Jan. 19, 1960 F. J. POKORNY ET AL 2,922,009

FIELD DISCHARGE CIRCUIT BREAKER TIMING

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FIG. 1.

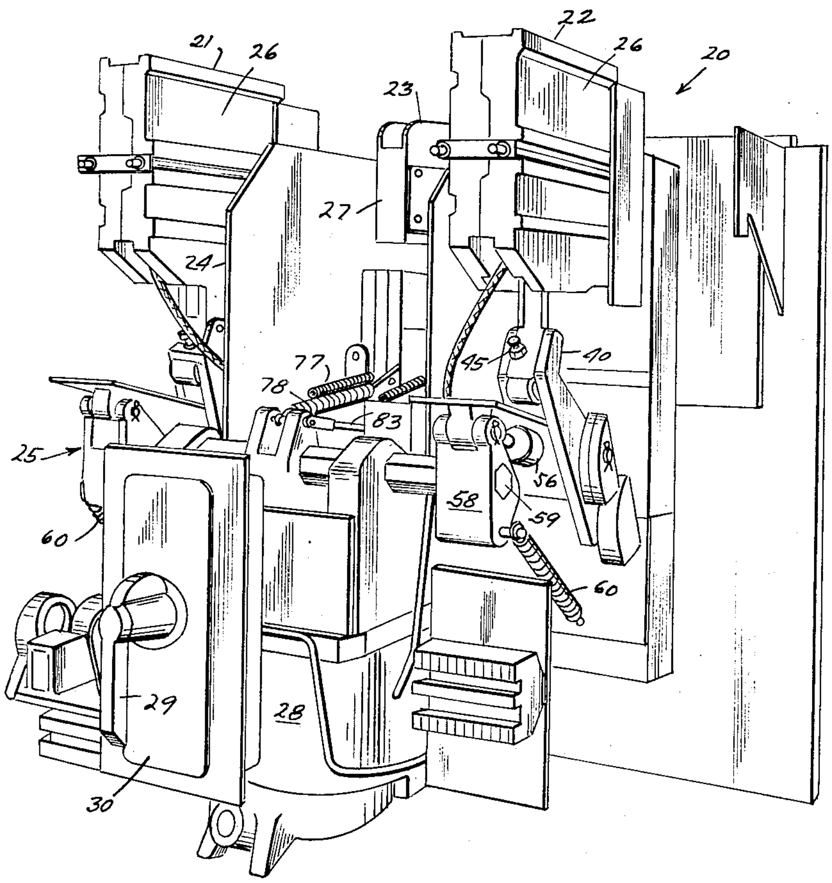
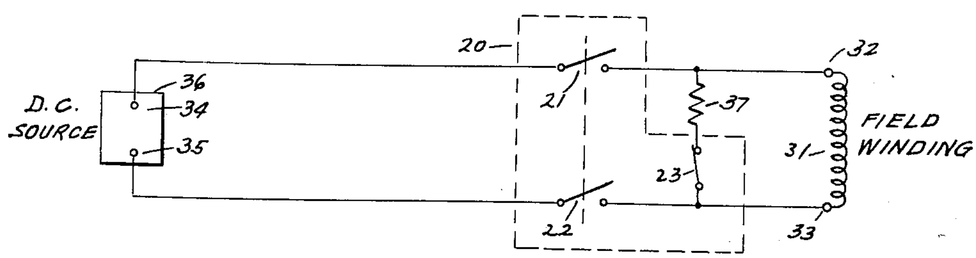


FIG. 2.



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FIELD DISCHARGE CIRCUIT BREAKER TIMING

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FIG. 3

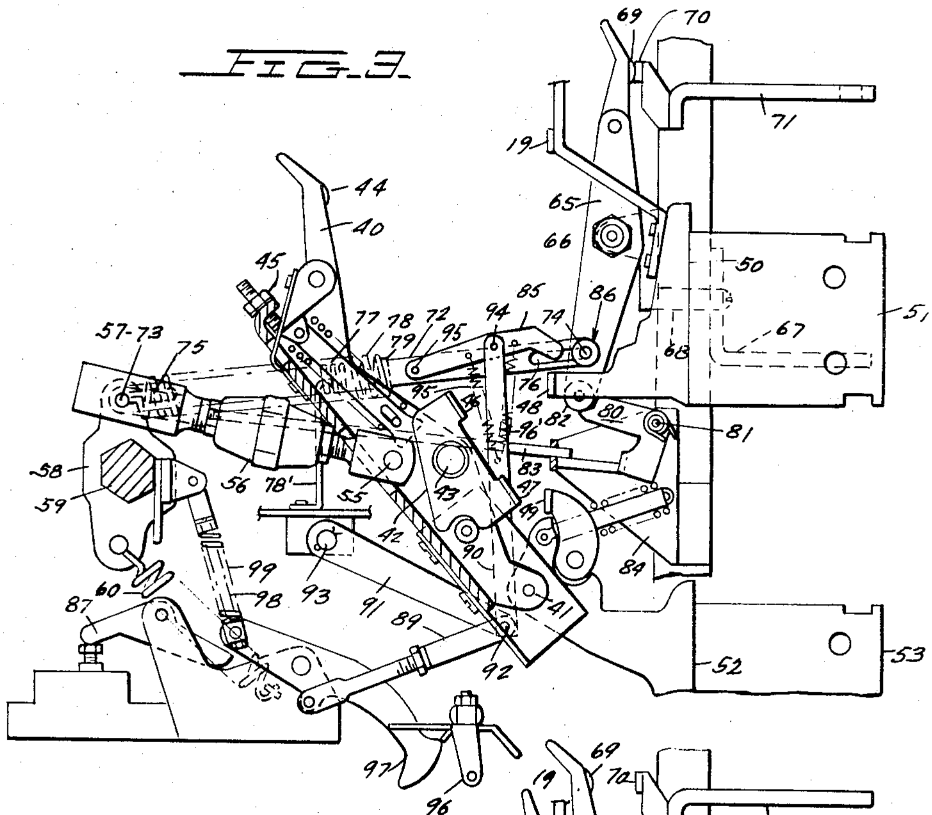
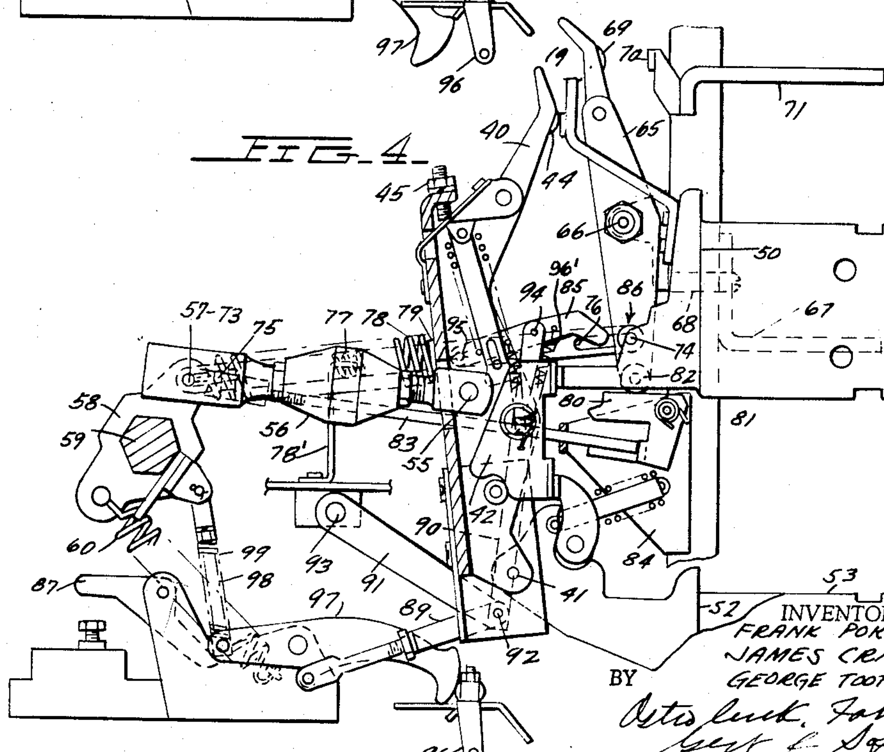


FIG. 4



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FIELD DISCHARGE CIRCUIT BREAKER TIMING

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FIG. 5

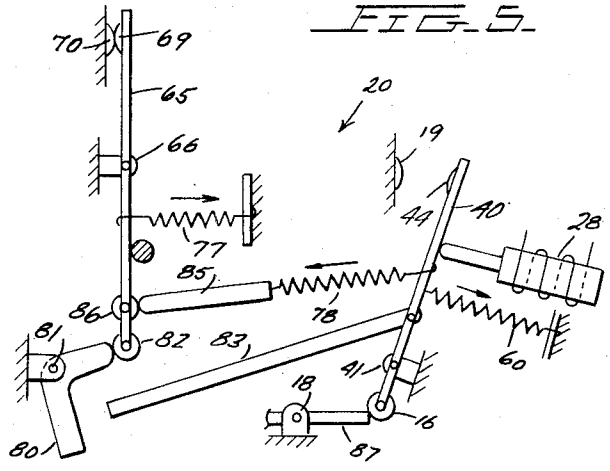
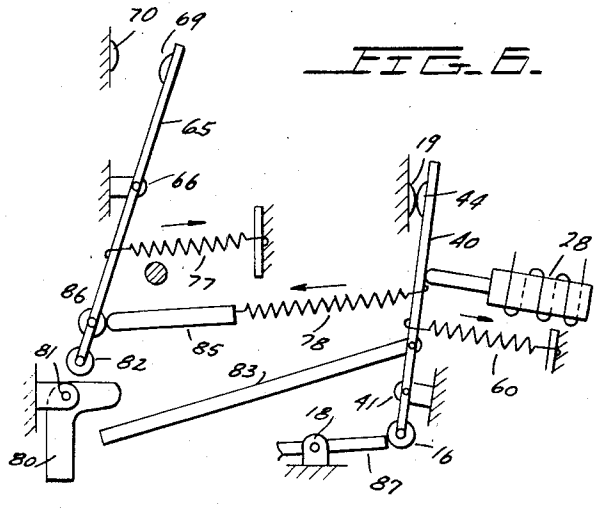


FIG. 6



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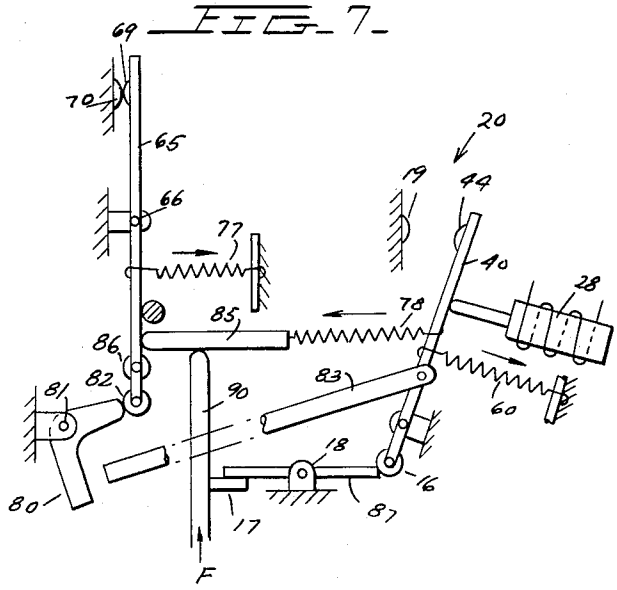
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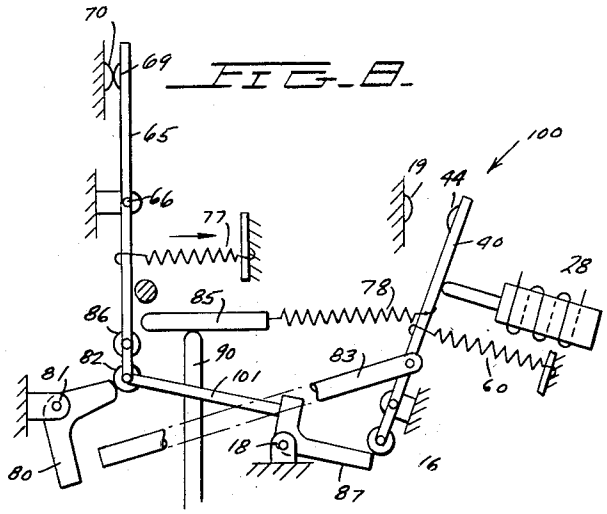
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FIG. 7.





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United States Patent Office 2,922,009 Patented Jan. 19, 1960

2,922,009

FIELD DISCHARGE CIRCUIT BREAKER TIMING

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Application December 30, 1957, Serial No. 705,854

11 Claims. (Cl. 200—146)

The instant invention relates to circuit breakers in general and more particularly to a field discharge circuit breaker having a novel construction which achieves a more reliable coordination between the circuit breaker contacts and field discharge contacts than has heretofore been possible.

In an energized D.C. motor or generator if the field circuit thereof is suddenly opened, then, owing to the rapid decrease of flux through the large number of field coil turns, a large E.M.F. will be induced between the two open ends. This E.M.F. may be sufficient to break down the insulation between the field coils and pole pieces. To prevent this, a resistor is permanently connected in parallel with the field coil or else a resistor is switched in parallel with the field coil when the energizing circuit to the field is opened.

It is essential that the switching of the discharge resistor be precisely coordinated with the switching of the field coil energizing circuit. To this end, a field discharge circuit breaker is provided which includes two pairs of circuit breaker contacts for switching the energizing circuit of the field coil and another pair of contacts for switching the field discharge resistor. That is, the field discharge resistor is connected to short circuit the field coil an instant before the circuit breaker contacts open and is disconnected from short circuiting the field coil an instant after the circuit breaker closes.

Field discharge circuit breakers of the prior art did not provide a precise timing between the circuit breaker contacts and field discharge contacts. Further, the adjustments thereof were very difficult to achieve. The flexing of the circuit breaker components caused by their own inertia contribute to undesirable variations in the contact sequence. Further, when the opening speed of the circuit breaker changed because of the changes in the magnitude of current flowing through the circuit breaker, its coordination with the field discharge contacts was upset.

The instant invention overcomes the deficiencies of prior art field discharge circuit breakers by utilizing a construction in which energy is stored in the system in both the closing and opening directions of the circuit breaker contacts. The stored energy is released responsive to the position of the circuit breaker contacts. Thereafter, the stored energy is effective to bring about a substantially instantaneous opening or closing of the field discharge contacts.

Accordingly, it is a primary object of the instant invention to provide a novel field discharge circuit breaker wherein the operation of two pairs of circuit breaker contacts is precisely coordinated with the operation of a pair of field discharge contacts.

Another object is to provide a novel construction for a field discharge circuit breaker which permits the making and breaking of the contacts thereof to be coordinated in a precise timing relationship which may readily be adjusted.

Still another object is to provide a field discharge circuit breaker in which both the opening and closing of the field discharge contacts is accomplished by means of energy stored in the system.

A further object is to provide a field discharge circuit breaker in which the operational speed thereof has a negligible effect upon the timing sequence for both opening and closing.

A still further object is to provide a field discharge circuit breaker in which trip operation will not have any effect on the open circuit breaker contacts and the contacts of the field discharge pole will remain closed.

These as well as other objects of this invention will become readily apparent after reading the following description of the accompanying drawings in which:

Figure 1 is a perspective view of our novel field discharge circuit breaker.

Figure 2 is a circuit diagram illustrating the manner in which a field discharge circuit breaker is connected in a circuit to protect the field winding of a D.C. motor.

Figure 3 is a side elevation of the field discharge circuit breaker of Figure 1 with the field discharge circuit contacts closed and the circuit breaker contacts open.

Figure 4 is a side elevation of the field discharge circuit breaker of Figure 1 with the field discharge circuit contacts open and the circuit breaker contacts closed.

Figures 5–7 are schematic illustrations of the field discharge circuit breaker of Figures 1–4. In Figure 5 the field discharge circuit breaker is opened, in Figure 6 the field discharge circuit breaker is closed, and in Figure 7 the field discharge circuit breaker has been tripped open.

Figure 8 illustrates, in schematic form, a second embodiment of our novel field discharge circuit breaker with the circuit breaker in the tripped open position.

Referring more particularly to Figures 1 and 2, field discharge circuit breaker **20** comprises circuit breaker or main poles **21** and **22** and field discharge pole **23** which is positioned therebetween and isolated therefrom by interphase barriers **24**. Main poles **21**, **22** are provided with arc chutes **26** while field discharge pole **23** is provided with a separate arc chute **27**.

Jack shaft assembly **25** provides a direct mechanical connection between main poles **21** and **22** so that these poles operate in unison. Operation of main poles **21**, **22** is customarily accomplished by means of solenoid assembly **28** which may take one of the many conventional constructions known to the art. Handle **29** mounted on escutcheon **30** is provided for manual operation.

When circuit breaker **20** is connected to protect the field winding **31** of a D.C. motor main poles **21** and **22** are each connected in series with an individual line connecting field winding terminals **32**, **33** to terminals **34**, **35** respectively of D.C. power source **36**. Field discharge pole **23** is connected in series with discharge resistor **37** and this series combination is connected between the winding terminals **32**, **33**. The operation of field discharge pole **23** is coordinated with that of circuit breaker poles **21**, **22**, in a manner to be hereinafter explained, so that upon energizing winding **31** circuit breaker poles **21**, **22** close and an instant thereafter field discharge pole **23** opens. Upon deenergizing winding **31** field discharge pole **23** closes an instant before circuit breaker poles **21**, **22** open. Thus when poles **21**, **22** open the electrical energy stored in winding **31** is confronted by the relatively low impedance of resistor **37** thereby preventing the buildup of excessive voltages between the winding terminals **32**, **33**.

Now referring more particularly to Figures 3 and 4, main poles **21**, **22** each comprise substantially identical assemblies. Therefore, only one main pole unit **21** shall be described.

Pole unit **21** includes a contact arm **40** pivotally mounted to the frame at **41**. Contact member **42** is

pivotally mounted at 43 to contact arm 40 while movable arcing contact 44 and its adjustable biasing means 45 are mounted at the upper end of contact arm 40.

Upper and lower main contacts 46, 47 are carried by contact member 42 and are engageable with stationary and semi-stationary main contacts 48, 49 respectively. Stationary main contact 48 is mounted on upper terminal 50 which is secured to upper current stud 51 while semi-stationary main contact 49 is mounted on lower terminal 52 which is connected in electrical series to the lower current stud 53. Movable arcing contact 44 is engageable with stationary arcing contact 19 secured to upper terminal 50. The manner in which the respective pairs of contacts cooperate is well known to the art and is fully set forth in U.S. Patent 2,664,479 assigned to the assignee of the instant invention.

Contact arm 40 is pivotally secured at 55 to one end of adjustable link 56 while the other end of link 56 is pivotally secured at 57 to crank 58 keyed to jack shaft 59. Opening spring 60 biases jack shaft 59 thereby urging contact arm 40 toward the open position of Figure 3. Clockwise rotation of jack shaft 59 will operate contact arm 40 to the closed position of Figure 4.

Field discharge pole 23 comprises a contact arm 65 mounted, at a point intermediate to the ends thereof, on stationary pivot 66. Pivot 66 is connected to lower stud 67 by suitable conductors including member 68. Movable contacts 69 mounted at the upper end of contact arm 65 is positioned to cooperate with stationary contact 70 which is mounted on upper stud 71.

Spring guide 72 is pivotally secured at 73 to jack shaft 59 and at 74 to the lower end of contact arm 65. Elongated slots 75, 76 are cut in spring guide 72 near the ends thereof and receive pivots 73, 74 respectively to form lost motion connections.

Tension spring 77 is connected between a frame member 78' and contact arm 65 at a point below pivot 66 thereby biasing contacts 69, 70 toward engagement. Compression spring 78 is positioned about spring guide 72 and bears against collar 79 and pivot 73 thereby biasing spring guide 72 to the right.

Hold-close latch 80 is pivotally mounted to the frame at 81 and biased in a clockwise direction to cooperate with lower roller 82 in latching contact arm 65 in the closed position of field discharge pole 23. Push rod 83, whose length is adjustable is also secured to crank 58 at pivot 73 and extends through a guide opening in bracket 84 so as to engage latch 80 when jack shaft 59 is rotated to its clockwise position where circuit breaker poles 21, 22 are both closed. As jack shaft 59 is rotated clockwise guide 72 moves slightly to the right until hold-open latch 85 engages roller 86, mounted to pivot 74, and thereafter spring 78 is compressed as pin 73 moves in slot 75.

When push rod 83 engages latch 80 it is caused to rotate counterclockwise to free roller 82 thereby unlatching arm 65 so as to permit spring 78 to bring about rapid opening of field discharge pole 23 at the instant after circuit breaker poles 21, 22 are closed (Figure 4). Spring 78, when loaded, exerts a much greater force than tension spring 77 so that the hold close force of spring 77 is readily overcome when hold-open latch 80, 82 is unlatched.

When jack shaft 59 is rotated to its clockwise position (Figure 4) to effect closing of the circuit breaker poles 21, 22, spring 99 mounted on link 98 is compressed. The force of the compressed spring 99 causes the impact latch 97 to rotate in a counterclockwise direction when tripper bar 96 is rotated counterclockwise by an external force in order to start the tripping of the circuit breaker. The counterclockwise rotation of the impact latch 97 causes the sequential movement of secondary latch 87 causing its unlatching and the resulting opening of the circuit breaker poles 21, 22. This movement of link 89 will be translated into an upward movement of trip link 90 which is pivotally secured at one end thereof to both linkage 89 and 91 at floating pin 92. Linkage 91 is pivotally secured to the frame at 93 so as to journal the movement of pin 92.

Trip link 90 is also secured to hold-open latch 85 at pin 94. Latch 85 is pivotally mounted at 95 to spring guide 72 and is biased clockwise about pin 95 by means of springs 96', to the latching position. The movement imparted to trip link 90 by the latch tripping mechanism through linkage 89 moves trip link 90 upward thereby rotating hold-open latch 85 counterclockwise until roller 86 can pass thereunder. Now spring 78 no longer exerts a force on contact 65 which is free to rapidly move clockwise about pivot 66 to the closed position of field discharge pole 23 under the influence of stretched tension spring 77 with pin 74 moving in slot 76. An instant after contacts 69, 70 engage, secondary latch 87 will be unlatched and opening springs 60 will be free to rotate jack shaft 59 counterclockwise to open circuit breaker poles 21, 22.

The timing sequence between the circuit breaker 21, 22 and field discharge 23 poles is readily adjustable. Link 56 may be adjusted to a convenient length together with the position of movable arcing contact 44 in its disengaged position. The opening sequence, that is, the opening of circuit breaker poles 21, 22 and the closing of field discharge pole 23, is controlled by adjusting the length of linkage 89. The closing sequence, that is, the closing of circuit breaker poles 21, 22 and the opening of field discharge pole 23, is controlled by adjusting the length of push rod 83.

Figures 5–7 illustrate field discharge circuit breaker 20 in schematic form. Where possible the reference numerals used in Figures 1–4 have been utilized for the corresponding elements in Figures 5–7 in order to simplify the correlation between the groups of Figures 1–4 and 5–7.

The closing sequence, or change in position from Figure 5 to Figure 6, is accomplished by energizing solenoid assembly 28 which rotates contact arm 40 counterclockwise about pivot 41. This compresses spring 78 thereby loading it to store a greater energy than tension spring 77 possesses. However, latch 80 and roller 82 cooperate at this time to prevent clockwise rotation of contact arm 65.

Counterclockwise rotation of arm 40 also moves push rod 83 to the left so that when contacts 44 and 19 engage, latch 80 is rotated clockwise about pin 81 and contact arm 65 is free to rotate clockwise about pivot 66 under the influence of spring 78, which overcomes the force of spring 77, thereby bringing about the disengagement of contacts 69, 70. When solenoid assembly 28 is deenergized latch 87, biased counterclockwise about pin 18, maintains contacts 44, 19 in engagement against the force of opening spring 60.

The opening sequence, or change in position from Figure 6 to Figure 7, is accomplished by an upward movement of trip link 90 which first moves latch 85 free of roller 86 so that spring 78 no longer exerts a force on contact arm 65. This permits spring 77 to rotate arm 65 counterclockwise about pivot 66 to bring contacts 69, 70 into engagement.

Thereafter, extension 17 of trip link 90 engages latch 87 to rotate it clockwise about pin 18 thereby disengaging roller 16 so that contact arm 40 is free to rotate clockwise about pivot 41 to disengage contacts 44, 19.

It is to be noted that the operation of the trip link 90 with field discharge circuit breaker 20 in the open position of Figure 5 will in no way effect the positions of any of the pairs of cooperating contacts.

Figure 8 illustrates, in schematic form, a slightly modified construction of the field discharge circuit breaker 20 hereinbefore described. For the sake of clarity and simplicity the reference numerals of Figures 5–7 have been retained in Figure 8 to designate substantially the same elements. The closing sequence of field discharge circuit

breaker **100** is identical to the previously described closing sequence of field discharge circuit **20**. Therefore, the description thereof will be omitted.

However, their opening sequences differ in that extension **17** of trip link **90** has been replaced by a second push rod **101** which is mounted to the end of contact arm **65**. Second push rod **101** is operatively positioned to rotate latch **87** to its unlatched position when contacts **69, 70** are engaged.

The opening sequence takes place as follows. Upward movement of trip link **90** unlatches latch **85** permitting closing spring **77** to rapidly bring field discharge contacts **69, 70** into engagement. During the final counterclockwise motion of contact arm **65** second push rod **101** engages and thereby unlatches latch **87** and in so doing permits spring **60** to bring about disengagement of circuit breaker contacts **44, 19**. In the closing sequence, when contacts **69, 70** have become disengaged, second push rod **101** has moved to the left thereby permitting latch **87** to rotate counterclockwise to its latching position.

Thus we have provided a novel construction for a field discharge circuit breaker in which an accurate contact sequence is achieved by utilizing stored energy to operate the field discharge contacts both into and out of engagement. In the closing sequence the energy is released an instant after the circuit breaker contacts engage with the energy release being controlled by the position of the circuit breaker contacts.

In the opening sequence the energy is released to close the field discharge contacts and an instant thereafter the releasing mechanism or field discharge contact arm releases the latch holding the circuit breaker contacts closed. In this way, the timing of the operational sequence is insignificantly effected by the operation of the circuit breaker in both the opening and closing sequences.

Although we have here described preferred embodiments of our novel invention, many variations and modifications will now be apparent to those skilled in the art, and we therefore prefer to be limited, not by the specific disclosure herein, but only by the appending claims.

We claim:

1. A field discharge circuit breaker comprising a first pair of cooperating contacts and a second pair of cooperating contacts; a first means biasing said first pair of contacts toward engagement; a first latch for maintaining said first pair of contacts in engagement; a second means, for storing energy, operatively connected between said first and said second pairs of contacts; said second pair of contacts when moving from their disengaged to engaged position loading said second means to an energy level in excess of said first means; said second pair of contacts unlatching said first latch after said second means is loaded thereby permitting said first pair of contacts to be disengaged through the action of said second means subsequent to the engagement of said second pair of contacts.

2. A field discharge circuit breaker comprising a first pair of cooperating contacts and a second pair of cooperating contacts; a first means biasing said first pair of contacts toward engagement; a first latch for maintaining said first pair of contacts in engagement; a second means, for storing energy, operatively connected between said first and said second pairs of contacts; said second pair of contacts when moving from their disengaged to engaged position loading said second means to an energy level in excess of said first means; said second pair of contacts unlatching said first latch after said second means is loaded thereby permitting said first pair of contacts to be disengaged through the action of said second means subsequent to the engagement of said second pair of contacts; a second latch for maintaining the operative connection between said second means and said first pair of contacts; a third means for unlatching said second latch thereby permitting said first pair of contacts to be engaged through the action of said first means.

3. A field discharge circuit breaker comprising a first pair of cooperating contacts and a second pair of cooperating contacts; a first means biasing said first pair of contacts toward engagement; a first latch for maintaining said first pair of contacts in engagement; a second means, for storing energy, operatively connected between said first and said second pairs of contacts; said second pair of contacts when moving from their disengaged to engaged position loading said second means to an energy level in excess of said first means; said second pair of contacts unlatching said first latch after said second means is loaded thereby permitting said first pair of contacts to be disengaged through the action of said second means; a second latch for maintaining the operative connection between said second means and said first pair of contacts; a third means for unlatching said second latch thereby permitting said first pair of contacts to be engaged through the action of said first means; a fourth means biasing said second pair of contacts toward disengagement and a third latch for maintaining said second pair of contacts in engagement; said third means also unlatching said third latch thereby permitting said second pair of contacts to be disengaged through the action of said fourth means; said second and said third latches being unlatched in a predetermined time sequence.

4. A field discharge circuit breaker comprising a first pair of cooperating contacts and a second pair of cooperating contacts; a first means biasing said first pair of contacts toward engagement; a first latch for maintaining said first pair of contacts in engagement; a second means, for storing energy, operatively connected between said first and said second pairs of contacts; said second pair of contacts when moving from their disengaged to engaged position loading said second means to an energy level in excess of said first means; said second pair of contacts unlatching said first latch after said second means is loaded thereby permitting said first pair of contacts to be disengaged through the action of said second means; a second latch for maintaining the operative connection between said second means and said first pair of contacts; a third means for unlatching said second latch thereby permitting said first pair of contacts to be engaged through the action of said first means; a fourth means biasing said second pair of contacts toward disengagement and a third latch for maintaining said second pair of contacts in engagement; said third means also unlatching said third latch thereby permitting said second pair of contacts to be disengaged through the action of said fourth means; said second and said third latches being unlatched in a predetermined time sequence; said third means including an element secured to said first pair of contacts and engageable with said third latch for unlatching thereof after said second latch has been unlatched.

5. A field discharge circuit breaker being comprised of a field discharge pole and a main pole; said field discharge pole being closed by means of a first energy storing means an instant before said main pole is opened; said field discharge pole being opened by means of a second energy storing means an instant after said main pole is closed; said second means being loaded to an energy level greater than the energy level of said first means during the closing motion of said main pole; said second means being connectable to oppose said first means to effect opening of said field discharge pole.

6. A field discharge circuit breaker being comprised of a field discharge pole and a main pole; said field discharge pole being closed by means of a first energy storing means an instant before said main pole is opened; said field discharge pole being opened by means of a second energy storing means an instant after said main pole is closed; said second means being loaded to an energy level greater than the energy level of said first

means during the closing motion of said main pole; said second means being connectable to oppose said first means to effect opening of said field discharge pole; a first latch means for maintaining said field discharge pole closed until said main pole is closed; said main pole when closed unlatching said first latch thereby permitting said second means to open said field discharge pole.

7. A field discharge circuit breaker being comprised of a field discharge pole and a main pole; said field discharge pole being closed by means of a first energy storing means an instant before said main pole is opened; said field discharge pole being opened by means of a second energy storing means an instant after said main pole is closed; said second means being loaded to an energy level greater than the energy level of said first means during the closing motion of said main pole; said second means being connectable to oppose said first means to effect opening of said field discharge pole; a first latch means for maintaining said field discharge pole closed until said main pole is closed; said main pole when closed unlatching said first latch thereby permitting said second means to open said field discharge pole; a second latch means when latched establishing an operative connection between said second means and said field discharge pole; said second latch when unlatched breaking said operative connection and permitting said first means to close said field discharge pole.

8. A field discharge circuit breaker being comprised of a main pole and a field discharge pole; said main pole including a first contact and a first contact arm carrying a second contact; said first contact arm being movable between a first and a second position wherein said first and said second contacts are engaged and disengaged respectively; said field discharge pole including a third contact and a second contact arm carrying a fourth contact; said second contact arm being movable between a third and a fourth position wherein said third and said fourth contacts are engaged and disengaged respectively; a first spring biasing said second contact arm toward said third position; a first latch for maintaining said second contact arm in said second position; a second spring and a spring guide member, for said second spring, having a pair of elongated slots extending between said first and said second contact arms; said second spring being loaded by movement of said first contact arm from said second to said first position; a second latch operatively connecting said second spring to said second contact arm and when so connected urging said second contact arm toward said fourth position; said second spring, when loaded, storing a greater energy than that stored in said first spring; a first push rod secured to said first contact arm engageable with said first latch for unlatching thereof when said first contact arm is in said first position.

9. A field discharge circuit breaker being comprised of a main pole and a field discharge pole; said main pole including a first contact and a first contact arm carrying a second contact; said first contact arm being movable between a first and a second position wherein said first and said second contacts are engaged and disengaged respectively; said field discharge pole including a third contact and a second contact arm carrying a fourth contact; said second contact arm being movable between a third and a fourth position wherein said third and said fourth contacts are engaged and disengaged respectively; a first spring biasing said second contact arm toward said third position; a first latch for maintaining said second contact arm in said second position; a second spring and a spring guide member, for said second spring, having a pair of elongated slots extending between said first and said second contact arms; said second spring being loaded by movement of said first contact arm from said second to said first position; a second latch operatively connecting said second spring to said second contact arm and when so connected urging said second contact arm toward said fourth position; said second spring, when loaded, storing a greater energy than that stored in said first spring; a first push rod secured to said first contact arm and engageable with said first latch for unlatching thereof when said first contact arm is in said first position; a third spring urging said first contact arm toward said second position and a third latch for maintaining said first contact arm in said first position; a trip link means engageable with said second latch for unlatching thereof; a member protruding from said trip link means and engageable with said third latch, after unlatching of said second latch, for unlatching of said third latch.

10. A field discharge circuit breaker being comprised of a main pole and a field discharge pole; said main pole including a first contact and a first contact arm carrying a second contact; said first contact arm being movable between a first and a second position wherein said first and said second contacts are engaged and disengaged respectively; said field discharge pole including a third contact and a second contact arm carrying a fourth contact; said second contact arm being movable between a third and a fourth position wherein said third and said fourth contacts are engaged and disengaged respectively; a first spring biasing said second contact arm toward said third position; a first latch for maintaining said second contact arm in said second position; a second spring and a spring guide member, for said second spring, having a pair of elongated slots extending between said first and said second contact arms; said second spring being loaded by movement of said first contact arm from said second to said first position; a second latch operatively connecting said second spring to said second contact arm and when so connected urging said second contact arm toward said fourth position; said second spring, when loaded, storing a greater energy than that stored in said first spring; a first push rod secured to said first contact arm and engageable with said first latch for unlatching thereof when said first contact arm is in said first position; a third spring urging said first contact arm toward said second position and a third latch for maintaining said first contact arm in said first position; a trip link means engageable with said second latch for unlatching thereof; a second push rod secured to said second contact arm and engageable with said third latch for unlatching thereof when said second contact arm is in said third position.

11. A field discharge circuit breaker being comprised of a main pole and a field discharge pole; said main pole including a first contact and a first contact arm carrying a second contact; said first contact arm being movable between a first and a second position wherein said first and said second contacts are engaged and disengaged respectively; said field discharge pole including a third contact and a second contact arm carrying a fourth contact; said second contact arm being movable between a third and a fourth position wherein said third and said fourth contacts are engaged and disengaged respectively; a first spring biasing said second contact arm toward said third position; a first latch for maintaining said second contact arm in said second position; a second spring and a spring guide member, for said second spring, having a pair of elongated slots extending between said first and said second contact arms; said second spring being loaded by movement of said first contact arm from said second to said first position; a second latch operatively connecting said second spring to said second contact arm and when so connected urging said second contact arm toward said fourth position; said second spring, when loaded, storing a greater energy than that stored in said first spring; a first push rod secured to said first contact arm and engageable with said first latch for unlatching thereof when said first contact arm is in said first position; a third spring urging said first contact arm toward said second position and a third latch for maintaining said first contact arm in said first position; a trip link means

engageable with said second latch for unlatching thereof; a second push rod secured to said second contact arm and engageable with said third latch for unlatching thereof when said second contact arm is in said third position; said trip link means, said first and said second push rods each being independently adjustable in length for adjusting the timing sequence between said main pole and said field discharge pole.

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