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(54) **OPERATING DEVICE FOR CIRCUIT BREAKERS**

BETÄTIGUNGSVORRICHTUNG FÜR LEISTUNGSSCHALTER

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Description

TECHNICAL FIELD

[0001] The present invention relates to an electromagnetic operating device intended for medium-voltage or high-voltage circuit breakers and comprising an opening magnet and a closing magnet for operating the movable contact system of the circuit breaker.

BACKGROUND ART

[0002] For operation of medium-voltage or high-voltage circuit breakers, spring operating devices as well as hydraulic and pneumatic operating devices are usually used. Such operating devices normally comprise a large number of different components, which entails a relatively high manufacturing cost.

[0003] Electromagnetic operating devices are used above all in low-voltage circuit breakers. In such small circuit breakers, it is common for the driving force of the electromagnet to be combined with the force of a return spring, such that the movable contact system may be displaced in opposite directions (make and break).

[0004] Electromagnetic operating devices have also been used in older high-voltage circuit breakers of the type in which the contact system is enclosed in a grounded oil-filled tank. In a known operating device of this kind, two separate operating magnets for opening and closing, respectively, are used. The magnets are connected to the contact system via a mechanism, composed of a plurality of arms, links and rods, which by its relatively large weight, friction in all the rotary bearings, etc., is slow in operation and energy-demanding.

SUMMARY OF THE INVENTION

[0005] The present invention aims to provide an electromagnetic operating device of the kind described in the preamble to claim 1, which is simpler, more reliable and less space-demanding than comparable prior art designs. In addition, the operating device shall be so designed that the energy losses caused by friction, etc., in the transmission between the magnets and the contact system are minimized, and that higher contact acceleration and contact speed may be achieved. This is achieved according to the invention with an operating device with the characteristic features mentioned in the characterizing part of claim 1.

[0006] According to the invention, the two magnetic cores are integrated into one single magnet body, and the two armatures are adapted, by activation of the respective magnet coil, to be displaced translatorily along the longitudinal axis of the magnet body for opening and closing, respectively, of the circuit breaker. In this way, an exceedingly simple magnet configuration is achieved, and the mechanical connection between the magnetic device and the contact system of the circuit breaker is considerably simplified. In addition, a higher contact speed is achieved, and the reliability is improved.

[0007] According to a further development of the invention, holding coils are arranged adjacent to the operating coils to retain the respective armature in its end position, after a breaker operation, with the aid of relatively low magnetizing current. In this way, the operating mechanism is further simplified, since the need of mechanical latches, latching magnets and permanent magnets is eliminated.

[0008] A magnetic operating device according to the present invention is most suitable for single-pole operation of SF_6 gas insulated circuit breakers. By its elongated configuration, the operating device may be advantageously integrated into, under or adjacent to the respective breaker pole to form a hermetically sealed unit, filled with insulating gas, where all mechanical operations take place inside the unit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The invention will be described in greater detail by description of embodiments with reference to the accompanying drawings, wherein

Figure 1 schematically shows how an operating device according to the invention may be composed,

Figure 2 shows the operating device according to Figure 1 in an improved form,

Figure 3 shows a time diagram for the currents in the magnet coils of the operating device according to Figure 2 upon closing and opening of a circuit breaker,

Figure 4 shows in a side view and partially in section a gas-insulated high-voltage circuit breaker with an operating device, designed according to the invention, integrated in the gas volume, and

Figure 5 shows in axial section the central part of the contact system of the circuit breaker according to Figure 4.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0010] The operating device schematically shown in Figure 1 comprises a magnetic device consisting of, on the one hand, an opening magnet 11 comprising an opening coil 12, a magnet core 13 and an opening armature 14, and, on the other hand, a closing magnet 15 comprising a closing coil 16, a magnet core 17 and a closing armature 18. The two magnet cores 13, 17 with a magnet yoke connected thereto are integrated into a

single magnet body 20, which together with the coils 12, 16 and the armatures 14, 18 form an operating magnet with a axi-symmetrical configuration.

[0011] The magnet body 20 is formed with two hollow-cylindrical spaces 21, 22 separated by a transverse yoke 23 arranged in the mid-portion of the magnet body. The opening coil 12 is arranged in the upper space 21, whereas the closing coil 16 is arranged in the lower space 22. The opening armature 14, which extends into the space 21 at the upper end of the magnet body, is connected to the movable contact system of the circuit breaker via an insulating operating rod 19. The closing armature 18, which extends into the space 22 at the lower end of the magnet body 20, is provided with (or makes contact with) a push rod 24 (non-magnetic) which extends axially through the magnet body 20.

[0012] The operating coils 12, 16 are connected to a common energy source 30 via separate thyristors 31 and 32, respectively, which are supplied with control current from a control circuit device 33. The energy source 30 may, for example, be a capacitor bank, an accumulator battery, or a rechargeable dry battery.

[0013] Opening of the circuit breaker is initiated by firing the opening thyristor 31 by supplying control current from the control circuit device 33. This causes current to pass through the opening coil 12, the opening magnet 11 thus being magnetized and its armature 14 being drawn in the direction of the arrow A towards the interior of the core 13. The movable contact system of the circuit breaker, which contact system is connected via the operating rod 19 direct to the armature 14, is thus moved to the open position and is retained there, for example by an open-position latch arranged adjacent to the armature 14.

[0014] For closing the circuit breaker, the closing thyristor 32 is fired, the closing magnet 15 thus being magnetized by the supply of current from the energy source 30. The closing armature 18 is thereby drawn in the direction of the arrow B towards the interior of the core 17 and, via the push rod 24 and the opening armature 14, brings about a displacement of the operating rod 19 in the direction of the arrow C. The movable contact system of the circuit breaker is thus displaced towards the closed position and is retained there, for example by a mechanical closed-position latch arranged adjacent to the armature 18.

[0015] Disengagement of the above-mentioned mechanical open-position and closed-position latches upon closing and opening, respectively, is achieved with the aid of electromagnets which may be operated from the same control circuit device 33 which, during breaker operation, supplies the respective thyristor 31, 32 with a trigger signal.

[0016] Instead of using mechanical latches for retaining the movable contact system in the open and closed contact position, respectively, in the manner described above, this function may also be achieved magnetically. Figure 2 shows a further development of the magnet device shown in Figure 1, where, on the one hand, a first holding coil 25 is arranged adjacent to the opening coil 12 for retaining the movable contact system of the circuit breaker in the open position after an opening operation, and, on the other hand, a second holding coil 26 is arranged adjacent to the closing coil 16 for retaining the movable contact system of the circuit breaker in the closed position after a closing operation.

[0017] By contrast with the operating coils 12, 16, the holding coils 25, 26 are designed for relatively low magnetizing current. The reason for this is that the attractive force (F) of an electromagnet is a function of the coil current (I) and the air gap (X) between the armature and the core, and may be roughly estimated by the equation

$$F = k \cdot I^2 / X^2$$

[0018] At the end of the armature movement, the air gap X is almost reduced to zero, and the holding forces which are required may therefore be easily achieved by relatively small currents which may thus be delivered by the auxiliary power equipment in the distribution station in which the circuit breaker is placed.

[0019] Figure 3 shows a time diagram for the coil currents in the magnetic device according to Figure 2 during closing and opening of a circuit breaker. The following designations for currents and time intervals are used in the diagram:

I_{MA} = the current in the closing coil 16

I_{HC} = the current in the second holding coil 26

I_{BR} = the current in the opening coil 12

I_{HO} = the current in the first holding coil 25

T_{MA} = time interval for closing of the breaker

T_{HC} = time interval when the breaker is locked in the closed position

T_{BR} = time interval for opening of the breaker

T_{HO} = time interval when the-breaker is locked in the open position.

[0020] As is clear from the diagram, the holding coils 25, 26 cooperate with the operating coils 12, 16 in such a way that the holding coils relieve the operating coils and complete the task of magnetizing the respective magnetic circuit and retaining the opening and the closing armature, respectively, in the end position of the respective armature movement.

[0021] Figures 4 and 5 show an integrated single-pole magnet-operated high-voltage circuit breaker consisting of a breaker pole of a type known per se, combined

with an electromagnetic operating device according to the present invention. The shown breaker pole is an SF_6 circuit breaker of self-blasting type, described in the ABB pamphlet SESWG/B 2330E SF_6 Circuit-Breaker Type LTB", published 1993. The contact system of the breaker pole is arranged in an elongated casing 40 of insulating material provided with an upper and a lower connecting flange 41 and 42, respectively. The contact system, whose central part is shown in Figure 5, comprises one fixed and one movable main contact 43 and 44, respectively, and one fixed and one movable arcing contact 45 and 46, respectively. A nozzle 47 of insulating material is arranged between the movable contacts 44 and 46 and is fixedly connected thereto. The movable contact system 44, 46 is connected, via a tubular contact rod 48, to the insulating operating rod 19, which extends through a hollow support insulator 49 and is connected at its lower end to the opening armature 14 of the operating device.

[0022] The breaker pole and the operating device are coaxially arranged and have an elongated, substantially axi-symmetrical configuration. The breaker pole and the operating device together form one single, hermetically sealed unit which is filled with SF6 gas. All mechanical operations occur inside the closed unit. For connection of the energy source 30 to the operating device, the operating device is provided with gas-tight bushings 27.

[0023] Instead of arranging the operating device below the support insulator 49, as shown in Figure 4, the operating device may be built into the lower part of the support insulator by mutual adaptation of the transverse dimensions of the support insulator and the operating device. In this way, the operating device need not be provided with a separate casing, and the dimensions of the integrated breaker pole may be further reduced.

[0024] An integrated breaker pole of the embodiment described entails great advantages, since it may be made completely ready for operation with the prescribed gas filling at the factory. This reduces the assembly work at the customer's site, which is largely limited to connecting two wires between the breaker pole and the energy supply equipment. (The return connection from the magnet coils 12, 16 can be grounded to the enclosures of the equipment.)

[0025] The invention is not limited to the embodiments shown, but several variants are possible within the scope of the claims. For example, instead of the push rod 24, a connection rod for interconnecting the armatures can be used. Furthermore, it may in certain cases be advantageous to use gate turn-off thyristors instead of the ordinary thyristors 31, 32 shown in Figure 1.

Claims

1. An electromagnetic operating device for circuit breakers comprising an opening magnet (11) and a closing magnet (15), each of which comprises an operating coil (12, 16), a magnetic core (13, 17) and an armature (14, 18) for operating the movable contact system of the breaker, **characterized** in that the two magnetic cores (13, 17) are coaxially integrated into one single magnet body (20), that the coil (12) and the armature (14) of the opening magnet (12) are arranged at one end of the magnet body (20), whereas the coil (16) and the armature (18) of the closing magnet are arranged at the other end of the magnet body (20), and that the two armatures (14, 18), by energizing the respective operating coil (12, 16), are translatorily displaceable along the longitudinal axis of the magnet body (20) for opening and closing the circuit breaker, the opening armature (14) being connected to the movable contact system of the circuit breaker via a first operating rod (19), whereas the closing armature (18) is adapted to displace a non-magnetic second operating rod (24), oriented in the axial direction of the magnet body, to operate the movable contact system via the opening armature (14).

2. An operating device according to claim 1, **characterized** in that the second operating rod (24) is a push rod.

3. An operating device according to claim 1, **characterized** in that the second operating rod (24) is a connection rod for interconnecting the armatures (14, 18).

4. An operating device according to any of the preceding claims, **characterized** in that the magnet body (20) with associated coils (12, 16) and armatures (14, 18) are axi-symmetrical.

5. An operating device according to any of the preceding claims, **characterized** in that the magnet body (20) exhibits two spaces (21, 22) separated by means of a transverse yoke (23), the opening coil (12) being arranged in one space (21) and the closing coil (16) in the other space (22).

6. An operating device according to any of the preceding claims, **characterized** in that the second operating rod (24) extends through an axial guide hole in the magnet body (20).

7. An operating device according to any of the preceding claims, **characterized** in that a first holding coil (25) is arranged adjacent to the opening coil (12) to retain, after an opening operation, the movable contact system of the circuit breaker in the open position.

8. An operating device according to any of the preceding claims, **characterized** in that a second holding coil (26) is arranged adjacent to the closing coil (16)

to retain, after a closing operation, the movable contact system of the circuit breaker in the closed position.

9. An operating device according to any of the preceding claims, **characterized** in that the operating coils (12, 16) are connected to a common energy source (30) via separate semiconductor switches (31, 32).

10. An operating device according to claim 8, **characterized** in that the energy source (30) consists of capacitor bank, an accumulator battery, or a dry battery, provided with means for automatic recharge.

11. Use of an operating device according to any of the preceding claims in a pressure-gas insulated medium-voltage or high-voltage circuit breaker, the circuit breaker and the operating device being integrated into a hermetically sealed unit filled with pressure gas.

Patentansprüche

1. Elektromagnetische Betätigungsvorrichtung für Leistungsschalter mit einem Öffnungsmagneten (11) und einem Schliessmagneten (15), die jeweils eine Betätigungsspule (12, 16), einen Magnetkern (13, 17) und einen Anker (14, 18) umfassen zum Betätigen der beweglichen Stromzuführung des Schalters, **dadurch gekennzeichnet,** daß die beiden Magnetkerne (13, 17) konzentrisch in einen einzigen Magnetteil (2()) integriert sind, daß die Spule (12) und der Anker (14) des Öffnungsmagneten (12) am einen Ende des Magnetteiles angeordnet sind, wogegen die Spule (16) und der Anker (18) des Schließmagncten am anderen Ende des Magnetteiles (2()) angeordnet sind und daß die beiden Anker (14, 18) durch Erregen der entsprechenden Spulen (12, 16) entlang der Längsachse des Magnetteiles (20) seitlich versetzbar sind um den Leistungsschalter zu öffnen und zu schließen, wobei der Öffnungsanker (14) an die bewegliche Stromzuführung des Lcistungsschalters über eine erste Betätigungsstange (19) angeschlossen ist, wogegen der Schliessanker (18) vorgesehen ist, eine nichtmagnetische zweite, in Achsialrichtung des Magnetteiles verlaufende Betätigungsstange (24) zu verschieben um die bewegliche Stromzuführung über den Öffnungsanker zu betätigen.

2. Betätigungsvorrichtung gemäß Patentanspruch 1, **dadurch gekennzeichnet,** daß die zweite Betätigungsstange (24) eine Schiebestange ist.

3. Betätigungsvorrichtung gemäß Patentanspruch 1, **dadurch gekennzeichnet,** daß die zweite Betätigungsstange (24) eine Verbindungsstange für die Vcrbindung der Anker (14, 18) ist.

4. Betätigungsvorrichtung gemäß irgendeinem der obigen Patentansprüche, **dadurch gekennzeichnet,** daß der Magnetteil (20) mit den zugehörigen Spulen (12, 16) und Ankern (14, 18) achsial symmetrisch ist.

5. Betätigungsvorrichtung gemäß irgendeinem der obigen Patentansprüche, **dadurch gekennzeichnet,** daß der Magnetteil (20) zwei mit Hilfe eines Querjoches (23) getrennte Räume (21, 22) aufweist, wobei die Öffnungsspulc (12) im einen Raum (21) und die Schließspule (16) im anderen Raum (22) angeordnet ist.

6. Betätigungsvorrichtung gemäß irgendeinem der obigen Patentansprüche, **dadurch gekennzeichnet,** daß die zweite Betätigungsstange (24) durch ein achsiales Zentrierloch im Magnetteil (20) verläuft.

7. Betätigungsvorrichtung gemäß irgendeinem der obigen Patentansprüche, **dadurch gekennzeichnet,** daß eine erste Haltespule (25) neben der Öffnungsspule (12) angeordnet ist, um nach dem Öffnungsvorgang die bewegliche Stromzuführung des Leistungsschalter in offener Lage zu halten.

8. Betätigungsvorrichtung gemäß irgendeinem der obigen Patentansprüche, **dadurch gekennzeichnet,** daß eine zweite Haltespule (26) neben der Schließspule (16) angeordnet ist um nach dem Schließvorgang die bewegliche Stromzuführung des Leistungsschalter in geschlossener Lage zu halten.

9. Betätigungsvorrichtung gemäß irgendeinem der obigen Patentansprüche, **dadurch gekennzeichnet,** daß die Betätigungsspulen (12, 16) an eine gemeinsame Stromquelle (30 über getrennte Halbleiterschalter (31, 32) angeschlossen sind.

10. Betätigungsvorrichtung gemäß Patentanspruch 8, **dadurch gekennzeichnet,** daß die Stromquelle aus einem Kondensatorsblock, einer Akkumulatorbatterie oder einer für automatische Aufladung versehenen Trockenbatterie besteht.

11. Verwendung einer Betätigungsvorrichtung gemäß irgendeinem der obigen Patentansprüche in einem mit Druckgas isolierten Leistungsschalter für Mittel- oder Hochspannung, wobei der Lcistungsschalter und die Betätigungsvorrichtung in einer hermetisch geschlossenen, mit Druckgas gefüllten Einheit integriert sind.

Revendications

1. Un dispositif d'actionnement électromagnétique pour des disjoncteurs comprenant un aimant d'ouverture (11) et un aimant de fermeture (15), chacun d'eux comprenant une bobine d'actionnement (12, 16), un noyau magnétique (13, 17) et une armature (14, 18) pour actionner le système de contacts mobiles du disjoncteur, caractérisé en ce que les deux noyaux magnétiques (13, 17) sont intégrés de façon coaxiale en un seul corps d'aimant (20), en ce que la bobine (12) et l'armature (14) de l'aimant d'ouverture (12) sont disposées à une extrémité du corps d'aimant (20), tandis que la bobine (16) et l'armature (18) de l'aimant de fermeture sont disposées à l'autre extrémité du corps d'aimant (20), et en ce que sous l'effet de l'excitation de la bobine d'actionnement respective (12, 16), les deux armatures (14, 18) peuvent être déplacées en translation le long de l'axe longitudinal du corps d'aimant (20), pour ouvrir et fermer le disjoncteur, l'armature d'ouverture (14) étant reliée au système de contacts mobiles du disjoncteur par l'intermédiaire d'une première tige d'actionnement (19), tandis que l'armature de fermeture (18) est conçue pour déplacer une seconde tige d'actionnement (24), non magnétique, orientée dans la direction axiale du corps d'aimant, pour actionner le système de contacts mobiles par l'intermédiaire de l'armature d'ouverture (14).

2. Dispositif d'actionnement selon la revendication 1, caractérisé en ce que la seconde tige d'actionnement (24) est une tige de poussée.

3. Dispositif d'actionnement selon la revendication 1, caractérisé en ce que la seconde tige d'actionnement (24) est une bielle destinée à accoupler mutuellement les armatures (14, 18).

4. Dispositif d'actionnement selon l'une quelconque des revendications précédentes, caractérisé en ce que le corps d'aimant (20) avec les bobines (12, 16) et les armatures (14, 18) associées sont axisymétriques.

5. Dispositif d'actionnement selon l'une quelconque des revendications précédentes, caractérisé en ce que le corps d'aimant (20) présente deux espaces (21, 22) séparés au moyen d'une culasse transversale (23), la bobine d'ouverture (12) étant disposée dans un espace (21) et la bobine de fermeture (16) étant disposée dans l'autre espace (22).

6. Dispositif d'actionnement selon l'une quelconque des revendications précédentes, caractérisé en ce que la seconde tige d'actionnement (24) s'étend à travers un trou de guidage axial dans le corps d'aimant (20).

7. Dispositif d'actionnement selon l'une quelconque des revendications précédentes, caractérisé en ce qu'une première bobine de maintien (25) est disposée en position adjacente à la bobine d'ouverture (12) pour retenir dans la position ouverte le système de contacts mobiles du disjoncteur, après une opération d'ouverture.

8. Dispositif d'actionnement selon l'une quelconque des revendications précédentes, caractérisé en ce qu'une seconde bobine de maintien (26) est disposée en position adjacente à la bobine de fermeture (16) pour retenir le système de contacts mobiles du disjoncteur dans la position fermée, après une opération de fermeture.

9. Dispositif d'actionnement selon l'une quelconque des revendications précédentes, caractérisé en ce que les bobines d'actionnement (12, 16) sont reliées à une source d'énergie commune (30) par l'intermédiaire d'éléments de commutation à semiconducteur distincts (31, 32).

10. Dispositif d'actionnement selon la revendication 8, caractérisé en ce que la source d'énergie (30) consiste en une batterie de condensateurs, une batterie d'accumulateurs ou une batterie sèche, équipées de moyens pour la recharge automatique.

11. Utilisation d'un dispositif d'actionnement selon l'une quelconque des revendications précédentes dans un disjoncteur de moyenne tension ou de haute tension isolé par un gaz sous pression, le disjoncteur et le dispositif d'actionnement étant intégrés dans une unité fermée hermétiquement étanche qui est emplie de gaz sous pression.

Fig. 1

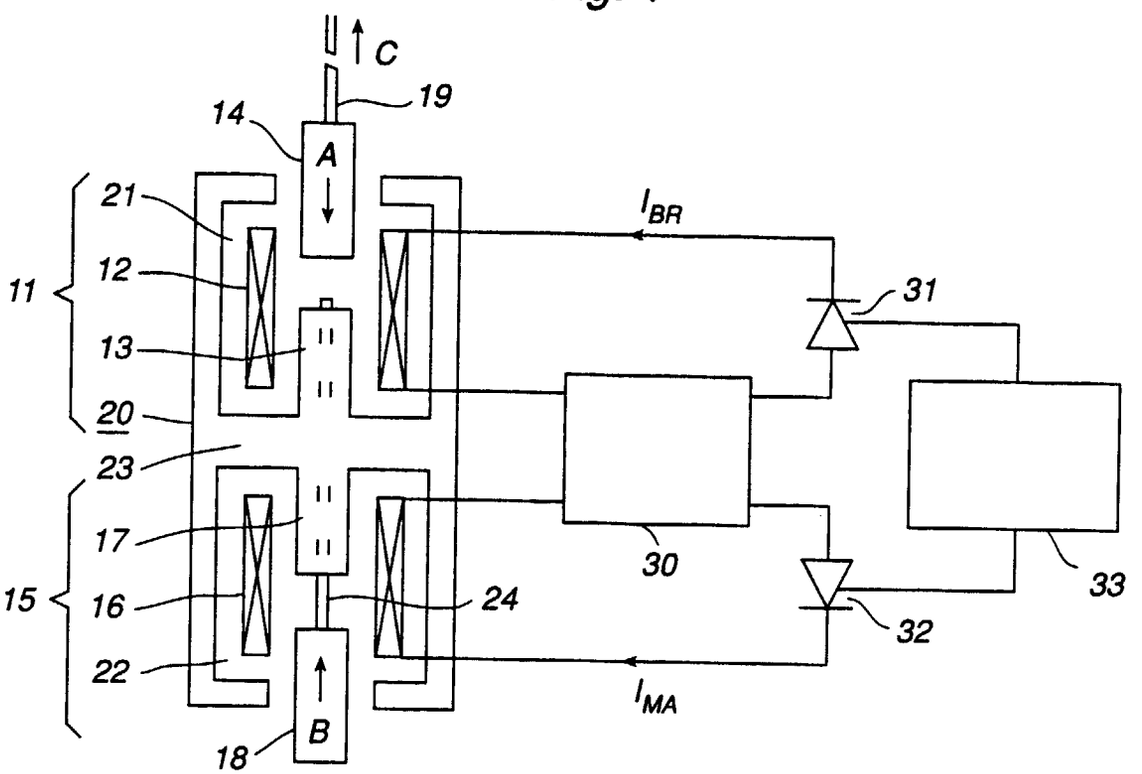
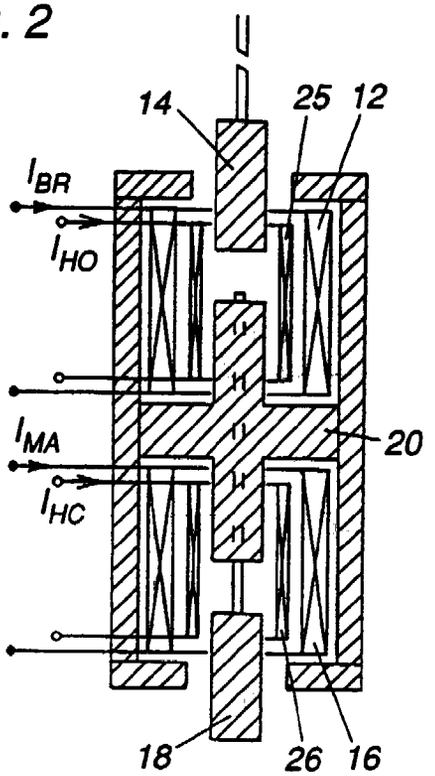


Fig. 2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25
12
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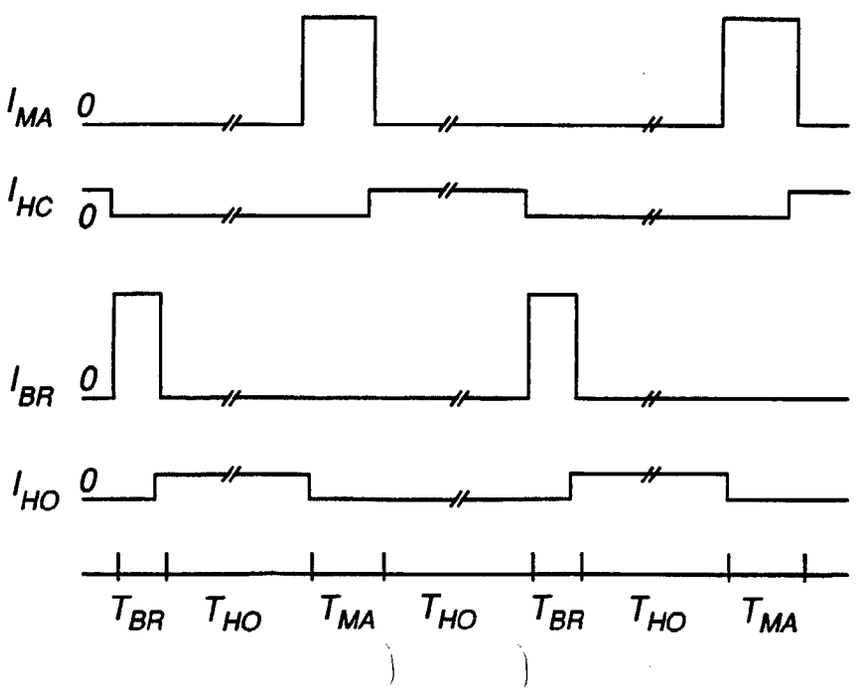
I_{HO}
I_{MA}
I_{HC}
20
18
26
16

Fig. 3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I_{BR} 0
I_{HO} 0
T_{BR} T_{HO} T_{MA} T_{HO} T_{BR} T_{HO} T_{MA}

Fig. 4

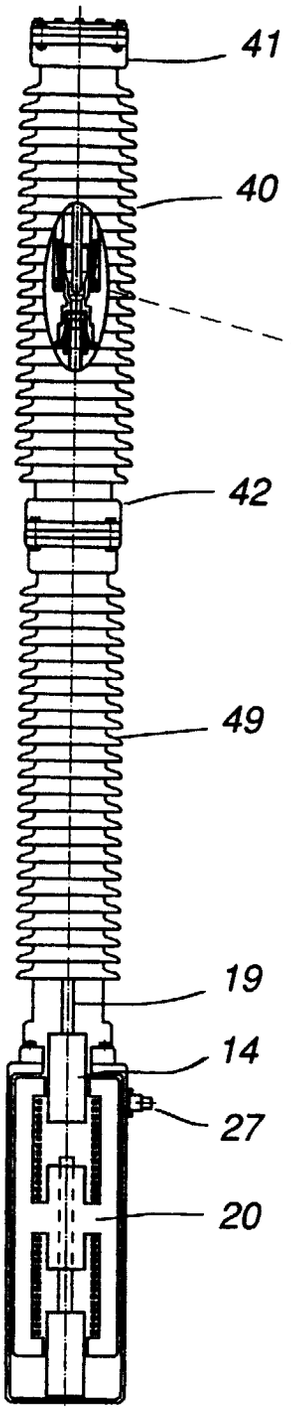

Fig. 5