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(54) **AUTOMATIC CURRENT LIMITING CIRCUIT BREAKER**

AUTOMATISCHER STROMBEGRENZENDER SCHUTZSCHALTER

DISJONCTEUR DE LIMITATION DE COURANT AUTOMATIQUE

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Description

[0001] The present invention relates to a circuit breaker and particularly to an automatic current limiting circuit breaker that has a system with double interruption in series with at least two arc quenching chambers for each pole.

[0002] Low-voltage electrical systems characterized by high currents and power levels normally use specific devices provided with a system that ensures the nominal current required for the various users, the insertion and disconnection of the load, the protection of the loads against abnormal events such as overloading and short-circuits by automatically opening the circuit, and finally the disconnection of the protected circuit by opening the movable contacts with respect to the fixed contacts in order to achieve full isolation of the load with respect to the electric power source. These devices are commonly known as automatic power switches for use in low-voltage industrial systems.

[0003] There are several industrial solutions for these devices. The most common solution entrusts the opening of the contacts to complex mechanisms actuated by the mechanical energy accumulated beforehand in special springs.

[0004] If the presumed level of short-circuit current is particularly high, the energy that can be accumulated in the springs may be insufficient for effective contact opening. In such cases one normally uses special types of automatic circuit breaker provided with technical solutions aimed at increasing the breaking capacity.

[0005] Among the most valid solutions there are two in particular that are often used together.

[0006] The first of these solutions entails doubling the contacts. In this case, each pole is interrupted in two separate regions that are electrically in series to each other, so that each one is subjected to less mechanical and thermal stress.

[0007] The second solution is based on a reduction of the tripping time, so as to prevent the presumed short-circuit current from reaching its maximum value.

[0008] This is a solution that requires the path of the current to have a shape that triggers, in case of a short circuit, an electrodynamic phenomenon capable of positively contributing to the production of the mechanical thrust required to open the contacts. In some cases, the energy required is in fact several hundred newtons per meter.

[0009] These solutions are often associated in so-called limiting circuit breakers, which as is known have, in principle, good efficiency and reliability but have some typical situations that involve compromise or criticality.

[0010] It is in fact known that duplicating the interruption elements entails a considerable increase in the dimensions of the apparatus. It is also necessary to electrically connect in series the two movable contacts of each pole by virtue of copper braids which, since they have to be flexible and therefore relatively thin, inevitably introduce high energy losses due to the Joule effect.

[0011] Moreover, there is the risk of an imperfect distribution of the mechanical loads supported by the movable contacts, with consequent repercussions on the electrical conductivity of the circuit breaker. This phenomenon can worsen during the life cycle of the unit, since it is linked to the constant but irregular wear of the plates located on the regions where the movable contacts encounter the fixed contacts.

[0012] The aim of the present invention is to provide an automatic current limiting circuit breaker whose mechanism and operating principle are simplified with respect to the circuit breakers of the known art. Document FR 2 373 143 discloses a device according to the preamble of claim 1.

[0013] Within the scope of this aim, an object of the present invention is to provide an automatic current limiting circuit breaker that improves the distribution of the mechanical loads supported by the movable contacts.

[0014] Another object is to provide an automatic current limiting circuit breaker in which energy dissipation due to the Joule effect is minimized.

[0015] Another object is to provide an automatic current limiting circuit breaker that has reduced overall dimensions for an equal electrical performance and expected life.

[0016] Another object of the present invention is to provide an automatic current limiting circuit breaker that is highly reliable, relatively easy to provide and at competitive costs.

[0017] This aim these and other objects that will become better apparent hereinafter are achieved by an automatic current limiting circuit breaker, which comprises an insulating enclosure that accommodates fixed contact means and movable contact means, actuation means for actuating said movable contact means between open-circuit conditions and closed-circuit conditions, and arc quenching means that comprise at least one first and one second arc quenching chamber which are mutually separate, the fixed contact means comprising at least one first and one second fixed contact, which are mutually spaced and positioned respectively adjacent to the first and second arc quenching chambers, the movable contact means comprising at least one first movable contact and one second movable contact, which are electrically series-connected and can move simultaneously between open-circuit and closed-circuit positions, characterized in that the movable contact means comprise a first contact arm and a second contact arm that have a first end at which the first movable contact and the second movable contact are respectively fixed and a second end that is fixed on, and free to rotate about, a common pivot that is operatively connected to said actuation means.

[0018] In this manner, in practice one provides an automatic current limiting circuit breaker that fully achieves the intended aim and objects. In particular, the specific configuration and operating principle of the movable contact means allows to reduce and simplify the number of

parts required without altering the functional characteristics of said circuit breaker.

[0019] Further characteristics and advantages will become better apparent from the description of preferred but not exclusive embodiments of the circuit breaker according to the invention, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

Figure 1 is a perspective view of an example of one of the poles of an automatic current limiting circuit breaker according to the invention;

Figure 2 is a perspective view of details of a pole of an automatic current limiting circuit breaker according to the invention;

Figure 3 is a partially sectional view of the same details of the pole of an automatic current limiting circuit breaker of Figure 2;

Figure 4 is a partially sectional view of other details of a pole of an automatic current limiting circuit breaker according to the invention.

[0020] With reference to the figures, the automatic current limiting circuit breaker according to the invention comprises an insulating enclosure 1, of which only a cut-out view is shown. The enclosure 1 accommodates fixed contact means, generally designated by the reference numeral 10, and movable contact means, generally designated by the reference numeral 20. The circuit breaker also comprises actuation means for moving the movable contact means between an open-circuit condition (shown in dashed lines in Figures 3 and 4) and a closed-circuit condition. A detail of the actuation means is given in Figures 1 and 4, which show an example of kinematic actuation chain 30.

[0021] The circuit breaker further comprises arc quenching means, constituted by two mutually separate arc quenching chambers; the arc quenching chambers are not shown in the figures for the sake of clarity. However, Figure 1 shows the seats 2 and 3 formed in the enclosure 1 and suitable to accommodate said arc quenching chambers.

[0022] The fixed contact means 10 comprise a first fixed contact 11 and a second fixed contact 12, which are mutually spaced and arranged respectively adjacent to the first and second arc quenching chambers, at the seats 2 and 3.

[0023] The movable contact means 20 comprise a first movable contact 21 and a second movable contact 22, which are electrically series-connected and can be moved simultaneously between open-circuit and closed-circuit positions. As shown in Figure 2, the movable contact means 20 furthermore comprise a first contact arm 23 and a second contact arm 24, which are constituted by two elongated conducting plates that have a first end, designated by the reference numerals 25 and 26 respectively, at which the first movable contact 21 and the second movable contact 22 are fixed. The second end, which is designated by the reference numeral 27 for the first movable arm 23, whereas the end of the second movable arm 24 is not visible, is fixed to a common pivot 40 so that the two movable arms 23 and 24 are free to rotate about it. The common pivot 40 is therefore operatively connected to the actuation means in order to allow the movement of the movable contacts.

[0024] Advantageously, the first and second contact arms 23 and 24 are mutually electrically series-connected by virtue of at least one flexible conductor. As shown in the figures, the electrical series connection can be provided by means of a pair of copper braids 51 and 52.

[0025] According to a preferred embodiment, the common pivot 40 is fixed to a plate 31 that is operatively connected to the actuation means. The plate 31 can slide freely in an appropriate space formed between the seats 2 and 3 of the arc quenching chambers.

[0026] As mentioned, it is important that the mechanical loads be distributed correctly between the movable contacts, also compensating for the wear that occurs over the life of the unit. For this purpose, the first and second contact arms 23 and 24 are preferably operatively associated with elastic means that perform this function. As shown in Figure 2, the elastic means can be constituted for example by two springs 32 and 33 that are respectively associated with the first and second contact arms 23 and 24, for example proximate to their end that lies opposite the movable contact 20.

[0027] The connection of the movable contact parts to the actuation means can be performed for example by means of a coupling lever 34, one end of which is rigidly coupled to the pivot 40 while the other end is rigidly coupled to the kinematic chain 30.

[0028] In practice it has been found that the automatic current limiting circuit breaker according to the invention fully achieves the intended aim and objects. The advantages arising from the fact that the rotation axes of the two movable contacts are made to coincide, as a consequence of the common pivoting point of the contact arms, are in fact as follows.

[0029] First of all, one has a better distribution of the mechanical loads supported by the movable contacts, with consequent benefits in terms of electrical conductivity of the circuit breaker and in terms of durability and stability of the kinematic system and therefore of the circuit breaker. The simplification of the kinematic mechanism that is based on setting the movable contacts about a common pivoting point in fact allows to continuously readapt and optimize the geometry of the coupling between the movable contacts and the fixed contacts, effectively compensating the effects of the normal progressive and independent wear of said contacts.

[0030] Furthermore, the reduced complexity of the kinematic system allows to reduce the overall space occupation of the units for an equal electrical performance and expected life.

[0031] One should not ignore the fact that by setting the movable contacts on a common pivoting point it is

possible to reduce the length of the conductors, usually copper braids, that electrically connect to each other the pairs of movable contacts related to each pole; therefore the electrical resistance also decreases proportionally as said length decreases, consequently containing losses due to the Joule effect.

Claims

1. An automatic current limiting circuit breaker, comprising an insulating enclosure (1) that accommodates fixed contact means (10) and movable contact means (20), actuation means for actuating said movable contact means (20) between open-circuit conditions and closed-circuit conditions, and arc quenching means that comprise at least one first and one second arc quenching chamber which are mutually separate, the fixed contact means (10) comprising at least one first (11) and one second fixed contact (12), which are mutually spaced and positioned respectively adjacent to said first and second arc quenching chambers, the movable contact means (20) comprising at least one first movable contact (21) and one second movable contact (22), which are electrically series-connected and can move simultaneously between open-circuit and closed-circuit positions, whereby said movable contact means (20) comprise a first contact arm (23) and a second contact arm (24) that have a first end (25, 26) at which said first movable contact (21) and said second movable contact (22) are respectively fixed and a second end (27) that is fixed on, and free to rotate about, a common pivot (40) that is operatively connected to said actuation means (30), **characterized in that** said first contact arm (23) is operatively associated with first elastic means (32) and said second contact arm (24) is operatively associated with second elastic means (33).

2. The automatic current limiting circuit breaker according to claim 1, **characterized in that** said first and second contact arms (23,24) are operatively associated with said first and second elastic means (32,33) proximate to one end that lies opposite to the corresponding said movable contact (21,22).

3. The automatic current limiting circuit breaker, according to claim 1 or 2, **characterized in that** said first and second contact arms (23, 24) are mutually electrically series-connected by means of at least one flexible conductor.

4. The automatic current limiting circuit breaker according to claim 3, **characterized in that** said first and second contact arms (23, 24) are mutually electrically series-connected by means of a pair of copper braids (51, 52).

5. The automatic current limiting circuit breaker according to one or more of the preceding claims, **characterized in that** said common pivot (40) is fixed to a plate (31) that is operatively connected to said actuation means.

6. The automatic current limiting circuit breaker according to one or more of the preceding claims, **characterized in that** said actuation means comprise a kinematic chain (30) and a coupling lever (34).

Patentansprüche

1. Automatischer strombegrenzender Trennschalter, der ein isolierendes Gehäuse (1) aufweist, in dem Festkontaktmittel (10) und Laufkontaktmittel (20), Stellmittel zur Verstellung der Laufkontaktmittel (20) zwischen offenen und geschlossenen Schaltkreisbedingungen und Lichtbogenlöschmittel untergebracht sind, die mindestens eine erste und eine zweite Lichtbogenlöschkammer einschließen, die voneinander getrennt sind, wobei die Festkontaktmittel (10) mindestens einen ersten (11) und einen zweiten Festkontakt (12) einschließen, die voneinander beabstandet und jeweils angrenzend an die ersten bzw. zweiten Lichtbogenlöschkammern angeordnet sind, wobei die Laufkontaktmittel (20) mindestens einen ersten (21) Laufkontakt und einen zweiten Lautkontakt (22) einschließen, die elektrisch in Reihe geschaltet sind und sich gleichzeitig zwischen offenen und geschlossenen Schaltkreispositionen bewegen können, wodurch die Lautkontaktmittel (20) einen ersten Kontaktarm (23) und einen zweiten Kontaktarm (24) aufweisen, die ein erstes Ende (25, 26), an dem der erste Laufkontakt (21) bzw. der zweite Laufkontakt (22) befestigt sind, und ein zweites Ende (27) aufweisen, das an einem gemeinsamen Drehzapfen (40), der wirkmäßig mit dem Stellmittel (30) verbunden ist, befestigt ist und sich frei um diesen drehen kann, **dadurch gekennzeichnet, dass** der erste Kontaktarm (23) wirkmäßig mit einem ersten elastischen Mittel (32) verbunden ist und der zweite Kontaktarm (24) wirkmäßig mit einem zweiten elastischen Mittel (33) verbunden ist.

2. Automatischer strombegrenzender Trennschalter nach Anspruch 1, **dadurch gekennzeichnet, dass** die ersten und zweiten Kontaktarme (23, 24) wirkmäßig mit den ersten und zweiten elastischen Mitteln (23, 24) nahe an einem Ende, das sich gegenüber dem entsprechenden Laufkontakt (21, 22) befindet, verbunden sind.

3. Automatischer strombegrenzender Trennschalter nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die ersten und zweiten Kontaktarme (23, 24) mittels mindestens eines flexiblen Leiters elektrisch

in Reihe geschaltet sind.

4. Automatischer strombegrenzender Trennschalter nach Anspruch 3, **dadurch gekennzeichnet, dass** die ersten und zweiten Kontaktarme (23, 24) mittels eines Paars aus Kupferlitzen (51, 52) elektrisch in Reihe geschaltet sind.

5. Automatischer strombegrenzender Trennschalter nach einem oder mehreren der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** der gemeinsame Drehzapfen (40) an einer Platte (31) befestigt ist, die wirkmäßig mit dem Stellmittel verbunden ist.

6. Automatischer strombegrenzender Trennschalter nach einem oder mehreren der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** das Stellmittel einen Antriebsstrang (30) und einen Verbindungshebel (34) aufweist.

Revendications

1. Un disjoncteur de limitation automatique de courant, comprenant un boîtier isolant (1) qui reçoit des organes de contact fixes (10) et des organes de contact mobiles (20), des organes de commande pour commander lesdits organes de contact mobiles (20) entre des conditions de circuit ouvert et des conditions de circuit fermé, et des organes d'extinction d'arc comprenant au moins une première et une deuxième chambres d'extinction d'arc mutuellement séparées, les organes de contact fixes (10) comprenant au moins un premier (11) et un deuxième (12) contacts fixes mutuellement espacés et positionnés respectivement de manière adjacente par rapport à la première et à la deuxième chambres d'extinction d'arc, les organes de contact mobiles (20) comprenant au moins un premier contact mobile (21) et un deuxième contact mobile (22) connectés électriquement en série, et pouvant se déplacer simultanément entre les positions de circuit ouvert et de circuit fermé, grâce à quoi lesdits organes de contact mobiles (20) comprennent un premier bras de contact (23) et un deuxième bras de contact (24) dotés d'une première extrémité (25, 26) à laquelle sont fixés respectivement ledit premier contact mobile (21) et ledit deuxième contact mobile (22), et une deuxième extrémité (27) fixée sur, et pouvant tourner autour, d'un pivot commun (40) connecté de manière fonctionnelle auxdits organes de commande (30) ; **caractérisé en ce que** le premier bras de contact (23) est associé de manière fonctionnelle à un premier organe élastique (32), et ledit deuxième bras de contact (24) est associé de manière fonctionnelle à un deuxième organe élastique (33).

2. Le disjoncteur de limitation automatique de courant selon la revendication 1, **caractérisé en ce que** lesdits premier et deuxième bras de contact (23, 24) sont associés de manière fonctionnelle auxdits premier et deuxième organes élastiques (32, 33), près d'une extrémité qui est opposée audit contact mobile correspondant (21, 22).

3. Le disjoncteur de limitation automatique de courant selon les revendications 1 ou 2, **caractérisé en ce que** lesdits premier et deuxième bras de contact (23, 24) sont mutuellement connectés électriquement en série, au moyen d'au moins un conducteur flexible.

4. Le disjoncteur de limitation automatique de courant selon la revendication 3, **caractérisé en ce que** lesdits premier et deuxième bras de contact (23, 24) sont mutuellement connectés électriquement en série, au moyen d'une paire de tresses de cuivre (51, 52).

5. Le disjoncteur de limitation automatique de courant selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** ledit pivot commun (40) est fixé à une plaque (31) qui est connectée de manière fonctionnelle auxdits organes de commande.

6. Le disjoncteur de limitation automatique de courant selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** lesdits organes de commande comprennent une chaîne cinématique (30) et un levier de couplage (34).

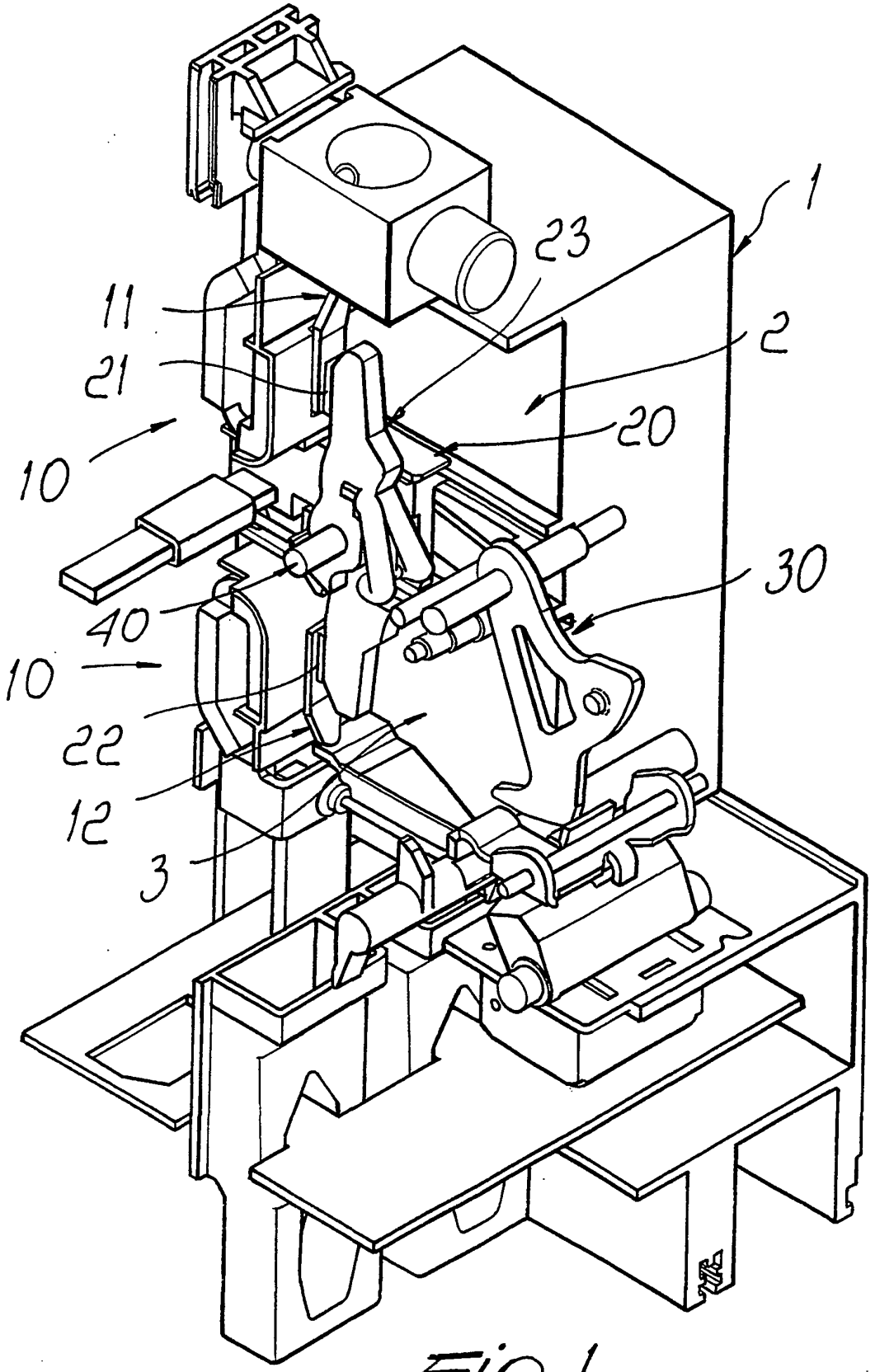

Fig. 1

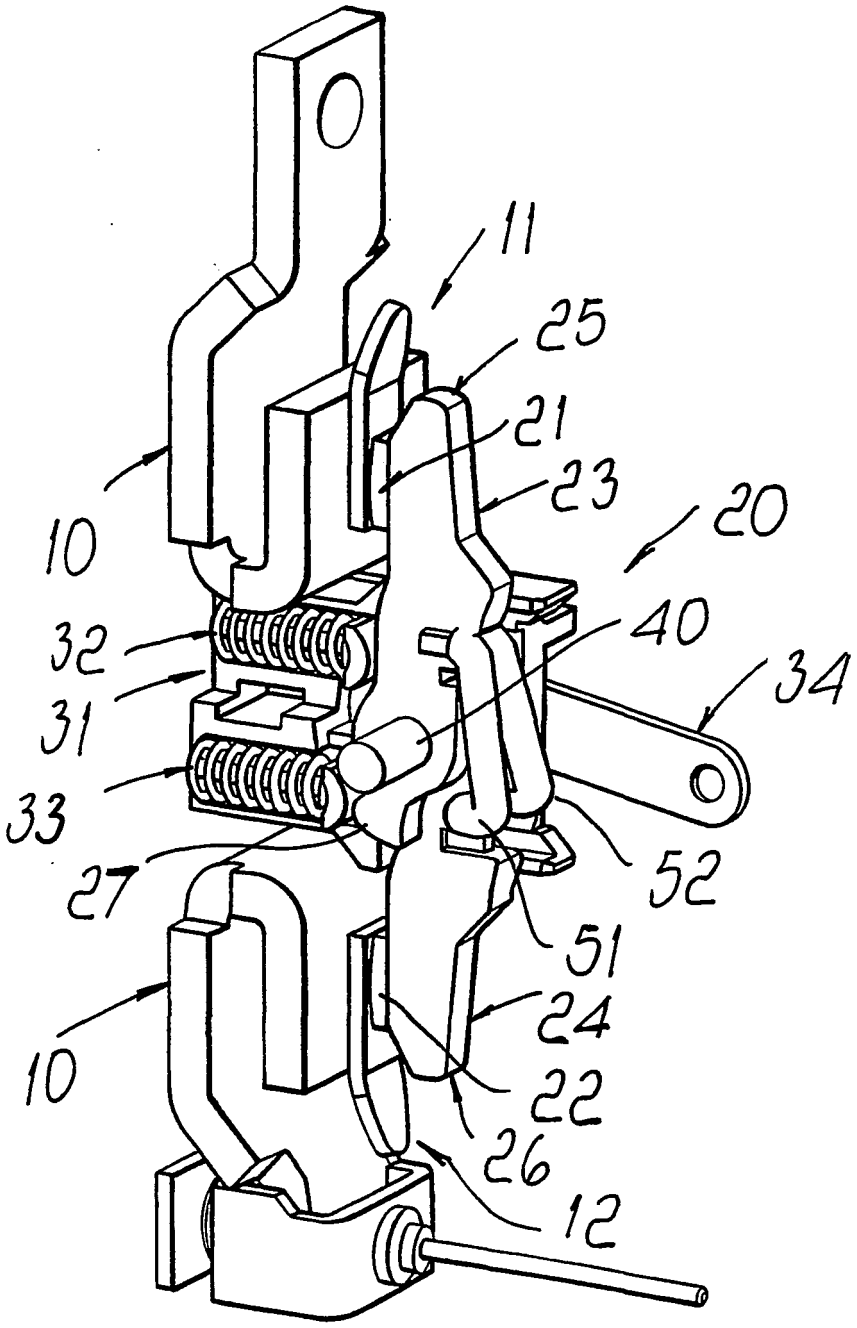

Fig. 2

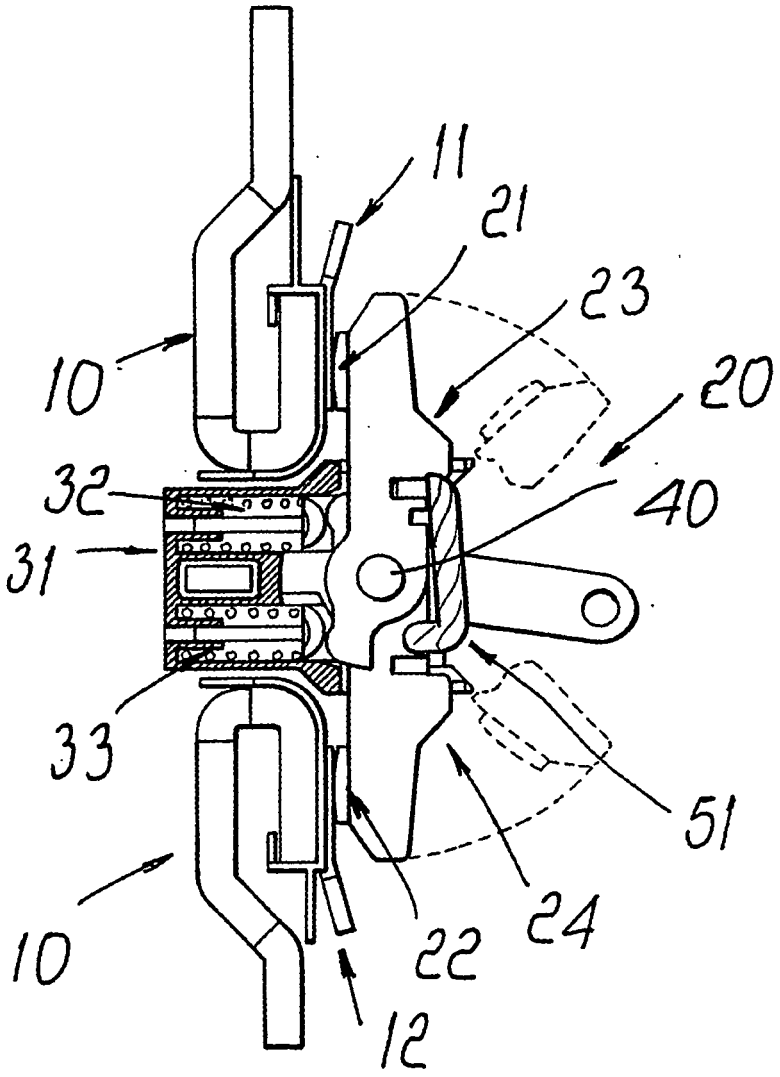

Fig. 3

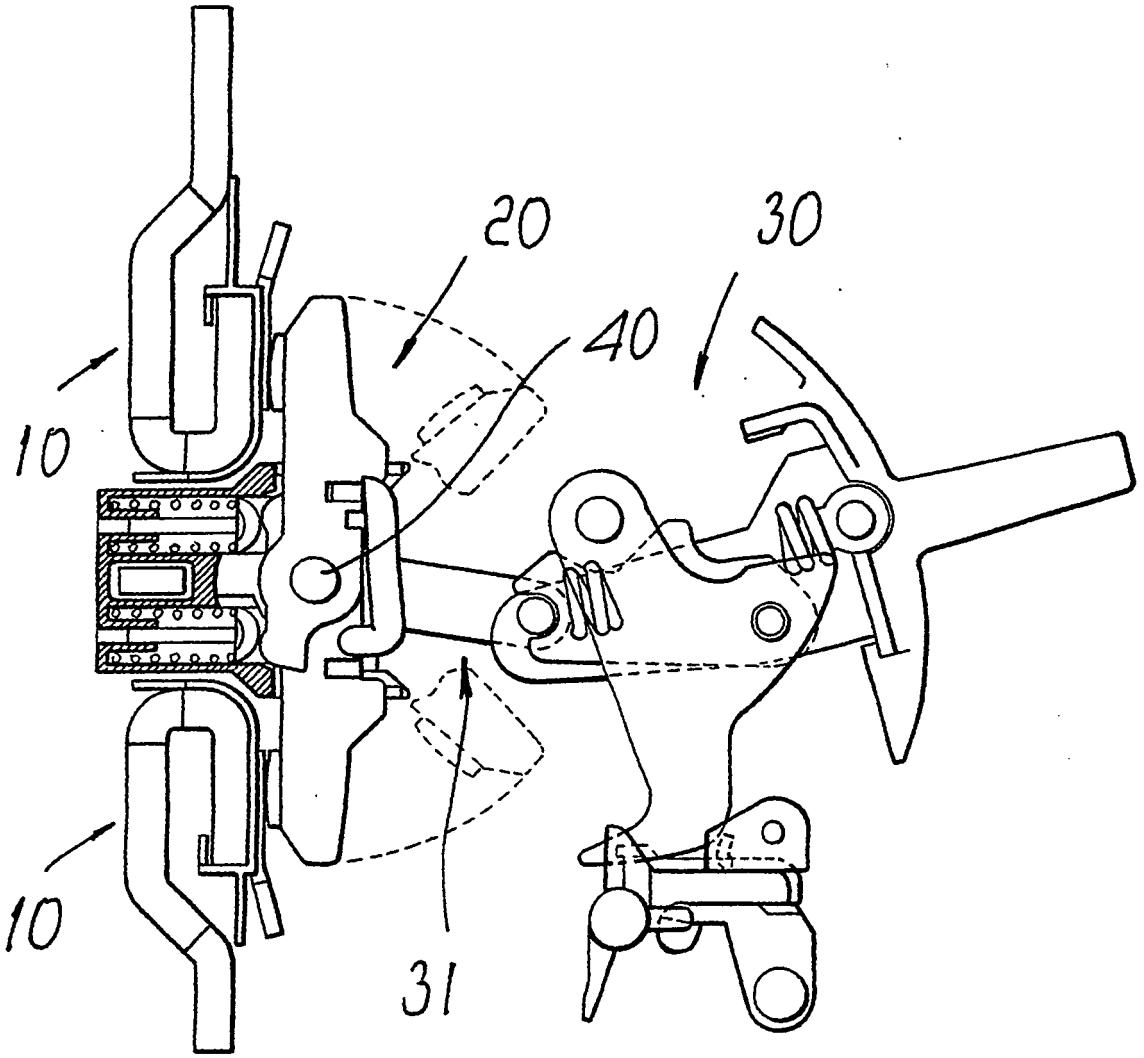

Fig. 4

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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