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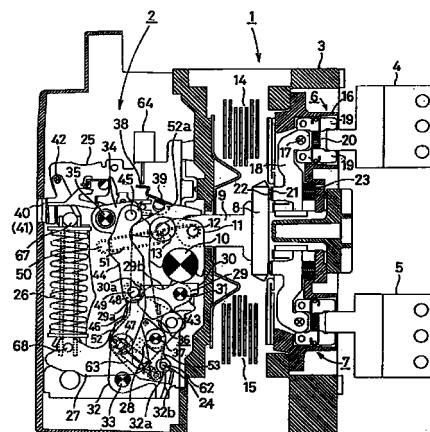
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(54) **Circuit breaker**

(57) A circuit breaker rapidly breaking the short-circuit current prior to the operation of an overcurrent tripping device when a short-circuit current flows is obtained. An operation setting spring (63) is provided between engagement means B (53) of latch means holding a supporting member (32) of a toggle link (44, 46) linked to opening/closing contacts (8, 18) and engagement means A (52) held by a latch receiver (39) displaced by an operation of an overcurrent tripping device (64). When electromagnetic repulsion force generated by the short-circuit current strains the operation setting spring, engagement means B is disengaged and the toggle link supporting member instantaneously is displaced to rapidly break the short-circuit current. As engagement means B is displaced through this operation, latch receiver driving means (57) moves the latch receiver via a relay lever (55) to release the strain of the operation setting spring.

FIG. 1



EP 1 014 415 A1

Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a technique for improving a short circuit breaking performance of a circuit breaker.

Description of the Background Art

[0002] In brief, a structure of a circuit breaker includes a terminal connected to an electric circuit, opening/closing contacts connected to the terminal, an opening/closing mechanism operating the opening/closing contacts, a closing operation device closing the opening/closing contacts through the operation of the opening/closing mechanism, an overcurrent tripping device, a tripping mechanism opening the opening/closing contacts through the operation of the opening/closing mechanism when the overcurrent tripping device operates.

[0003] The overcurrent tripping device is constituted according to a circuit protection system from a combination of a long time tripping element performing a tripping operation after a relatively long time from starting of overcurrent flow, a short time tripping element performing the tripping operation after a predetermined short time from the starting of the overcurrent flow and an instantaneous tripping element performing the tripping operation instantaneously.

[0004] The opening/closing mechanism includes a toggle link mechanism having one end linked to the opening/closing contacts and another end linked to the tripping mechanism formed by latch means. The opening/closing mechanism is biased by a breaking spring in such a direction that the opening/closing contacts are opened. When the bent toggle link is extended through the closing operation, the opening/closing contacts contact. As closing retaining means supports the toggle link in its extended state, the contact state is maintained. Here, the contacts will be separated when the toggle link is bent by the operation of the tripping mechanism. Additionally, a contact pressure spring is provided for generating a contact pressure between the opening/closing contacts so that electromagnetic repulsion force that generated at the time of short-circuit Current flow would not separate the opening/closing contacts. The counteracting force of the contact pressure spring also has an effect on the toggle link to separate the openings/closing contacts.

[0005] The tripping mechanism includes latch means preventing displacement of a toggle link supporting member supporting the toggle link being biased as described above and a latch receiver preventing displacement of the latch means. When the operation of the overcurrent tripping device causes the operation of

latch receiver, the latch means is displaced and disengaged from the toggle link supporting member and the opening/closing contacts separate.

[0006] One role of the circuit breaker is to break a short-circuit current. The circuit breaker capable of breaking a high short-circuit current will be considered to have a high breaking performance. The present invention relates to two techniques for improving the breaking performance: one is a technique for separating the opening/closing contacts as soon as possible when the short-circuit current flows. Such conventional technique is disclosed in Japanese Utility Model Laying-Open No. 63-43797.

[0007] In the circuit breaker according to the conventional technique, when a short-circuit current of an amount equal to or higher than a predetermined value flows, the toggle link supporting member directly is disengaged from a member constituting the latch means (hereinafter referred to as a latch member), and the toggle link in its extended state is released and opening/closing contacts can be separated instantaneously without the process of a normal tripping operation by the overcurrent tripping device. With this operation, the sequential steps including the overcurrent tripping device operation, the latch receiver operation, displacement of the latch means, and displacement of the toggle link supporting member do not need to be performed. Hence, a time lag caused by a mechanical reason is eliminated and the faster separation of opening/closing contacts can be achieved.

[0008] The point of this technique lies in that the latch member is supported by the spring. In other words, electromagnetic repulsion force, generated so as to separate the opening/closing contacts when short-circuit current flows, acts the latch member to displace via the toggle link and the toggle link supporting member. When the short-circuit current equal to or higher than a predetermined amount flows, the acting force strains the spring and displaces the latch member, and the latch member and the toggle link supporting member are disengaged. This spring is an operation setting spring determining a predetermined value of the short-circuit current according to the above described function.

[0009] A second technique relating to the present invention relates to a closing performance at the occurrence of short circuit. Even when an electromagnetic repulsion force is generated due to the flow of short-circuit current in the circuit breaker in a dosed state, the opening/closing contacts would not open because of the contact pressure spring, and the toggle link is maintained in its extended state by the closing retaining means. On the other hand, when the short circuit is formed at the load side circuit of the circuit breaker in the open state, and the circuit breaker is closed (hereinafter this operation will be referred to as "short circuit closing operation"), the opening/closing contacts contact during the extension operation of the toggle link

mechanism from its bent state and a short-circuit current flows. To extend the toggle link at this timing, a closing force large enough to oppose the electromagnetic repulsion force in addition to the acting forces of the breaking spring and the contact pressure spring must be generated.

[0010] In many cases, a large scale circuit or an important circuit in particular is formed by a selective breaking system in which even when a short circuit is formed in one branch, a main circuit breaker continues to supply power to another branches. The main circuit breaker with such system is provided with an overcurrent tripping device constituted of a short time tripping element and not of an instantaneous tripping element to prevent the tripping operation while the short circuit current is broken by the circuit breaker of the branch where the short circuit occurs. When the short circuit closing operation is performed under a high short-circuit current for such main circuit breaker, the opening/closing contacts repeat opening operation and re-contacting operation due to the electromagnetic repulsion force because of the lack of instantaneous tripping operation and the insufficient closing force, then the circuit is damaged by the arc. Therefore, a large closing device is required to provide higher breaking capability.

[0011] A way to solve the problem in the short circuit dosing operation without the use of a large closing device is the use of an instantaneous tripping device at the time of closing (Making Current Release/MCR). A circuit breaker having the MCR function is formed such that the MCR separates the opening/closing contacts instantaneously when a current equal to or higher than a predetermined threshold value flows during the short circuit closing operation and the opening/closing contacts open after the operation of the overcurrent tripping device when the current flows in the closed state.

[0012] The conventional technique employing the MCR is disclosed in Japanese Patent Laying-Open No. 50-5872. The conventional MCR is an overcurrent tripping device utilizing an electromagnet where a movable core instantaneously attracted by a stationary core when a short-circuit current equal to or higher than a predetermined threshold value flows, wherein a block member operating in unison with an operation of the opening/closing mechanism is provided between the movable core and the stationary core. The MCR is located at such a position that the block member prevents the attraction of the movable core when the circuit breaker is in a dosed state, and is displaced from the position such that the blocking function does not work during the dosing operation.

[0013] The circuit breaker according to the conventional technique relating to the first technique described above has a structure where the toggle link is bent when the short-circuit current is broken by the direct disengagement of the toggle link supporting member and the latch member, and a large reset operation force is required to return the toggle link supporting member

back to the reset state.

[0014] In addition, in the circuit breaker having the MCR of the conventional art according to the second technique relating to the present invention, a time lag exists even in an instantaneous opening because it is performed through the process of the attraction of the movable core by the stationary core, the operation of the latch receiver, and the operation of the tripping mechanism in the short circuit closing operation.

SUMMARY OF THE INVENTION

[0015] Thus, an object of the present invention is to improve the short-circuit current breaking performance of the circuit breaker through the fastest possible opening of the opening/closing contacts and to simplify the reset operation, to allow an automatic reset or the like.

[0016] Another object of the present invention is to provide a small and inexpensive main circuit breaker with an MCR causing less time lag in the short circuit closing operation in a circuit with a selective breaking system.

[0017] To solve the above-described problems, a circuit breaker according to a first aspect of the present invention includes: opening/closing contacts; a breaking spring biasing the opening/closing contacts in an opening direction; a toggle link having one end linked to one of the opening/closing contacts; a toggle link supporting member supporting another end of the toggle link and receiving a biasing force from the breaking spring; latch means stopping displacement of the toggle link supporting member caused by the biasing force; a latch receiver stopping displacement of the latch means biased through the stoppage of the displacement of the toggle link supporting member; and an overcurrent tripping device displacing the latch receiver to release the stoppage by the latch means. In addition, the latch means includes engagement means A engaging with the latch receiver, engagement means B engaging with the toggle link supporting member, an operation setting spring biasing the engagement means and latch receiver driving means, and the engagement means are displaceable with respect to each other. When a short-circuit current equal to or higher than a first predetermined value flows through the circuit breaker, electromagnetic repulsion force generated between the opening/closing contacts acts on the engagement means B via the toggle link supporting member to strain the operation setting spring, the displacement of the engagement means B causes the toggle link supporting member disengaged, the opening/closing contacts separate, and the latch receiver driving means is displaced following the displacement of the engagement means B to displace the latch receiver, thus disengaging the engagement means A.

[0018] When a short-circuit current flows through the circuit breaker having the above described structure, the electromagnetic repulsion force generated

between the opening/closing contacts acts the toggle link supporting member to displace via the toggle link. Though the latch means is also acted by the above action, as engagement means A thereof is stopped by the latch receiver, the acting force of the toggle link supporting member acts engagement means B to displace via an operation setting spring. When the magnitude of short-circuit current is high enough to strain the operation setting spring by the acting force, engagement means B is displaced and disengaged from the toggle link supporting member, the toggle link supporting member is displaced and the opening/closing contacts open. As these operations are performed regardless of delayed operation of the overcurrent tripping device and the mechanism performing a sequence of various mechanical operations such as the disengagement from the latch member caused by the displacement of the latch receiver, the opening/closing contacts separate rapidly.

[0019] Further, engagement means B displaced in this operation facilitates the return of the toggle link supporting member because latch receiver driving means displaces the latch receiver and thus engagement means A regardless of the operation of the overcurrent tripping device to eliminate the strain of the operation setting spring.

[0020] Such instantaneous opening operation and simplified reset operation are performed when the current exceeds the threshold value, even in case the circuit breaker is in closed state or the short circuit dosing operation is performed.

[0021] The effect obtained from the circuit breaker according to one aspect of the present invention described above is achieved more effectively in a circuit breaker in which engagement means A and engagement means B forming the latch means are levers provided on a same shaft, a circuit breaker in which the latch receiver driving means is a lever provided on the engagement means A rotating following displacement of the engagement means B and a circuit breaker in which a relay lever linking the latch receiver driving means and the engagement means B is provided on the engagement means A.

[0022] A circuit breaker according to another aspect of the present invention further includes in the engagement means A, an operation control lever controlling a current of the first predetermined value and an operation control spring acting the operation control lever engaging with the engagement means B in a direction to prevent the displacement of the engagement means B displaceable in a direction to disengage the toggle link supporting member in one of above described circuit breakers including the circuit breaker according to one aspect of the present invention.

[0023] With such structure, an acting force overcoming the action of the operation control spring as well as the action of the operation setting spring must be applied to the engagement means via the toggle link

supporting member in order to disengage engagement means B from the toggle link supporting member. In other words, a current of the first predetermined value can be set to a higher value.

[0024] A circuit breaker according to still another aspect of the present invention further includes a closing operation member closing the circuit breaker by extending the toggle link from bent state; and lock means not preventing the displacement when the engagement means B is displaced in the course of the extension of the toggle link and preventing the displacement when the engagement means B is displaced after the extension, through displacement following the displacement of the closing operation member in a closing operation, in one of above described circuit breaker including the circuit breaker according to one or another aspect of the present invention.

[0025] Even when a short-circuit current equal to or higher than the first predetermined value flows through such circuit breaker in the closed state, as the engagement of engagement means B and the toggle link supporting member is maintained to prevent the displacement of engagement means B by the lock member, the effect in the circuit breaker according to the one aspect described above is not exhibited. Therefore, the tripping operation is performed through the sequential process of: operation of the overcurrent tripping device, the displacement of the latch receiver, the displacement of engagement means B together with engagement means A, displacement of the toggle link supporting means, and the opening of the opening/closing contacts.

[0026] In addition, when the short-circuit current equal to or higher than the first predetermined value flows at the short circuit closing operation of the circuit breaker, engagement means B is displaced because the lock member does not exert its locking function and is disengaged from the toggle link supporting member and the same effect as in the circuit breaker according to the first aspect described above is exhibited.

[0027] In the circuit breaker provided with a relay lever with an engagement end engageable with the lock means, even when a current equal to or higher than the first predetermined value flows in the closed state, the opening/closing contacts do not open because the displacement of engagement means B is prevented by the lock of the relay lever.

[0028] In the circuit breaker where the lock means is displaced by the biasing force of engagement means B and the locking function is removed when a short-circuit current equal to or higher than the second predetermined value flows in the dosed state, the lock means is displaced by the force received from engagement means B and the locking function is removed when the short-circuit current equal to or higher than the second predetermined value flows in the closed state.

[0029] In the circuit breaker, the breaking operation is not performed until the operation of the overcurrent

tripping device is carried out when a current flowing in the closed state is less than the second predetermined value and the breaking operation is performed instantaneously when the current is equal to or higher than the second predetermined value.

[0030] The foregoing and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031]

Fig. 1 is a sectional side view of a circuit breaker in a closed state according to the first embodiment of the present invention;

Fig. 2 is a perspective view of a main portion of an opening/closing mechanism of Fig. 1;

Fig. 3 is a perspective view of latch means of Fig. 1;

Fig. 4 is a schematic view of a main portion of an opening/closing mechanism in a closed state;

Fig. 5 is a view of an opening/closing mechanism in an open state before reset corresponding to that of Fig. 4;

Fig. 6 is a view of an opening/closing mechanism in an open state after reset corresponding to that of Fig. 4;

Fig. 7 is a view of an opening/closing mechanism at an instant of contact of the opening/closing contacts corresponding to that of Fig. 4;

Fig. 8 is a schematic view of latch means in a closed state;

Fig. 9 is a view of latch means in an open state before reset corresponding to that of Fig. 8;

Fig. 10 is a view of latch means in an open state after reset corresponding to that of Fig. 8;

Fig. 11 is a view of latch means at an instant of contact of the opening/closing contacts corresponding to that of Fig. 8;

Fig. 12 shows a main portion of latch means in a dosed state of a circuit breaker according to the second embodiment of the present invention;

Fig. 13 is a schematic side view of latch means in a closed state in a circuit breaker shown in Fig. 12; and

Fig. 14 is a view of latch means in an open state before reset corresponding to Fig. 13.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0032] Embodiments of a circuit breaker according to the present invention will be described with reference to Figs. 1 to 14.

First Embodiment

[0033] A circuit breaker according to the first embodiment of the present invention shown in Figs. 1 to 11 includes a contact unit 1 with opening/closing contacts and an opening/closing mechanism unit 2 controlling opening/closing of the opening/dosing contacts.

[0034] As shown in Fig. 1, contact unit 1 is disposed on an insulating molding 3 and includes power supply side and load side terminals 4, 5, power supply side and load side stationary side contact units 6, 7, a movable contact 8 separating from and contacting with both stationary side contact units 6, 7, a movable contact point 22 provided on movable contact 8, a movable contact holder 9 of an insulating member holding movable contact 8, and guide means not shown guiding movable contact holder 9 right and left. In addition, contact unit 1 includes a rotatably held cross-bar 10, a contact lever 11 rotating together with cross-bar 10, a contact lever shaft 12 linking movable contact holder 9 and contact lever 11, a toggle roller 13 attached on to contact lever 11 and arc-extinguishing devices 14, 15 corresponding to the power supply side and the load side extinguishing arc generated at the breaking of the current by the circuit breaker.

[0035] Stationary contact unit 6 includes a stationary contact 18 on a stationary contact mould 16 rotatable about a shaft 17, a stationary contact point 21 on stationary contact 18, a contact pressure spring 23 generating a contact pressure between stationary contact point 21 and a movable contact point 22, a pair of relay contacts 19 electrically connecting stationary contact 18 and power supply side terminal 4 and a spring 20 generating a contact pressure on relay contact 19. Here, stationary side contact unit 7 is arranged symmetrically with stationary side contact unit 6 and the description thereof is not provided because the structures of the two are the same.

[0036] Opening/closing mechanism unit 2 includes a closing operation device and is arranged on a frame 25 as shown in Figs. 1 to 3. The dosing operation device is not a main portion of the present invention and the detailed description and drawing thereof will not be provided. The dosing operation device includes a closing spring 26 charged by charging means constituted of an electric motor and a ratchet mechanism according to the conventional art arranged between a stationary pin 67 and a pin 68 of an operation lever 27.

[0037] Operation lever 27 rotating back and forth in accordance with discharge and charge of closing spring 26 is rotatably provided on a shaft 28. A closing operation member 29 and a closing holding latch 30 on a shaft 31, a toggle link supporting member 32 on a shaft 33, a toggle cam 34 on a shaft 35, latch means 36 on a shaft 37, a trip actuator 38 on a shaft-like latch receiver 39, a trip button 40 and a closing button 41 of the same shape on a shaft 42 in line, and an operation lever roller 43 on operation lever 27 are each provided rotatably.

[0038] Further, the toggle link includes an upper toggle link 44 and a lower toggle link 46. Toggle cam 34 and upper toggle link 44 are rotatably linked by a shaft 45. Toggle link supporting member 32 and lower toggle link 46 are rotatably linked by a shaft 47, and upper toggle link 44 and lower toggle link 46 are rotatably linked by a link shaft 49 including a link shaft roller 48. Here, a breaking spring 51 biasing contact lever 11 to rotate anti-clockwise is attached between contact lever shaft 12 of contact unit 1 and a stationary pin 50 attached to opening/closing mechanism unit 2.

[0039] Latch means 36 includes engagement means A 52 and engagement means B 53 rotatably held on shaft 37 as shown in detail in Fig. 3 and Figs. 8-11. In engagement means A 52, a relay lever 55 bent in a U-shape and latch receiver driving means 57 are rotatably provided on a shaft 54 and a shaft 56, respectively. One end of engagement means B 53 and one end of relay lever 55 are linked via a link pin 58 and another end of relay lever 55 and one end of latch receiver driving means 57 are linked via a link pin 59 such that these lever members rotate in connection with each other. A roller 65 is attached to another end of latch receiver driving means 57 and disposed to face an actuator 60 provided on latch receiver 39. An engagement end 55a formed in relay lever 55 is engageable with an engagement edge 61a of lock means 61 attached to closing retaining latch 30.

[0040] Further, a trip roller 62 is rotatably held on another end of engagement means B 53 and an operation setting spring 63 is provided between engagement means A 52 and another end of engagement means B 53, thus relatively biasing engagement means B 53 to rotate clockwise.

[0041] The closed state of the circuit breaker will be described with reference to Figs. 1, 2, 3 and 8. In the closed state, spring forces of breaking spring 51 and contact pressure spring 23 are applied on toggle link supporting member 32 via movable contact 8, movable contact holder 9, contact lever 11, toggle roller 13, toggle cam 34 and upper toggle link 44 and lower toggle link 46 in an extended state, thus biasing toggle link supporting member 32 to rotate anti-clockwise. The biasing force of rotation applied on toggle link supporting member 32 is delivered to engagement means B 53 via trip roller 62 in engagement with an engagement edge 32a of the toggle link supporting member and biases engagement means B 53 to rotate anti-clockwise. The biasing force of rotation of engagement means B 53, however, is not large enough to extend operation setting spring 63. Then, a trip roller shaft 24 engages with an edge portion 52b of engagement means A 52 and engagement means A 52 is biased to rotate anti-clockwise together with engagement means B 53. Engagement means A 52 biased to rotate in this way is prevented from rotation by an engagement edge 52a engaging with a stop portion of latch receiver 39 formed in a semicircular shape in section.

[0042] Upper side toggle link 44 and lower side toggle link 46 are biased to bend in a dogleg shape, which is similar to the shape of the calculation mark of "greater than (>)", by a spring force of contact pressure spring 23 or the like. They are maintained in an extended state with link shaft roller 48, which is a link portion thereof, supported by a cam edge 29a of closing operation member 29. In addition, engagement edge 55a of the relay lever opposes to engagement edge 61a of the lock means.

[0043] Further, closing retaining latch 30 described above is arranged coaxially with closing operation member 29 such that they can rotate independently from each other. Closing retaining latch 30 is biased by a returning spring not shown to rotate anti-clockwise and prevented from rotating by stopper means not shown as it takes a position where a retaining engagement edge 30a faces with link shaft 49.

[0044] Here, Fig. 1 shows the state of closing spring 26 after the discharge. In the circuit breaker, closing spring 26 can be automatically charged after the completion of closing operation. In this case, when the charging operation starts in the state of Fig. 1 immediately after the closing operation, operation lever 27 rotates clockwise, closing operation member 29 rotates anti-clockwise following the displacement of operation lever roller 43. As link shaft roller 48 moves slightly rightward along cam edge 29a, closing retaining latch 30 comes to engage with link shaft 49 instead of link shaft roller 48 and closing operation member 29, and maintains the extension of the toggle link. Figs. 2 and 4 show the state of closing operation member 29 after the completion of its rotation.

[0045] Next, an operation of the circuit breaker when it is manually operated to turn from the closed state to the open state will be described.

[0046] When trip button 40 is pushed, latch receiver 39 rotates anti-clockwise via the action of the link member whose detailed description was not provided and trip actuator 38. The rotation of latch receiver 39 causes disengagement of engagement edge 52a, and then engagement means A 52 rotates anti-clockwise together with engagement means B 53, and disengaged from trip roller 62, and toggle link supporting member 32 rotates anti-clockwise. Following this rotation, lower toggle link 46 and upper toggle link 44 are displaced lower leftward. Then toggle cam 34 rotates clockwise, contact lever 11 rotates anti-clockwise, and movable contact point 22 separates from stationary contact point 21. After the separation, movable contact 8 moves further leftward due solely to the action of breaking spring 51, thus two contact points are spaced apart by a predetermined distance and the open state is established. The main portion of the opening/dosing mechanism in this condition is shown in Fig. 5. Fig. 9 shows latch means 36, where trip roller 62 is located on cam edge 32b of the toggle link supporting member. Here, the same operation will be performed at the oper-

ation of an over current tripping device 64 with the driving of trip actuator 38.

[0047] Next is the description of an operation of the circuit breaker when it is reset in the open state. Provided that the circuit is in the open state shown in Figs. 5 and 9, when closing spring 26 is charged, operation lever 27 rotates clockwise and, closing operation member 29 rotates anti-clockwise due to the action of returning spring not shown following the displacement of operation lever roller 43. As link shaft roller 48 is displaced rightward along the cam surface of closing operation member 29 and reaches a cam edge 29b of a recess shape, the toggle link is bent in a dogleg shape similar to the shape of mark (>). Then, closing retaining latch 30 comes to a state shown in Fig. 6 where a cam edge 30b engages with link shaft 49. Here, when the circuit opening operation is performed while closing spring 26 is automatically charged after the completion of closing, the toggle link bends and takes a dogleg shape similar to the shape of mark (>) directly from the state shown in Fig. 5.

[0048] Further, toggle link supporting member 32 is rotated clockwise by a returning spring not shown and is prevented from rotation by stopper means not shown, then trip roller 62 becomes engageable with engagement edge 32a of the toggle link supporting member as shown in Fig. 6. On the other hand, engagement means A 52 is rotated clockwise by a returning spring not shown and latch receiver 39 is also rotated clockwise by a returning spring not shown and each prevented from rotation by stopper means not shown, and then engagement end 52a of engagement means A becomes engageable with latch receiver 39 as shown in Fig. 10.

[0049] Next, a closing operation of the circuit breaker will be described. When closing button 41 is pushed in a reset state shown in Figs. 6 and 10, closing latch mechanism, whose detailed description was not provided, is disengaged, closing spring 26 is discharged and operation lever 27 rotates anti-clockwise. The rotation causes the clockwise rotation of closing operation member 29 via operation lever roller 43 and link shaft roller 48 moves leftward along cam surface 29a from recessed cam surface 29b of the closing operation member, stretching the toggle link. Following the extension, toggle cam 34 rotates anti-clockwise, contact lever 11 rotates clockwise via toggle roller 13, and movable contact 8 moves rightward making movable contact point 22 contact with stationary contact point 21. After the contact, movable contact 8 moves further slightly rightward and causes stationary contact 18 rotate anti-clockwise against the spring force of contact pressure spring 23, forming the dosed state shown in Fig. 1.

[0050] During the closing operation, link shaft 49 is displaced while sliding cam edge 30b and rotating closing retaining latch 30 clockwise. Closing retaining latch 30 rotates back when cam edge 30b and link shaft 49 are disengaged, and is further rotated anti-clockwise by the returning spring. The rotation is stopped by stopper

means at a position shown in Fig. 1 where retaining engagement edge 30a opposes to link shaft 49.

[0051] In addition, during the operation, engagement edge 32a of toggle link supporting member 32 engages with trip roller 62 and engagement edge 52a of engagement means A engages with latch receiver 39.

[0052] The foregoing is the description of manual operation of opening, reset, and closing of the circuit breaker. Next is the description of an operation when a short-circuit current flows through the circuit breaker.

[0053] First, in the short circuit closing operation, during the closing operation described above, a short-circuit current flows at an instant movable contact point 22 contacts with stationary contact point 21 shortly before the completion of change to the closed state shown in Fig. 1. At this moment, in the main portion of the opening/closing mechanism, closing operation member 29 is rotating and link shaft 49 is moving as shown in Fig. 7. As closing retaining latch 30 is rotating clockwise following the displacement of link shaft 49, engagement end 55a of the relay lever and engagement edge 61a of the lock means are not in an opposing state as shown in Fig. 11. In other words, relay lever 55 is in a rotatable state.

[0054] Thus, at the instant two contact points contact, a large acting force, which is a sum of acting force generated during the normal closing operation and electromagnetic repulsion force generated between two contact points, is applied on toggle link supporting member 32, biasing and making it rotate anti-clockwise, then engagement means B 53 and engagement means A 52 are biased and rotate anti-clockwise via trip roller 62. When the amount of short-circuit current is equal to or higher than a first predetermined value which is a threshold value allowing the extension of operation setting spring by rotation biasing force, engagement means A 52 does not rotate and engagement means B 53 rotates anti-clockwise. Then, sequentially, trip roller 62 is disengaged from engagement edge 32a, toggle link supporting member 32 rotates anti-clockwise, movable contact point 22 instantly separates from stationary contact point 21, thus the short-circuit current is broken.

[0055] A returning spring not shown cannot cause clockwise rotation of toggle link supporting member 32 immediately after the rotation of toggle link supporting member 32 because a large force of operation setting spring 63 in the extended state acts on a cam edge 32b via trip roller 62 even when the closing spring is in a charged state.

[0056] With the anti-clockwise rotation of latch receiver driving means 57 via relay lever 55 during the above described operation, roller 65 pushes actuator 60, latch receiver 39 rotates anti-clockwise, latch receiver 39 is disengaged from engagement end 52a, engagement means A 52 rotates anti-clockwise, edge 52b of engagement means A engages with trip roller shaft 24, and engagement means A and engagement means B comes to a mated state. At the same time, the

act of operation setting spring 63 on toggle link supporting member 32 is removed, and toggle link supporting member 32 and engagement means A52 come to a free state, in other words become rotatable by respective returning spring, thus forming the same state as immediately after the manual circuit opening described above.

[0057] Thus, when the short-circuit current of an amount equal to or higher than the first predetermined value determined by the extension of operation setting spring 63 flows during the short circuit dosing operation, trip roller 62 is disengage from toggle link supporting member 32 and the opening/dosing contacts instantaneously separate before the rotation of latch receiver 39 caused by the operation of the overcurrent tripping device and in addition, the reset is simplified. Here, when the short-circuit current is lower than the first predetermined value, short-circuit current is broken when the normal closing operation is completed, forming the closed circuit and overcurrent tripping device 64 operates.

[0058] Next, when a short-circuit current equal to or higher than the first predetermined value flows in the circuit breaker in the dosed state, relay Lever 55 is biased via engagement means B 53 to rotate clockwise due to the large acting force, which is a sum of contact pressure and electromagnetic repulsion force of breaking spring 51 and two contact points. Unlike the short circuit closing operation, when relay lever 55 rotates slightly from the state shown in Fig. 8, engagement end 55a engages with engagement edge 61a of the lock means and the rotation thereof is prevented. Through the prevention of the rotation of relay lever 55, the rotation of engagement means B 53 is also prevented and toggle link supporting member 32 does not rotate neither. In addition, as neither latch receiver driving means 57 nor engagement means A 52 rotate, instantaneous breaking of the short-circuit current does not occur. When overcurrent tripping device 64 operates, short-circuit current is broken.

[0059] Here, for the prevention of the rotation of relay lever 55, it is sufficient to make the engagement of engagement end 55a of the relay lever and engagement edge 61a of the lock means take either of the following states. In a first state, engagement is achieved at an angle where rotation biasing force of relay lever 55 biases lock means 61 such that it rotates anti-clockwise. In this case, locking function is exhibited because lock means 61 is prevented from anti-clockwise rotation by stopper means not shown. In a second state, engagement is achieved in an angel where lock means is biased to rotate clockwise but the biasing force applied to lock means is not large enough to realize the rotation. When the structure is formed so as to achieve the second state, lock means 61 can be rotated clockwise by the biasing force applied via relay lever 55 if the short-circuit current is high. Thus, when a short-circuit current equal to or higher than a second predetermined value,

which is a threshold value allowing the rotation, flows, toggle link supporting member 32 rotates as in the case of short circuit closing operation and the opening/closing contact points can be made separate instantaneously to break the short-circuit current. In other words, when the short-circuit current flowing in the closed state is lower than the second predetermined value, the breaking is performed after the operation of overcurrent tripping device 64, whereas when the current is equal to or higher than the second predetermined value, the breaking is performed instantaneously.

[0060] The second predetermined value can be changed according to the engagement angle of the engagement edge of the lock means and the engagement end of the relay lever described above as well as to the spring force of the returning spring of closing retaining latch 30 having the lock means attached thereto. Therefore, provided that the second predetermined value is a limit value below which the opening/closing contacts in the closed state do not separate by the electromagnetic repulsion force, no damage will be caused by the electromagnetic repulsion force and the selective breaking is allowed at the value not higher than the second predetermined value, and the higher short-circuit current can be broken though the selective breaking cannot be achieved at the value not less than the second predetermined value. Thus the overall range of application is widened.

[0061] In the embodiment described above, lock means 61 is integrally arranged with closing retaining latch 30 so as to rotate in combination therewith. Alternatively, lock means 61 and closing retaining latch 30 can be provided on the same shaft such that two operate in combination in a normal opening/closing operation and operate separately when relay lever 55 biases lock means 61 to rotate.

[0062] The embodiment described above includes lock means and is provided with MCR function. It is obvious, however, that short-circuit current can be broken instantaneously when a short-circuit current equal to or higher than the first predetermined value flows in either of the closed state or in the short circuit closing operation by removing lock means.

Second Embodiment

[0063] In the circuit breaker of the first embodiment described above, a current of the first predetermined value is determined mainly by operation setting spring 63. In such a structure, however, a larger operation setting spring is required to increase the current of the first predetermined value. In the circuit breaker of the second embodiment described below, the current of the first predetermined value can be increased with the addition of some components to the circuit breaker of the first embodiment.

[0064] In Figs. 12 and 13, a main portion of the circuit breaker of the second embodiment is shown in the

closed state. The circuit breaker includes, adding to the structure of first embodiment, an operation control lever 71 rotatably attached on a shaft 70 on engagement means A 52, and an operation control spring 72 provided between one arm 71a of operation control lever 71 and a pin 73 on engagement means A 52. In Fig. 13, operation control lever 71 is biased anti-clockwise by operation control spring 72 and the rotation thereof is prevented by another arm 71b in contact with trip roller shaft 24 which is a central axis of trip roller 62.

[0065] Similar to the first embodiment, when a high short-circuit current flows through the circuit breaker of the second embodiment with the structure described above, engagement means B rotates anti-clockwise, trip roller 62 is disengaged from toggle link supporting member 32 and the circuit is opened without the operation of the overcurrent tripping device. When engagement means B rotates during the process of circuit opening operation of the circuit breaker of the second embodiment, trip roller shaft 24 engages with a control engagement edge 71c formed on another arm of operation control lever 71 and makes operation control lever 71 rotate clockwise against operation control spring 72.

[0066] With the structure and operation as described above, the circuit breaker of the second embodiment will not come to the open state when a biasing force applied on control engagement edge 71c of the operation control lever from trip roller shaft 24 is smaller than the acting force of operation control spring 72. Therefore, with the addition of operation control lever 71 and operation control spring 72, the current of the first predetermined value can substantially be increased. In addition, as rotation moment on operation control lever 71 from operation control lever shaft 24 becomes smaller as the locations of a contact point of control engagement edge 71c of operation control lever 71 and trip roller shaft 24, the center of trip roller shaft 24 and the center of shaft 70 come to be aligned like a line, the current of the first predetermined value can substantially be increased even if the acting force of operation control spring 72 is small.

[0067] Here, trip roller 62 is on engagement edge 32b and operation control lever 71 is in a state where anti-clockwise rotation is prevented with corner upper edge 71d of operation control lever 71 being in contact with trip roller shaft 24 after the disengagement from engagement edge 32a of the toggle link supporting member as shown in Fig. 14. Similar to the first embodiment, when engagement edge 52a of engagement means is disengaged from latch receiver 39, engagement means 52 rotates anti-clockwise and trip roller 62 returns onto engagement edge 32a of the toggle link supporting member, operation control lever 71 rotate anti-clockwise following the movement of trip roller shaft 24 and trip roller shaft 24 and another arm 71b of the operation control lever engage again.

[0068] Although the present invention has been described and illustrated in detail, it is clearly under-

stood that the same is by way of illustration and example only and is not to be taken by way of limitation, the spirit and scope of the present invention being limited only by the terms of the appended claims.

Claims

1. A circuit breaker comprising:

opening/closing contacts (8, 18);
 a breaking spring (51) biasing said opening/closing contacts in an opening direction;
 a toggle link (44, 46) having one end linked to one of said opening/closing contacts (8);
 a toggle link supporting member (32) supporting another end of said toggle link and receiving a biasing force from said breaking spring;
 latch means (36) stopping displacement of the toggle link supporting member caused by said biasing force;
 a latch receiver (39) stopping displacement of said latch means biased through the stoppage of the displacement of said toggle link supporting member; and
 an overcurrent tripping device (64) displacing said latch receiver to release the stoppage by said latch means; wherein
 said latch means including engagement means A (52) engaging with said latch receiver, engagement means B (53) engaging with said toggle link supporting member, an operation setting spring (63) biasing said engagement means and latch receiver driving means (57), said engagement means being displaceable with respect to each other;
 when a short-circuit current equal to or higher than a first predetermined value flows through said circuit breaker, electromagnetic repulsion force generated between said opening/closing contacts acts on said engagement means B via said toggle link supporting member to strain said operation setting spring, the displacement of said engagement means B causes said toggle link supporting member disengaged, said opening/closing contacts separate, and said latch receiver driving means is displaced following the displacement of said engagement means B to displace said latch receiver, thus disengaging said engagement means A.

2. The circuit breaker according to claim 1 wherein engagement means A and engagement means B forming said latch means are levers provided on a same shaft (37).

3. The circuit breaker according to claim 1 or 2 wherein said latch receiver driving means is a lever provided on said engagement means A rotating fol-

lowing displacement of said engagement means B.

4. The circuit breaker according to one of claims 1 to 3
wherein a relay lever (55) linking said latch receiver
driving means and said engagement means B is 5
provided on said engagement means A.

5. The circuit breaker according to one of claims 1 to 4
wherein said engagement means A is provided with
an operation control lever (71) controlling a current 10
of said first predetermined value and an operation
control spring (72) acting said operation control
lever engaging with said engagement means B in a
direction to prevent the displacement of said
engagement means B displaceable in a direction to 15
disengage said toggle link supporting member.

6. The circuit breaker according to one of claims 1 to 5
further comprising 20

a closing operation member (29) closing said
circuit breaker by extending said toggle link
from bent state and
lock means (61) not preventing the displace-
ment when said engagement means B is dis- 25
placed in the course of the extension of said
toggle link and preventing the displacement
when said engagement means B is displaced
after the extension, through displacement fol-
lowing the displacement of said closing opera- 30
tion member in a closing operation.

7. The circuit breaker according to claim 6 wherein
said relay lever is provided with an engagement
end (55a) engageable with said lock means. 35

8. The circuit breaker according to claim 6 or 7
wherein said lock means is displaced by a force
received from said engagement means B to disen-
gage said lock means when a short-circuit current 40
of an amount equal to or higher than a second pre-
determined value flows in a closed state.

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FIG. 1

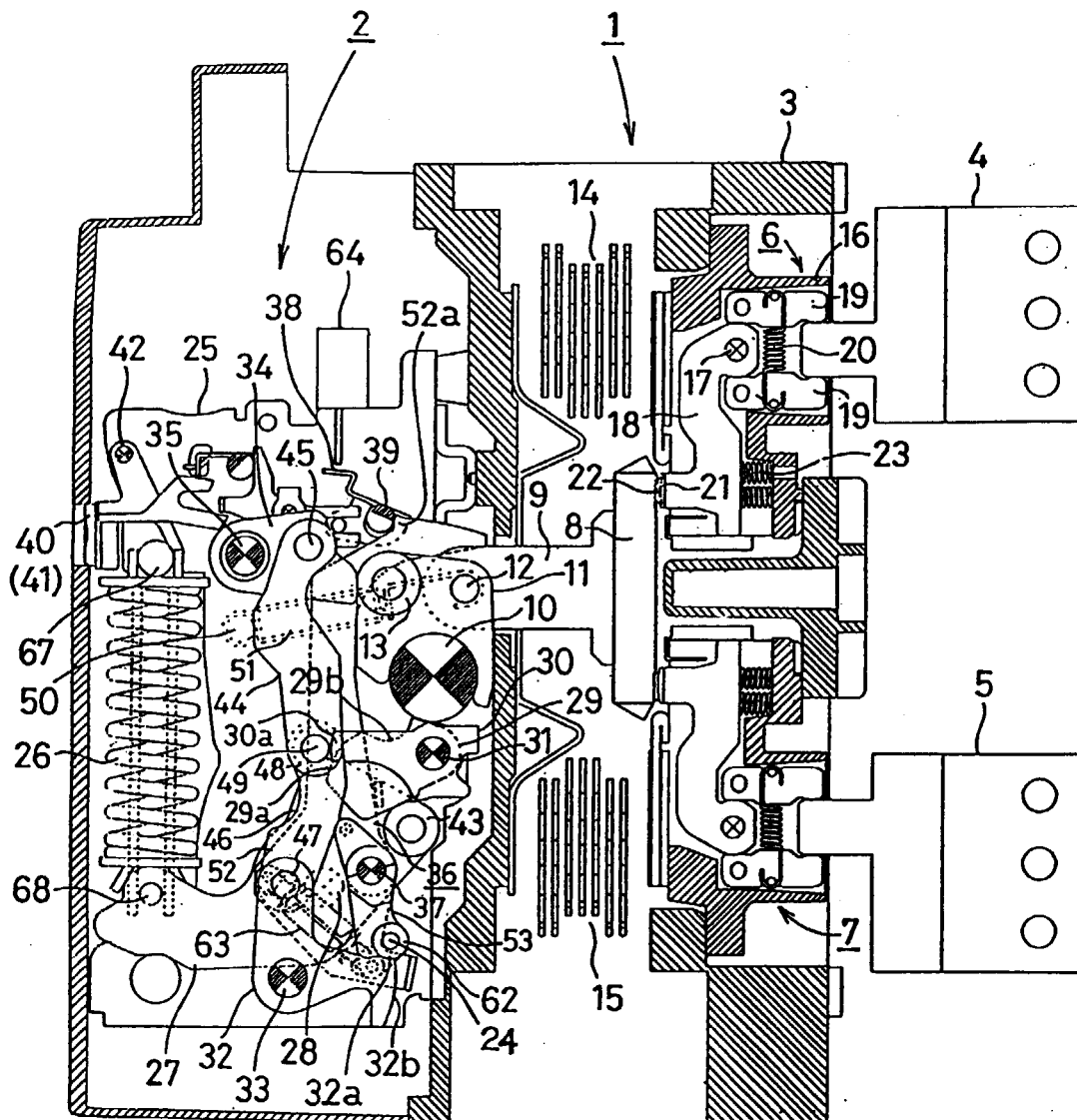


FIG. 2

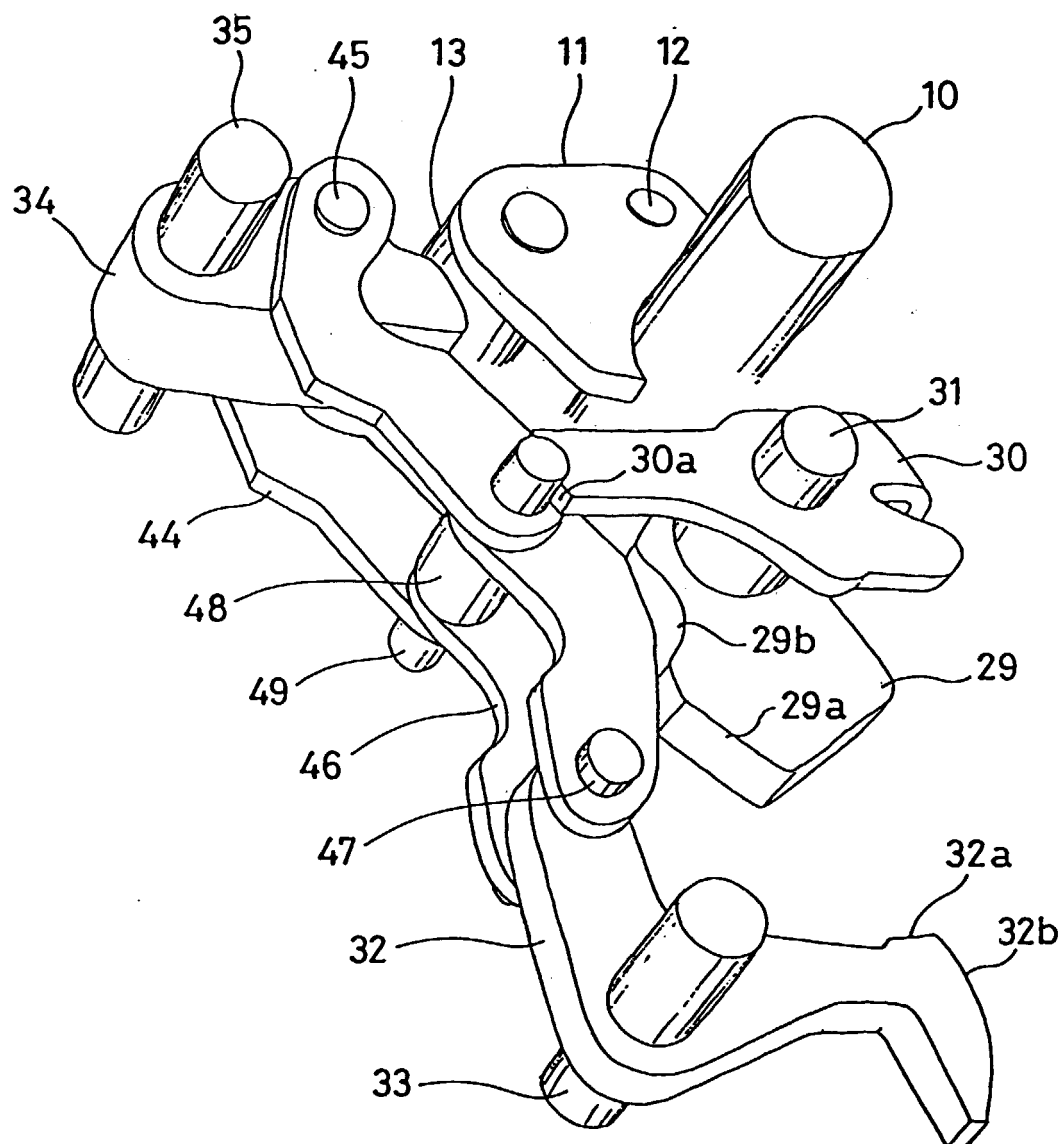


FIG. 3

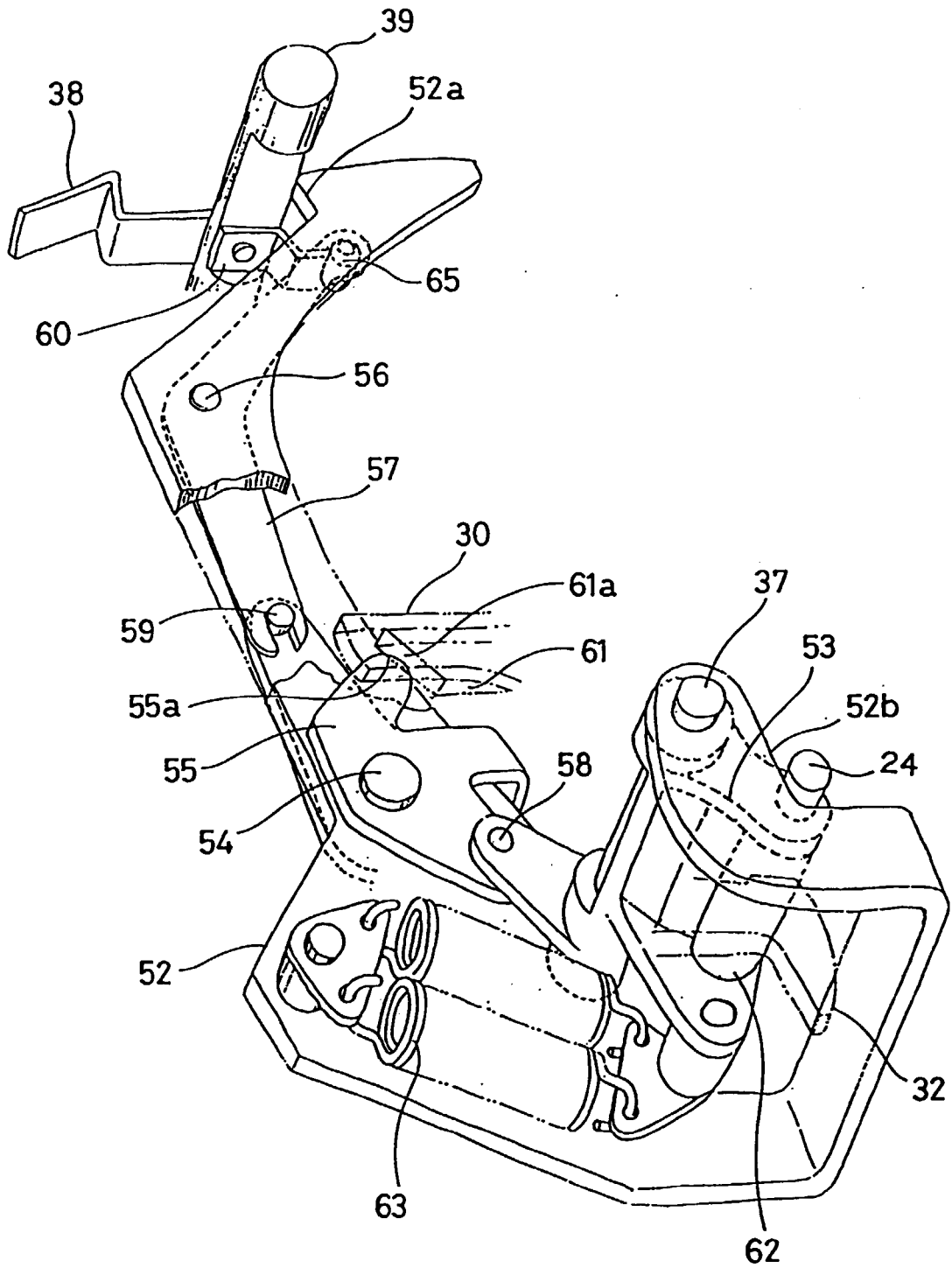


FIG. 4

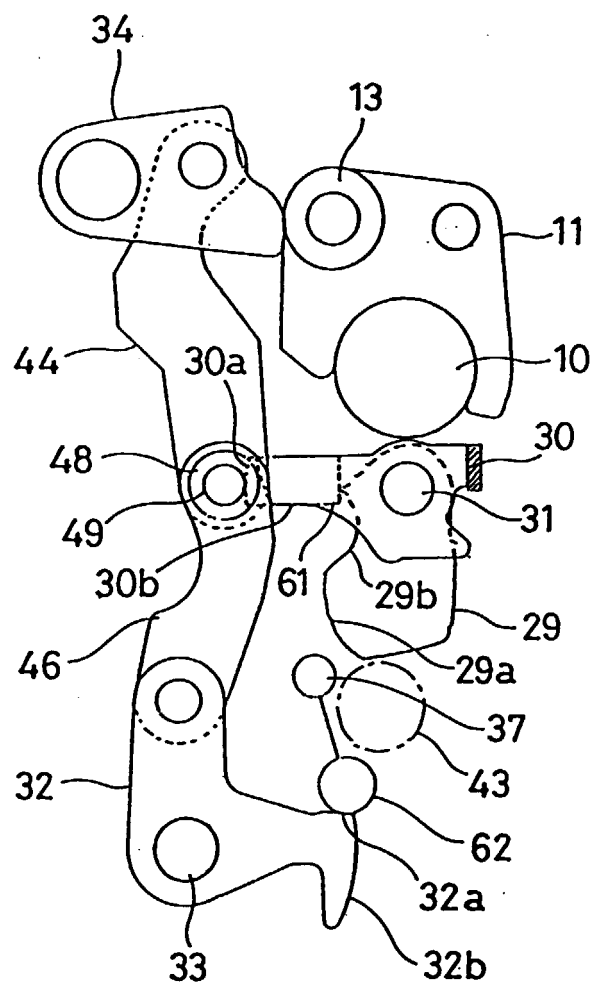


FIG. 5

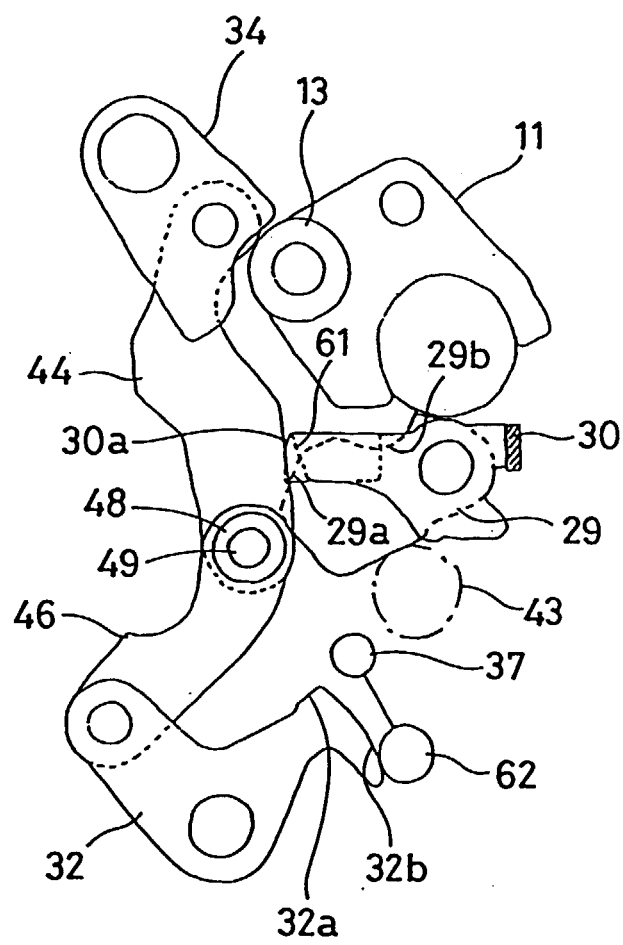


FIG. 6

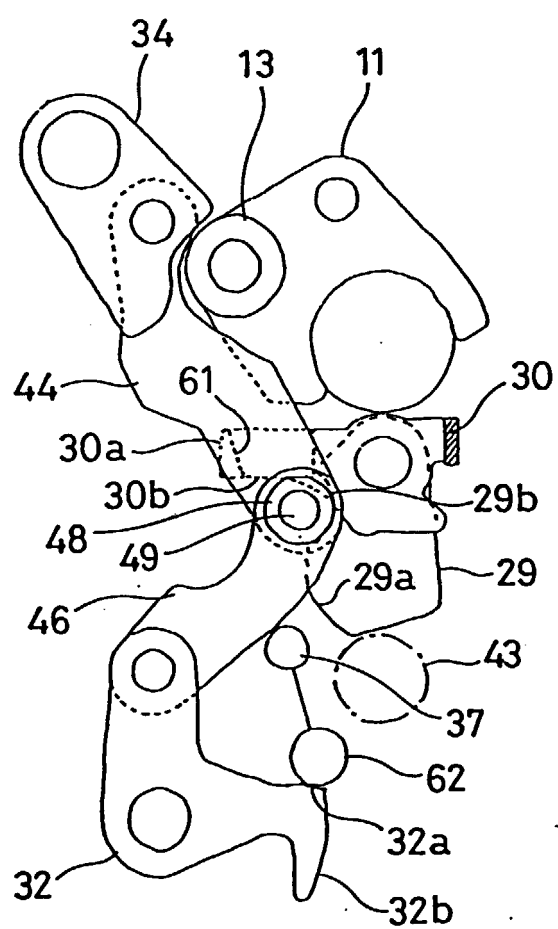


FIG. 7

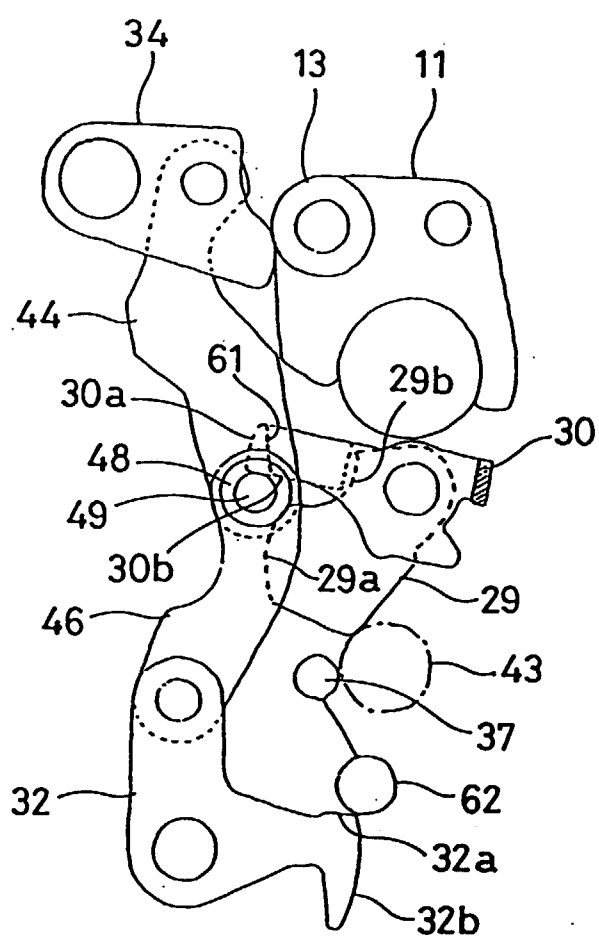


FIG. 8

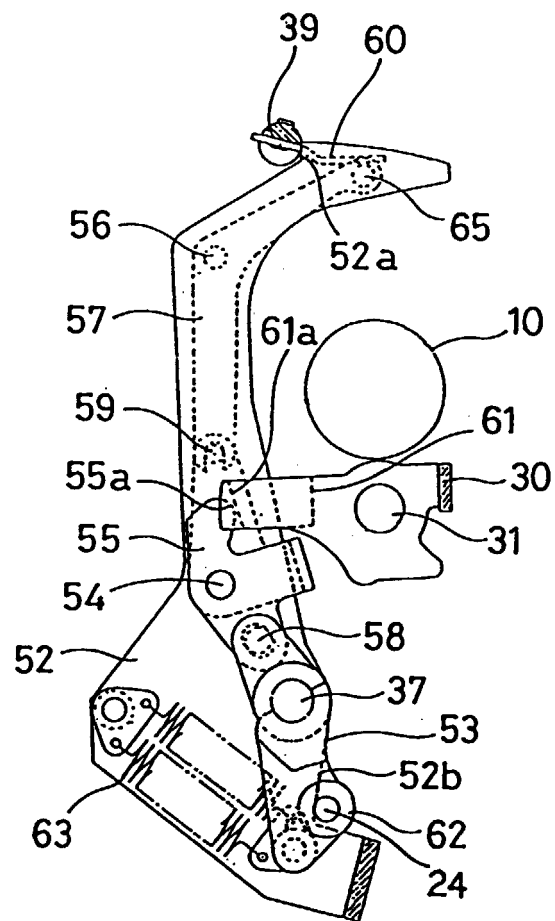


FIG. 9

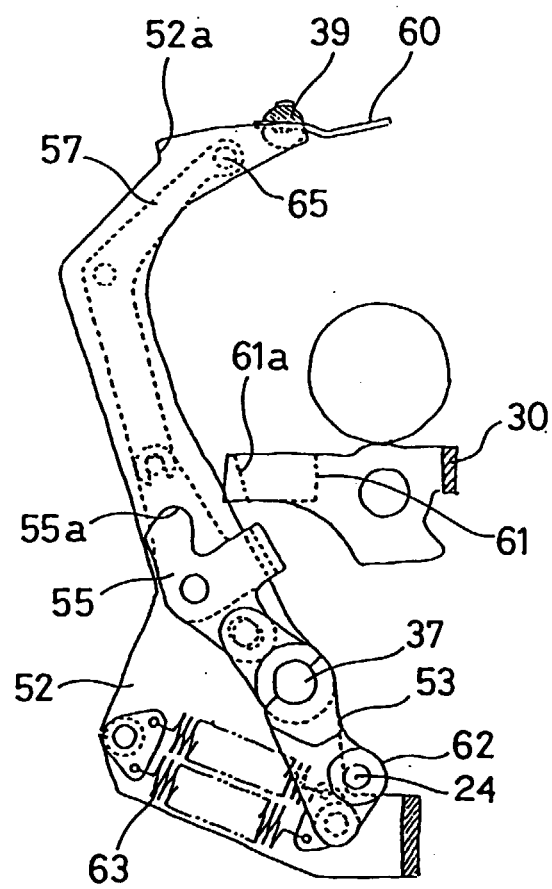


FIG. 10

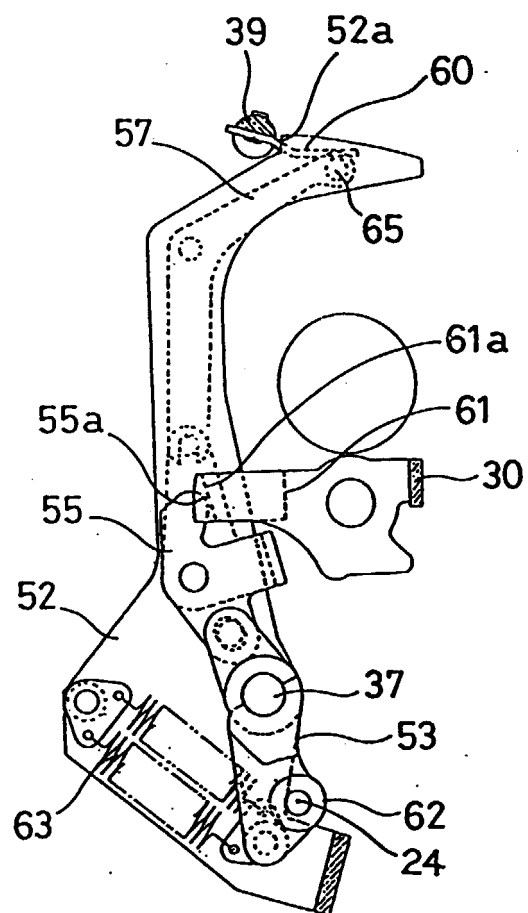


FIG. 11

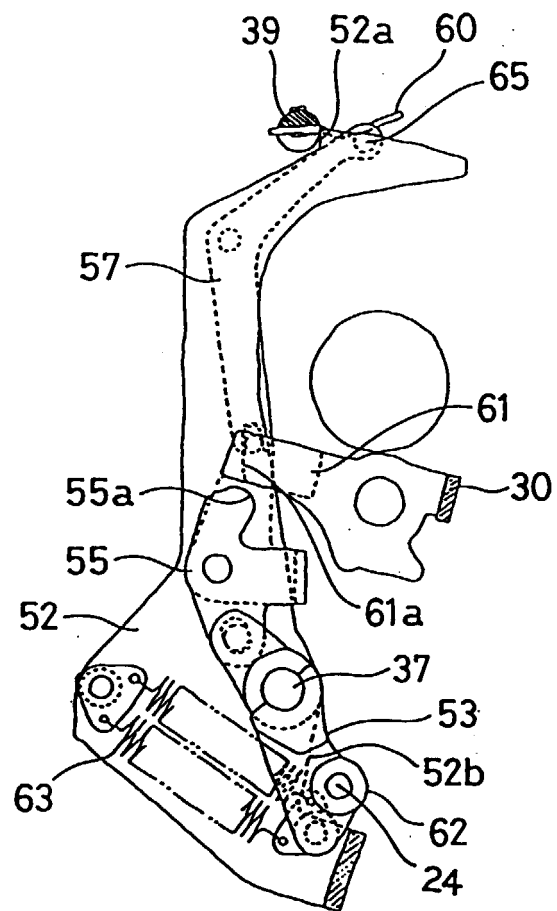


FIG. 12

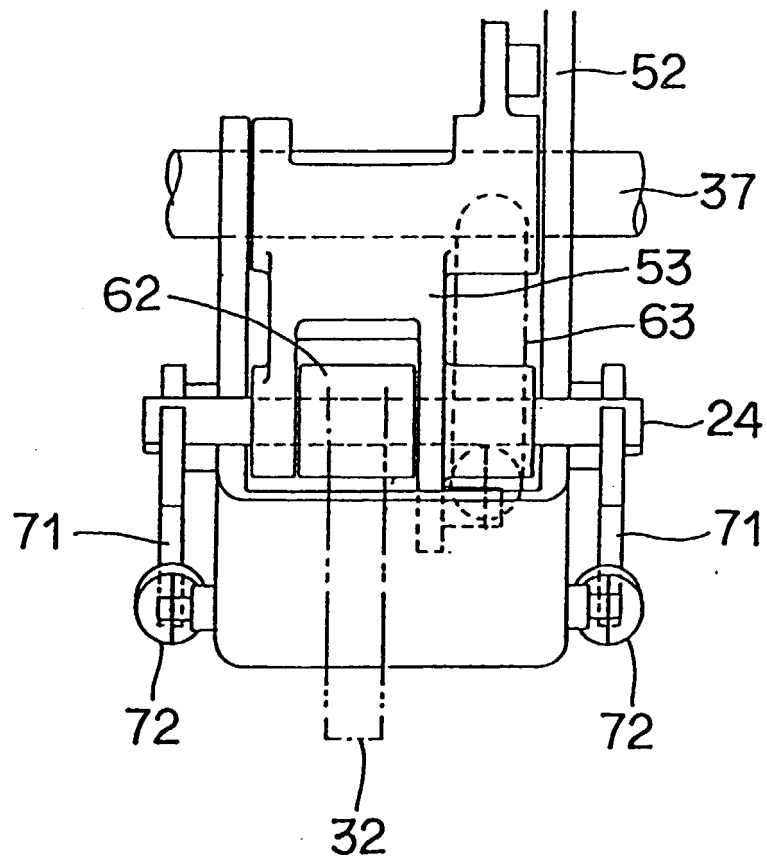


FIG. 13

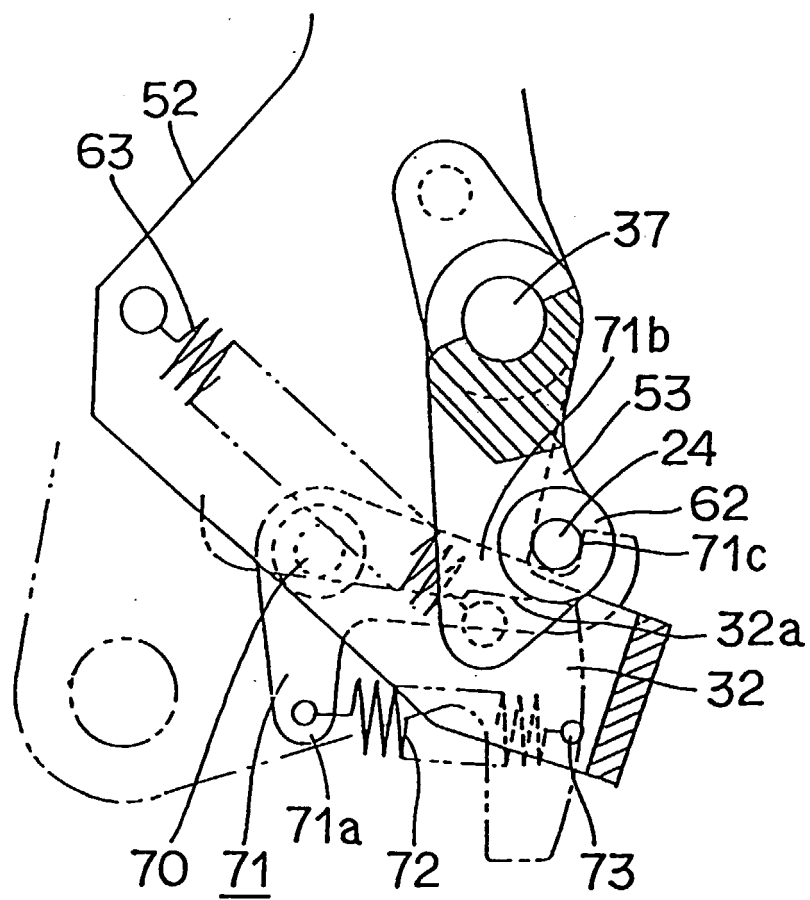
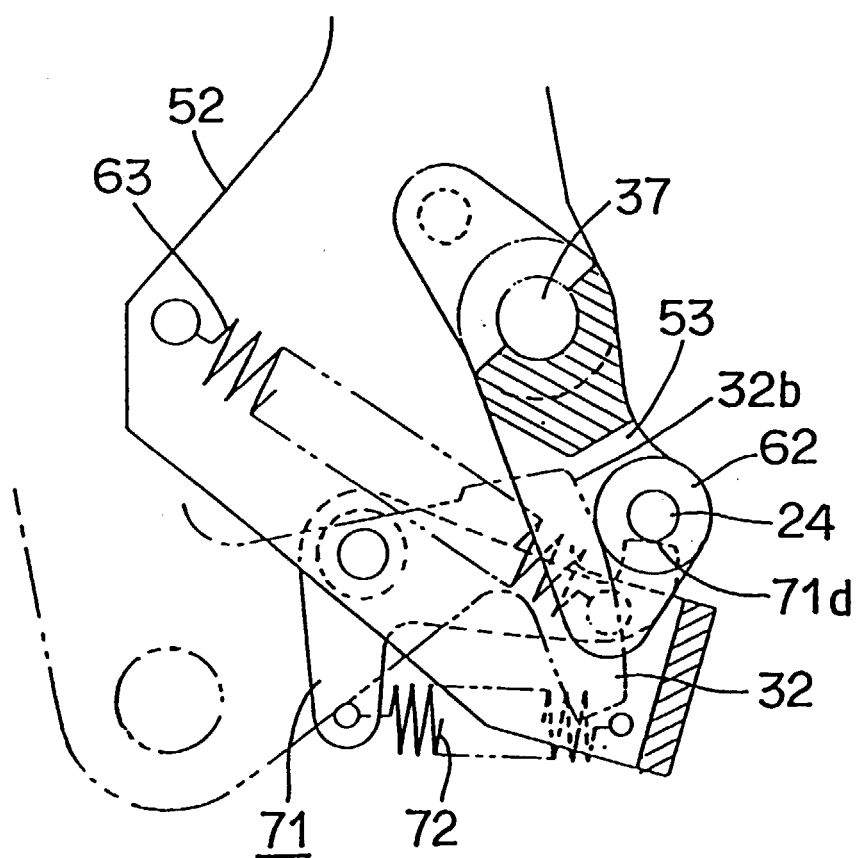


FIG. 14





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 12 4033

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Place of search THE HAGUE		Date of completion of the search 30 March 2000	Examiner Desmet, W
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