

[54] **HIGH-VOLTAGE CIRCUIT BREAKER
EQUIPPED WITH MEANS FOR PLACING A
RESISTOR IN PARALLEL WITH THE
BREAKER CONTACT DURING BREAKER
CLOSING OPERATIONS**

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[52] U.S. Cl. 200/148 D, 200/144 AP

[51] Int. Cl. H01h 33/60

[58] Field of Search 200/148 B, 148 D,
200/148 R, 144 AP

[56] **References Cited**

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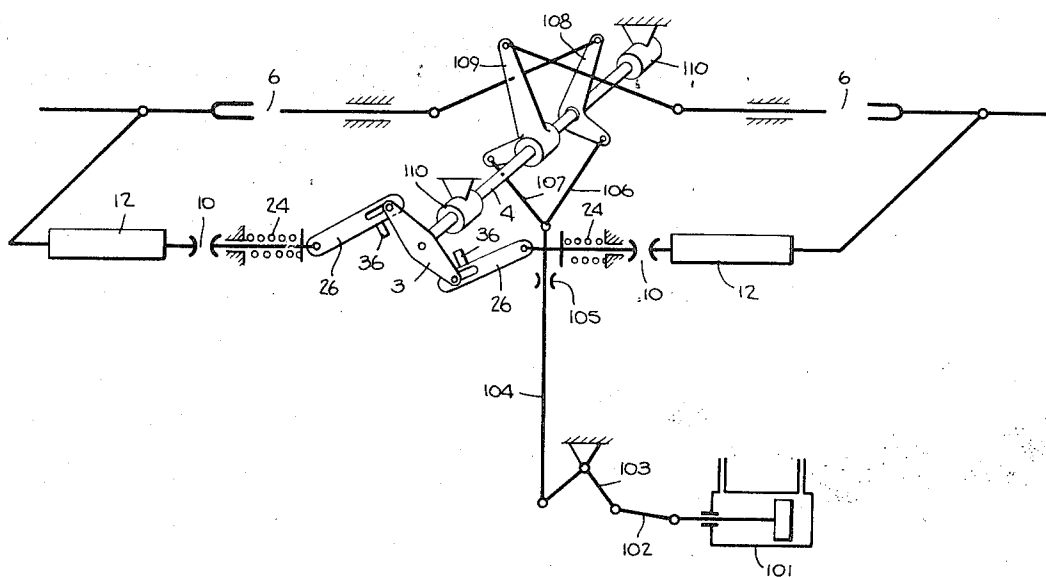
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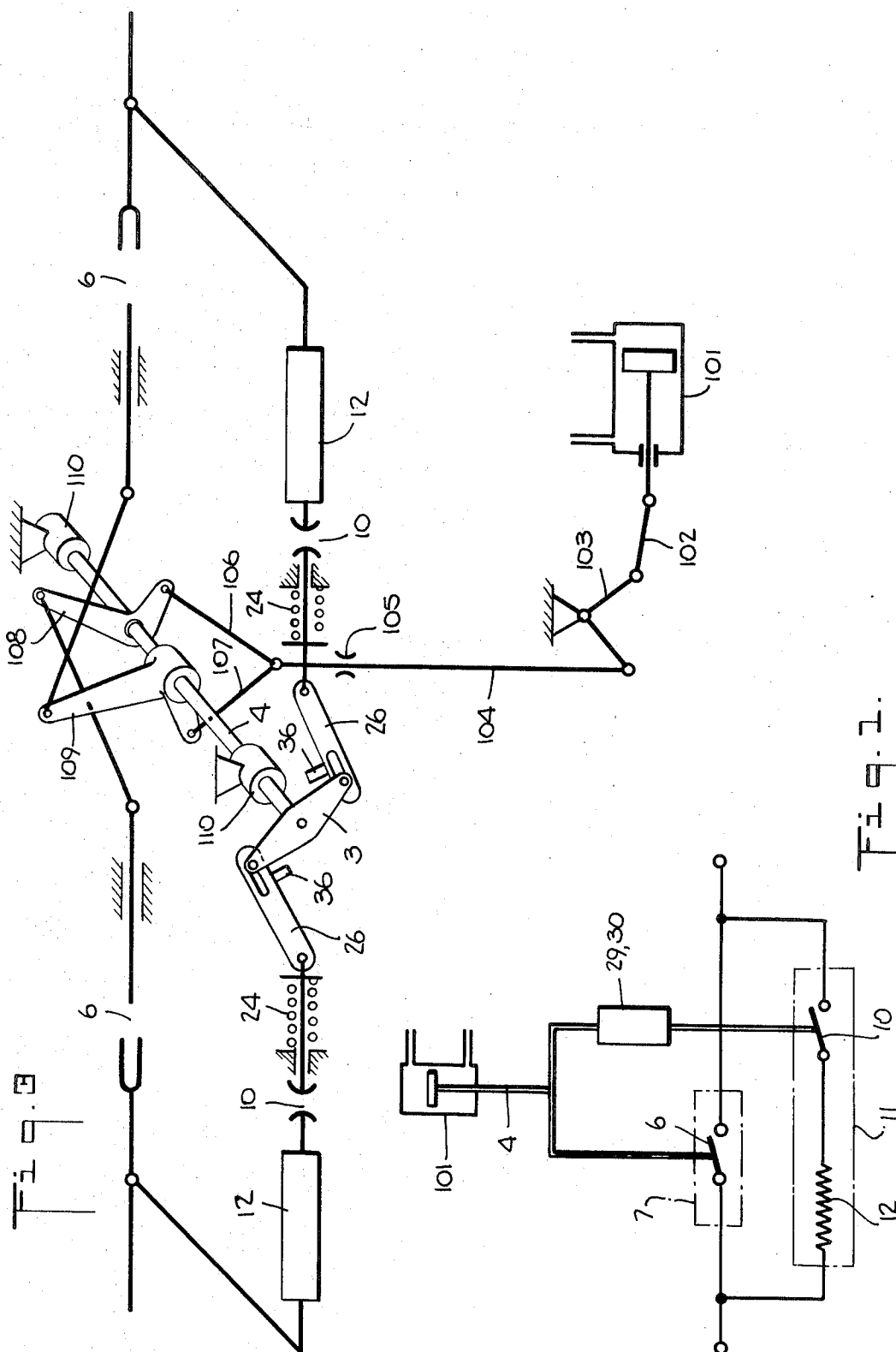
Primary Examiner—Robert S. Macon
Attorney—Hugh A. Chapin

[57] **ABSTRACT**

A high-voltage circuit breaker has a primary switch, an auxiliary switch and a resistor connected in series with said auxiliary switch. The serial combination of the resistor and the auxiliary switch is in parallel with the primary switch. The primary switch and the auxiliary switch have a common mechanical drive movable to various positions for actuating the switches. The auxiliary switch has a spring for holding it in the open position and a force-coupled connector is provided for force-coupling the drive to the auxiliary switch. The connector is disengageable from the drive in dependence upon the position of the drive. When the breaker operates, the auxiliary switch closes prior to the closing of the primary switch and opens again after the primary switch is closed.

17 Claims, 3 Drawing Figures





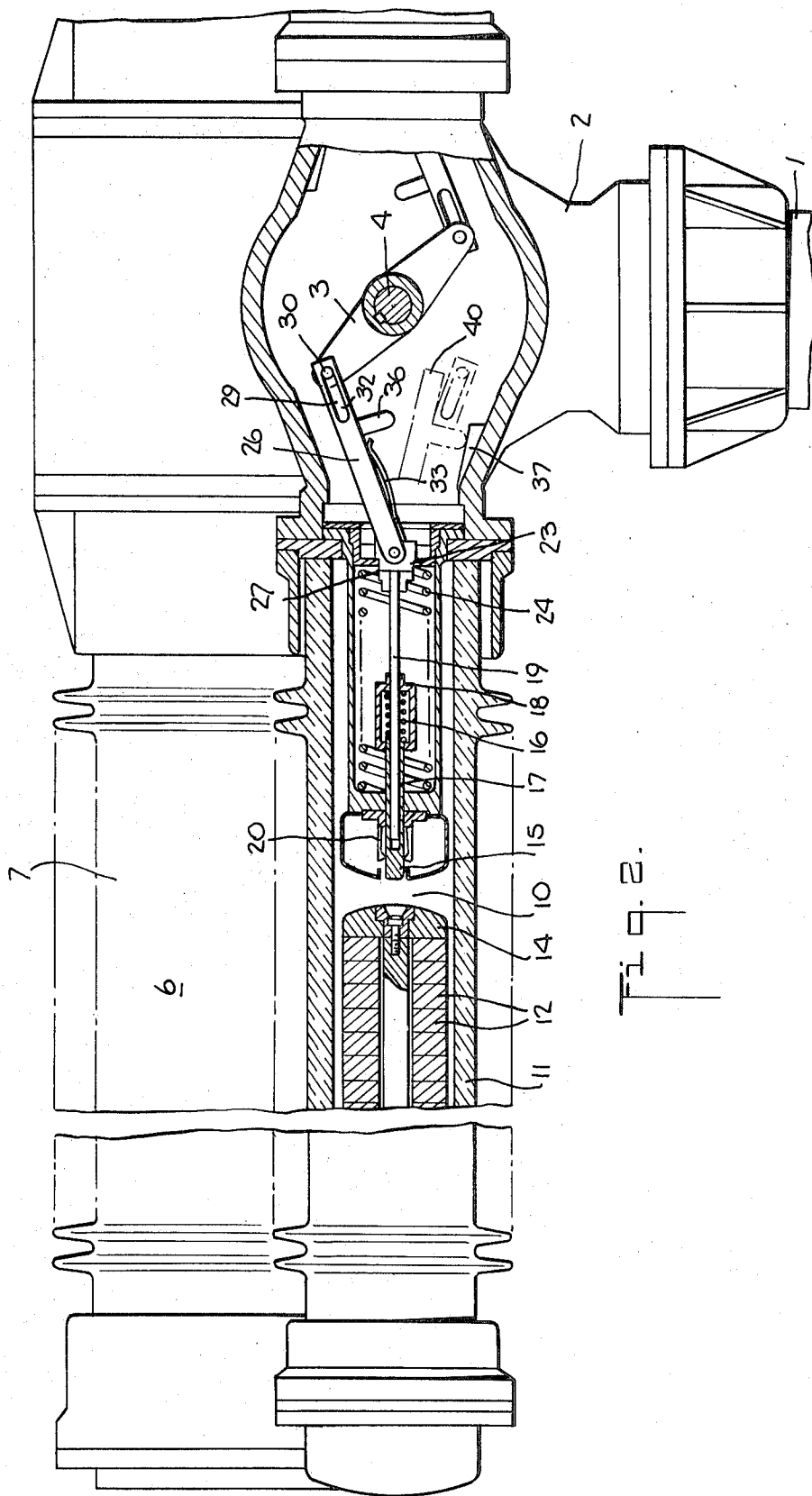


FIG. 2.

HIGH-VOLTAGE CIRCUIT BREAKER EQUIPPED WITH MEANS FOR PLACING A RESISTOR IN PARALLEL WITH THE BREAKER CONTACT DURING BREAKER CLOSING OPERATIONS

BACKGROUND OF THE INVENTION

The invention relates to a high-voltage circuit breaker having a primary switch, a resistor and an auxiliary switch connected in series with the resistor, the serial combination of the resistor and auxiliary switch being connected in parallel with the primary switch. More particularly, the invention relates to such a breaker equipped with a force-coupled connector for providing a force-coupling between the auxiliary switch and the breaker drive in dependence upon the position of the drive.

It is an object of the invention to provide a high-voltage circuit breaker wherein the reliability of switching is increased.

It is another object of the invention to provide a high-voltage circuit breaker having a simple drive mechanism.

Subsidiary to the foregoing objects, it is an object of the invention to provide such a circuit breaker wherein the proper time sequence of actuating the primary and auxiliary switches is maintained to a degree of accuracy higher than that obtained with known compressed-gas circuit breakers.

In the above-mentioned compressed-gas circuit breakers the switches are mutually coupled only by pneumatic means as disclosed for example in Deutsche Auslegeschrift 1, 086,780.

According to a feature of the invention, a common drive is provided for the auxiliary switch and primary switch of the breaker. The auxiliary switch has a spring for holding it in the open position as well as force-coupled connector for force-coupling the drive to the auxiliary switch in dependence upon the position of the drive, or stated otherwise, the force-coupled connector is disengaged in dependence upon the position of the drive.

In the circuit breaker according to the invention, a common actuator provides that the desired timing sequence of actuating the primary and auxiliary switches is precisely maintained for the essential switching operation, especially, the closing operation. The desired timing sequence is assured because of a rigid mechanical connection. Different switching times can be obtained, for example, by means of different angular positions of the crank arms of a common drive shaft. The angle between the crank arms provides the difference of timing desired for the switching operation.

The connection between auxiliary switch and drive which can be disengaged in dependence upon the distance travelled makes it possible to place a load on the resistor for only a short period of time. For example, a switch closing resistor that is intended to reduce over-voltage when switching in a high-voltage line need only be used when the circuit breaker is closed and not when it is open.

The connection that is disengageable in dependence on distance travelled can be realized by actuating the auxiliary switch with a crank and a rod having a slot in which a pin of the crank is engaged, the free movement of the crank pin being blocked in dependence upon position. The block to the movement of the crank pin in the slot permits the connection to transmit a force. If

the limitation or block is removed, the slot affords sufficient space that the spring of the auxiliary switch that urges this switch into the open position is free to function.

According to a preferred embodiment of the invention, a stop cam is articulately joined to the end of the rod facing the auxiliary switch. The stop cam coacts with the crank pin and acts against the force of a spring in the end position of the crank so as to be displaceable from the blocking position. Preferably, the spring is a leaf spring. The leaf spring can hold a one-arm lever in the blocking position. The one-armed lever functions as the stop cam and is accommodated in a fork-shaped crank arm. The stop cam is forced from the blocking position only at the end of the crank motion.

The circuit breaker according to still another and advantageous feature of the invention, the auxiliary switch has a butt contact with a movable composite contact pin that can be shortened against the action of a spring; this spring forms part of the composite pin. Such a butt contact can open and close with a minimum of pre-discharge phenomena. The spring of the composite pin adapts the switching movement to the spacing between contacts of the auxiliary switch.

The circuit breaker of the invention is especially suitable for very high-voltages, for example, for 380 KV and higher. According to another embodiment, it is preferable to arrange two primary switches and two auxiliary switches on the same axis so as to be symmetrical with respect to each other and to operate all the switches with the same actuator.

Although the invention is illustrated and described herein as a high-voltage circuit breaker, it is nevertheless not intended to be limited to the details shown, since various modifications may be made therein within the scope and the range of the claims. The invention, however, together with additional objects and advantages will be best understood from the following description and in connection with the accompanying drawings discussed below.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram illustrating the principal components of the high-voltage circuit breaker according to the invention.

FIG. 2 is an elevation view of the circuit breaker of the invention showing a break-out view, partially in section, of the operating parts of the auxiliary switch.

FIG. 3 is a schematic diagram, in perspective view, of a high-voltage circuit breaker equipped with two auxiliary and two primary switches according to an alternate embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The electric high-voltage circuit breaker shown in FIG. 1 has a switching chamber 7 with primary switch 6. A series circuit consisting of a resistor 12 and an auxiliary switch 10 is connected in parallel with switch 6. The auxiliary switch 10 and the resistor 12 are mounted together in a tube 11 made of insulating material. The primary switch 6 and the auxiliary switch 10 are driven by mechanical drive means comprising a common drive in the form of an actuator member 4. The actuator member 4 can in turn be driven by a double-action hydraulic or pneumatic cylinder 101. The primary switch 6 and the auxiliary switch 10 thus a common mechani-

cal drive. In addition, a force-coupled connecting means in the form of device 29, 30 is provided between the auxiliary switch 10 and the actuator 4. The device 29, 30 is disengageable in dependence upon position; this will be explained in greater detail below.

Referring now to FIG. 2, the support insulator 1 supports a metallic drive housing 2, in which a two-arm crank 3 is securely mounted on a switching shaft 4. The switching shaft 4 is actuated by an actuating device that is preferably a hydraulic drive at ground potential. A primary switch 6 is located within the switching chamber 7 and is coupled to switching shaft 4.

An auxiliary switch 10 and the switch-closing resistor 12 are connected electrically in shunt with the primary switch 6. The switch 10 and resistor 12 are mounted in tube 11. The auxiliary switch 10 includes a fixed contact 14 and a movable, two-part contact pin 15. The composite contact pin includes a forward part 17 and a rear part 19. A spring 16 urges the forward part 17 of the composite contact pin 15 outwardly, the forward part 17 being directed by guide 18 of the rear part 19; this permits the length of the contact pin 15 to be shortened. A slide contact 20 provides for the passage of current from the contact pin 15 to the drive housing 2.

A spring plate 23 is attached at the end of the composite contact pin 15 facing away from the stationary contact 14. A pressure spring 24 bears against plate 23 and biases the contact pin 15 in the direction of switch opening. For switch closure, the contact pin 15 is actuated with a rod 26 that is pivoted at the spring plate 23 at location 27. The rod 26 is part of the force-coupled connection means and has an elongated opening or slot 29. A crank 3 with crank pin 30 also constitutes part of the force-coupled connection means. The crank pin 30 of the crank 3 engages the slot 29 and, in this way, a lost-motion connection is provided which can be blocked in dependence upon position. Blocking action is provided by blocking means comprising a stop cam 32 pivotally mounted on pin 27. The cam 32 is urged by a leaf spring 33 into the position shown in FIG. 2 in solid outline. In this position the cam edge 35 limits the free movement of the crank pin 30 in the slot 29. Only at the end of a rotary movement which brings the crank 3 into the other end position is the block to the pin 30 removed. There, displacement means comprising a projection 36 of the cam 32 hits a stop or abutment 37 and swings the stop cam 32 out of the path of the crank pin 30 in the slot 29 as shown in phantom outline at 40.

The switching operation of the circuit breaker according to the invention will now be described with reference to FIG. 2.

The breaker is shown in the open position and the primary switch 6 and the auxiliary switch 10 are both open. For closing the breaker, the switching shaft 4 is rotated counterclockwise by means of intermediate members not shown. The different angular positions of the crank arms of the primary and auxiliary switches ensure that the auxiliary switch 10 closes first, because the crank pin 30 pushes against the composite contact pin 15 by means of the stop cam 32 and the rod 26, so that the contact pin 15 is moved against the action of the spring 24 in the direction of closing.

The tip of the contact pin 15 coacts with the stationary contact 14 in the manner of a butt contact, the contact 14 having a somewhat conical contour at the region of contact. Because this contact occurs prior to the closing of the primary switch, the capacitances of

the line to be connected are charged through the resistor 12.

The closing of the primary switch 6 takes place with a time delay determined by the characteristic impedance and the capacitances of the high-voltage line to be connected as well as by the resistor 12. After the primary switch 6 is closed, auxiliary switch 10 is again opened as the crank 3 retracts the contact pin 15 after passing the extended position. In this connection, the crank 3 is aided by the spring 24. At the end of the pivot movement, the projection 36 strikes the surface 37 and removes the block that the stop cam 32 applies to the crank pin 30 in the slot 29, so that the spring 24 can bring the contact pin 15 into the open end position. The primary switch 6 remains closed as the auxiliary switch 10 is brought to the open position.

The auxiliary switch 10 is not actuated when the breaker is opened because the connection between the rod 26 and the crank 3 is disengaged. Only in the end position of the switch opening movement, does the crank pin 30 occupy such a position in slot 29 that the stop cam 32, under the action of the leaf spring 33, can drop into the position shown, in which the lost-motion connection is blocked. The resistor 12 need therefore be determined only for the closing current.

FIG. 3 illustrates an alternate embodiment of the high-voltage circuit breaker equipped with two primary switches 6 and two auxiliary switches 10 as well as two resistors 12; the configuration being symmetrical with respect to the switching shaft 4.

The switching shaft 4 is rotatably supported in bearings 110 that are fixed with respect to the housing. The crank 3 is carried at one end of the shaft 4 and is connected rigidly with the shaft 4 so as to permit no rotational shift. On the shaft 4 are mounted two direction-changing levers 108 and 109, which are coupled, on the one hand, with the primary switches 6 and, on the other hand, with a drive rod 104 through levers 106 and 107. The drive rod 104 is guided for vertical movement in a thrust bearing 105 that is fixed with respect to the housing. By means of the direction-changing levers 108 and 109, the vertical motion of the drive rod 104 is transformed into a reciprocating motion at right angles to the vertical motion for the primary switches 6. Tee direction-changing lever 108 is rigidly connected with the shaft 4 to prevent rotational shift whereas, the direction-changing lever 109 is supported on the switching shaft 4 so as to be freely rotatable. The drive rod 104 is actuated via a direction-changing lever 103 and a connecting rod 102 by a double-acting hydraulic or pneumatic cylinder 101.

When the drive rod 104 is moved, the switching shaft 4 is forced to rotate together with the direction-changing lever 108, so that a rigid mechanical coupling results between the direction-changing lever 108 and the crank 3 and thereby also a rigid mechanical coupling between the primary switch 6 and the auxiliary switch 10. The mode of operation of the circuit breaker shown in connection with FIG. 2 applies during the switching operation and like parts are designated with the same reference numerals.

FIG. 3 also shows that the primary switches 6 and the auxiliary switches 10 are arranged on the same axis symmetrically with respect to each other and are actuated by the same drive 101, 102, 103 and 104.

What is claimed is:

1. A high-voltage circuit breaker comprising a primary switch; an auxiliary switch; and a resistor connected in series with said auxiliary switch, the serial combination of said resistor and said auxiliary switch being connected in parallel with said primary switch; mechanical drive means comprising a common drive movable to different positions for actuating said switches; said auxiliary switch comprising a spring for holding said auxiliary switch in the open position; and force-coupled connection means for force-coupling said drive to said auxiliary switch and for disengaging said drive in dependence upon the position of said drive, said auxiliary switch further comprising a set of two contacts, at least one of said contacts being a movable contact connected to said force-coupled connection means for contacting the other of said contact in a butt-like manner when said auxiliary switch is closed, said movable contact being a composite member comprising a rear part connected to said force-coupled connection means, a forward part for contacting said other contact, said forward part being longitudinally displaceable with respect to said rear part to an extended position for increasing the total length of said movable contact, and a spring disposed between said forward part and said rear part for holding said forward part in said extended position, whereby said movable contact member becomes shorter when moved into contact with said other contact.

2. A high-voltage circuit breaker of claim 1 connected into a high-voltage line for switching the same, said breaker comprising primary switch actuation means connected to said common drive for closing said primary switch at the end of a time period after said auxiliary switch is closed, said time period being determined by said resistor and the capacitance and characteristic impedance of the line switched by the breaker.

3. A high-voltage circuit breaker according to claim 1 comprising an additional primary switch connected to said common drive and an additional auxiliary switch connected to said common drive, each of said additional switches being driven by said common drive and being disposed symmetrically with respect to corresponding ones of said first mentioned primary and auxiliary switches.

4. A high-voltage circuit breaker comprising a primary switch; an auxiliary switch; and a resistor connected in series with said auxiliary switch, the serial combination of said resistor and said auxiliary switch being connected in parallel with said primary switch; mechanical drive means comprising a common drive movable to different positions for actuating said switches; said auxiliary switch comprising a spring for holding said auxiliary switch in the open position; and force-coupled connection means for force-coupling said drive to said auxiliary switch and for disengaging said drive in dependence upon the position of said drive, said common drive being a rotatable drive shaft, said force-coupled said connection means comprising a rod connected to said auxiliary switch and having a slot therein, a crank mounted on said drive shaft and having a crank pin engaging said slot, and blocking means for blocking the free movement of said pin in said slot in dependence upon the position of said crank so as to provide a removable force-coupled connection between said shaft and said auxiliary switch, whereby said crank actuates said auxiliary switch via said rod

when rotated by said drive shaft and when said pin is blocked.

5. The high-voltage circuit breaker of claim 4, wherein said crank is rotatable by said shaft between end positions, and wherein said rod has an end connected to said auxiliary switch, said blocking means comprising a stop cam articulately joined at said end of said rod and blocking the free movement of said crank pin in said slot in dependence upon the position of said crank, and a cam spring pressing against said stop cam for holding said cam in a blocking position to block said crank pin, and displacement means for overcoming the force of said cam spring and displacing said stop cam from said blocking position when said crank reaches one of said end positions thereby removing the block to the free movement of said crank pin in said slot.

6. The high-voltage circuit breaker of claim 5, said cam spring being a leaf spring.

7. The high-voltage circuit breaker of claim 5, comprising a housing surrounding said drive shaft and said force-coupled connection means, said housing having an inner wall surface, said displacement means comprising an abutment formed on said inner surface, and a projection extending laterally from said stop cam, said projection having a length sufficient to strike said abutment and displace said stop cam against the force of said cam spring when said crank reaches said one end position.

8. A high-voltage circuit breaker comprising a primary switch; an auxiliary switch; and a resistor connected in series with said auxiliary switch, the serial combination of said resistor and said auxiliary switch being connected in parallel with said primary switch; and mechanical drive means for actuating said switches, said mechanical drive means including a drive movable between first and second positions for opening and closing said primary switch, a spring for spring holding said auxiliary switch in the open position thereof, force-coupled connection means for transmitting a force from said drive to said auxiliary switch sufficient to overcome the resisting force of said spring and to close said auxiliary switch before said drive closes said primary switch and to then reopen said auxiliary switch after said drive closes said primary switch in the movement of said drive to said second position, and means for disengaging said force-coupled connection means from said drive in dependence upon the position of said drive in the movement from said first position to said second position whereby the force of said spring acts on said auxiliary switch to spring hold the same in said open position thereof and whereby said auxiliary switch is not actuated when said drive returns from said second position to said first position to open said primary switch.

9. The high-voltage circuit breaker of claim 8, said drive being a rotatable drive shaft, said force-coupled connection means comprising a rod connected to said auxiliary switch and having a slot therein, a crank mounted on said drive shaft and having a crank pin engaging said slot, said means for disengaging said force-coupled connection means including blocking means for blocking the free movement of said pin in said slot in dependence upon the position of said crank so as to provide a removable force-coupled connection between said shaft and said auxiliary switch whereby said crank actuates said auxiliary switch via said rod when rotated by said drive shaft and when said pin is blocked.

10. The high-voltage circuit breaker of claim 9 wherein said crank is rotatable by said shaft between end positions corresponding to said first and second positions, and wherein said rod has an end connected to said auxiliary switch, said blocking means comprising a stop cam articulately joined at said end of said rod and blocking the free movement of said crank pin in said slot in dependence upon the position of said crank, and a cam spring pressing against said stop cam for holding said cam in a blocking position to block said crank pin, and displacement means for overcoming the force of said cam spring and displacing said stop cam from said blocking position when said crank reaches the end position corresponding to said second position thereby removing the block to the free movement of said crank pin in said slot.

11. The high-voltage circuit breaker of claim 10, said cam spring being a leaf spring.

12. The high-voltage circuit breaker of claim 10, comprising a housing surrounding said drive shaft and said force-coupled connection means, said housing having an inner wall surface, said displacement means comprising an abutment formed on said inner wall surface, and a projection extending laterally from said stop cam, said projection having a length sufficient to strike said abutment and displace said stop cam against the force of said cam spring when said crank reaches said end position corresponding to said second position.

13. The high-voltage circuit breaker of claim 8, said auxiliary switch comprising a set of two contacts, at least one of said contacts being a movable contact connected to said force-coupled connection means for contacting the other of said contacts in a butt-like manner when said auxiliary switch is closed, said movable contact being a composite member comprising a rear part connected to said force-coupled connection means, a forward part for contacting said other contact, said forward part being longitudinally displaceable with respect to said rear part to an extended position

for increasing the total length of said movable contact, and a spring disposed between said forward part and said rear part for holding said forward part in said extended position, whereby said movable contact member becomes shorter when moved into contact with said other contact.

14. A high-voltage circuit breaker of claim 8 connected into a high-voltage line for switching the same, said breaker comprising primary switch actuation means connected to said common drive for closing said primary switch at the end of a time period after said auxiliary switch is closed, said time period being determined by said resistor and the capacitance and characteristic impedance of the line switched by the breaker.

15. A high-voltage circuit breaker according to claim 8 comprising an additional primary switch connected to said common drive and an additional auxiliary switch connected to said common drive, each of said additional switches being driven by said common drive and being disposed symmetrically with respect to corresponding ones of said first mentioned primary and auxiliary switches.

16. A high-voltage circuit breaker of claim 4 connected into a high-voltage line for switching the same, said breaker comprising primary switch actuation means connected to said common drive for closing said primary switch at the end of a time period after said auxiliary switch is closed, said time period being determined by said resistor and the capacitance and characteristic impedance of the line switched by the breaker.

17. A high-voltage circuit breaker according to claim 4 comprising an additional primary switch connected to said common drive and an additional auxiliary switch connected to said common drive, each of said additional switches being driven by said common drive and being disposed symmetrically with respect to corresponding ones of said first mentioned primary and auxiliary switches.

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UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,763,340

DATED : October 2, 1973

Page 1 of 2

INVENTOR(S) : Dieter Noack

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the Drawing:

Sheet 2, Fig. 2, the illustration of element 23 was incorrect. Substitute the attached sheet 2, Fig. 2 for that in the patent.

Signed and Sealed this
twenty-fifth Day of May 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks

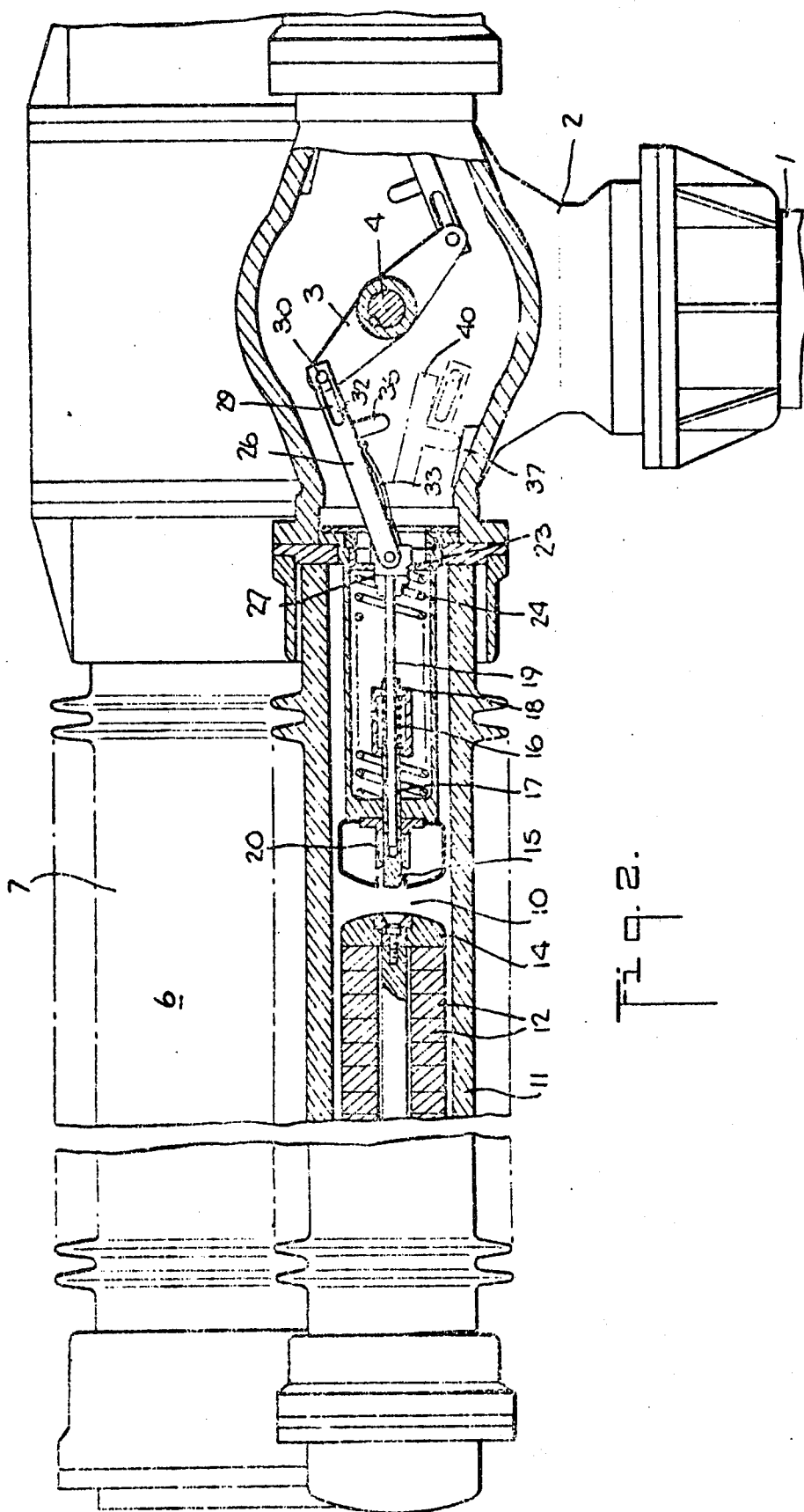


Fig. 2.