for actuating said break contacts; and impulse providing means operating in response to a tripping command to impart an initial impulsive force to drive said piston in said piston chamber and thereby open said break contacts.

**2.** A tank-type gas-break circuit breaker according to claim **1** wherein said impulse providing means includes an electromagnetic coil facing said one end face of said piston.

**3.** A tank-type gas-break circuit breaker according to claim **1** wherein said impulsive providing means includes an explosive material disposed adjacent said one end face of said piston, said explosive material being actuated to produce said impulsive driving force.

**4.** A tank-type gas-break circuit breaker according to claim **1** wherein a buffer means is provided between said operating rod and said piston.

**5.** A tank-type gas-break circuit breaker according to claim **4** wherein said impulsive providing means includes an electromagnetic coil facing said one end face of said piston.

**6.** A tank-type gas-break circuit breaker according to claim **4** wherein said impulsive providing means includes an explosive material disposed adjacent said one end face of said piston, said explosive material being actuated to produce said impusive driving force.

**7.** A tank-type gas-break circuit breaker as claimed in claim **1** wherein said driving means further includes: a first pressure chamber substantially surrounding said piston chamber; passage means communicating said first pressure chamber with said piston chamber, said piston closing said passage means during the closed position of said break contacts; spring mans disposed in said piston chamber continuously urging said piston to close said passage means; means providing a high pressure gas to fill said first chamber to cause the pressure therein to be higher than the pressure in said piston chamber, so that when said impulse providing means is actuated said piston has imparted thereto said initial impulsive force to impulsively open said passage means and allow high pressure gas to leak against said one end face of said piston and thereby provide a secondary force on said piston subsequent to said initial force to open said break contact.

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