Feb. 24, 1970 L. N. MERRIKEN ET AL 3,497,838

CIRCUIT BREAKER HAVING INERTIAL DELAY

Filed April 22, 1968 5 Sheets-Sheet 1

FIG. 1.

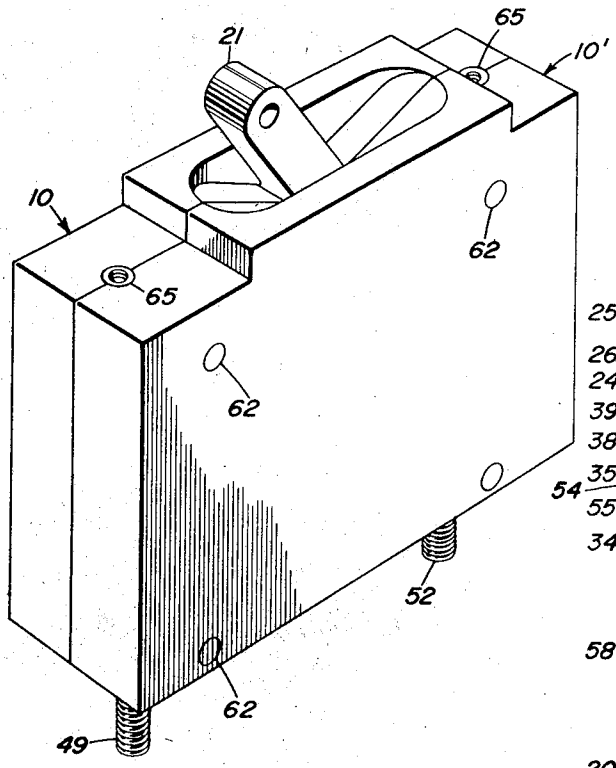


FIG. 5.

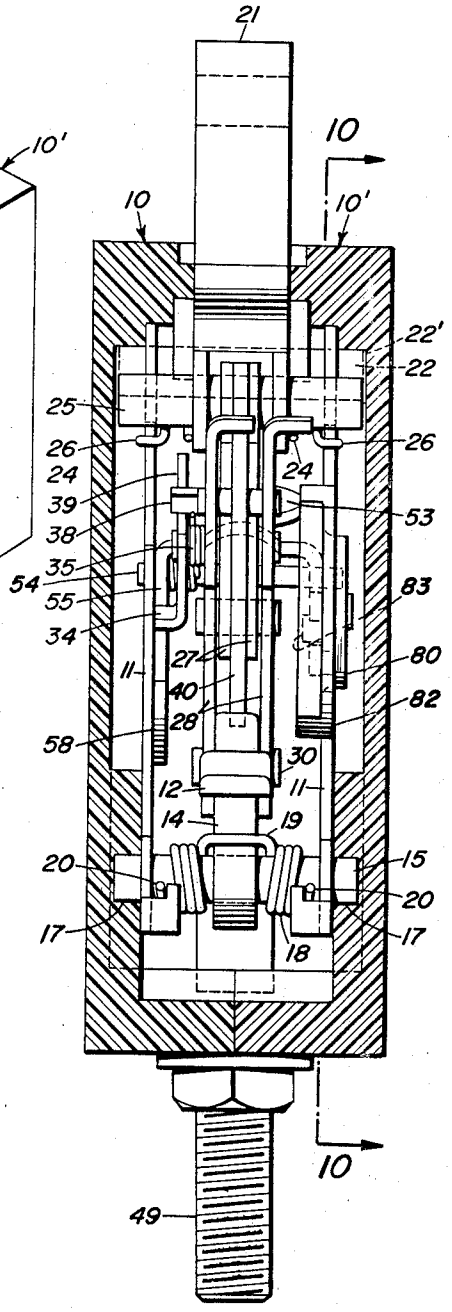
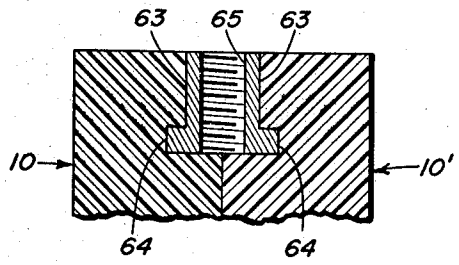


FIG. 6.



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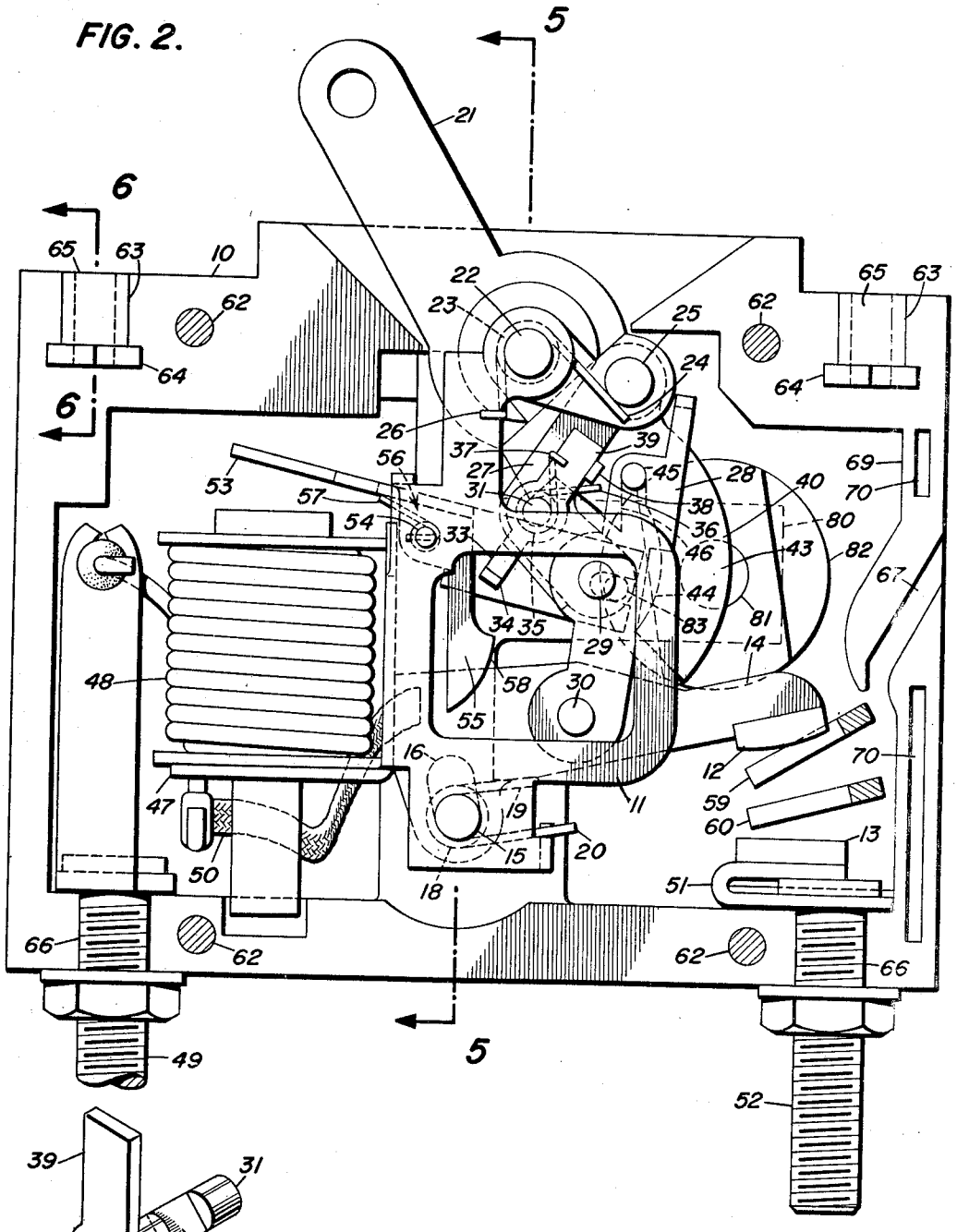
CIRCUIT BREAKER HAVING INERTIAL DELAY

Filed April 22, 1968 5 Sheets-Sheet 2

FIG. 2.



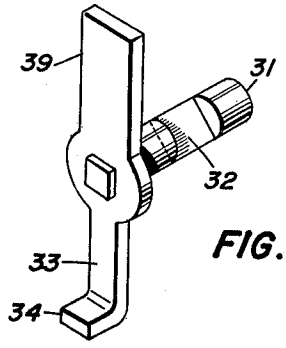


FIG. 7.

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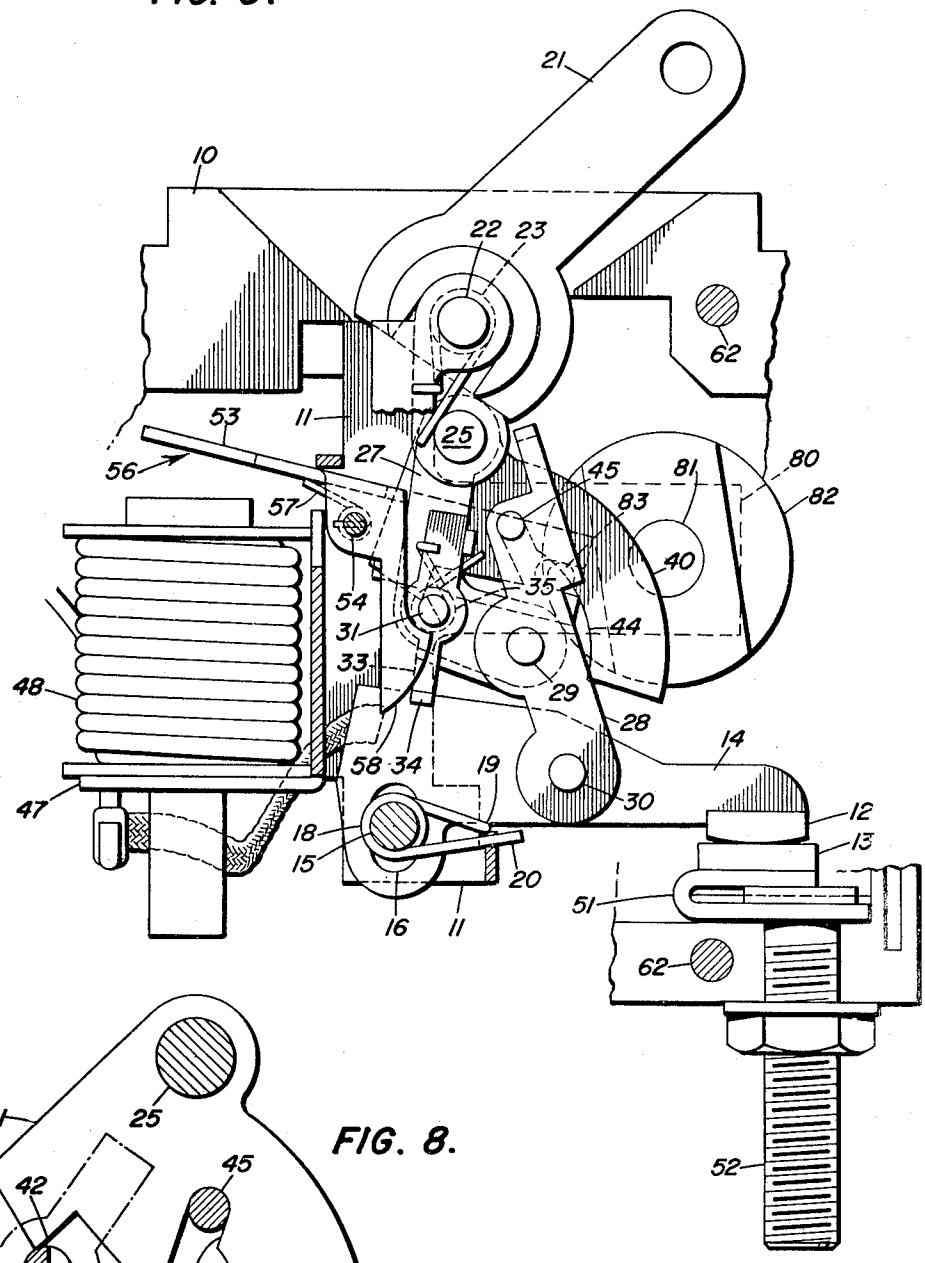
Feb. 24, 1970 L. N. MERRIKEN ET AL 3,497,838

CIRCUIT BREAKER HAVING INERTIAL DELAY

Filed April 22, 1968 5 Sheets-Sheet 3

FIG. 3.



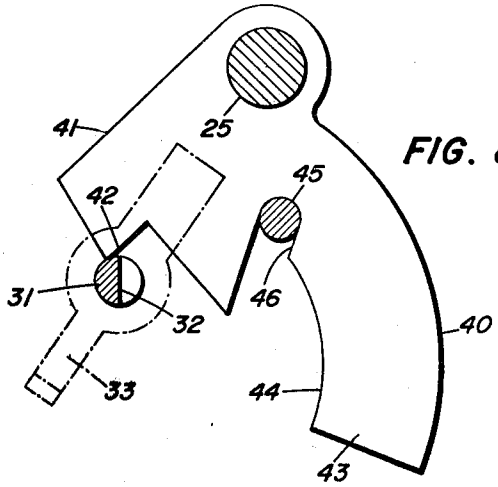


FIG. 8.

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CIRCUIT BREAKER HAVING INERTIAL DELAY

Filed April 22, 1968 5 Sheets-Sheet 4

FIG. 4.

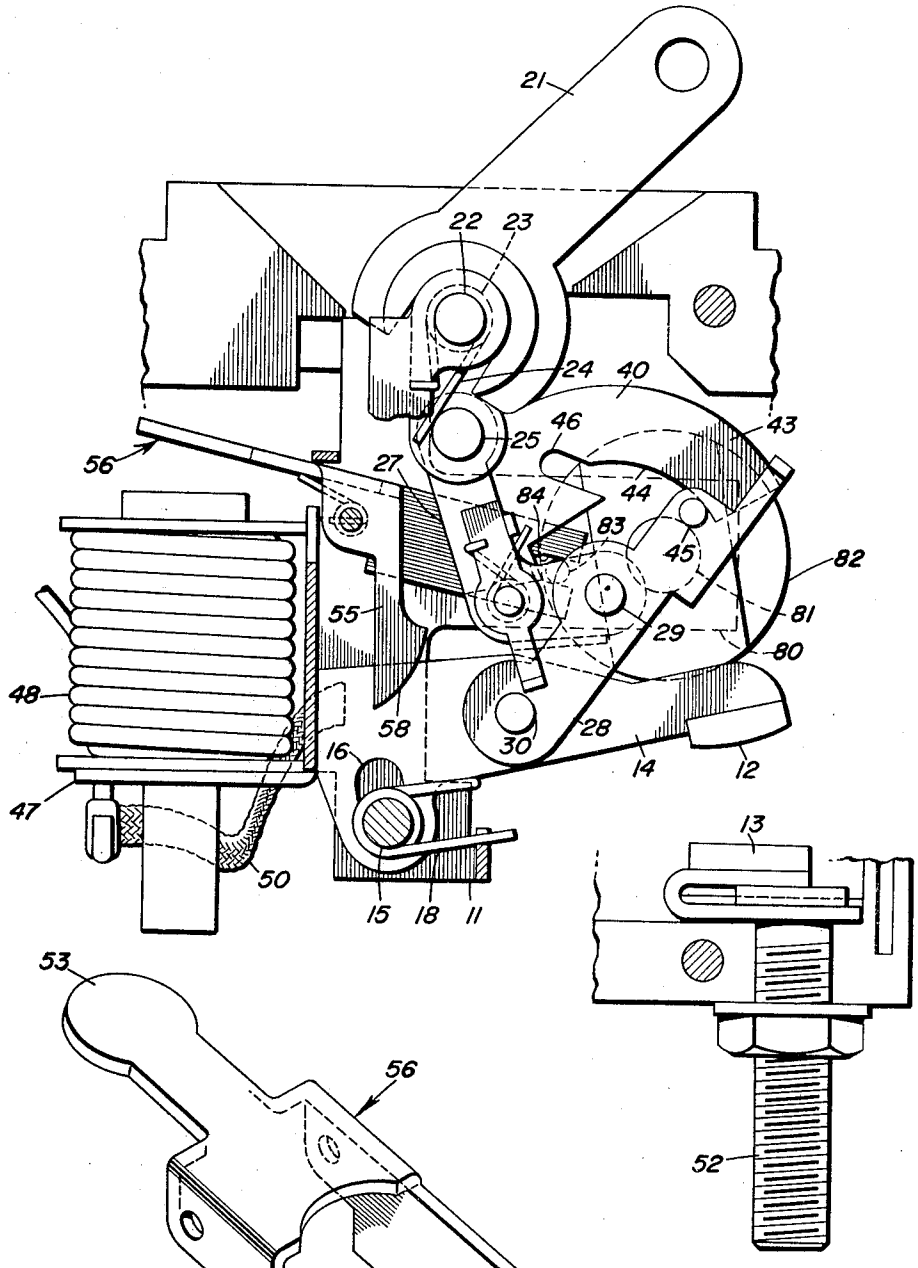

FIG. 9.

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Feb. 24, 1970 L. N. MERRIKEN ET AL 3,497,838

CIRCUIT BREAKER HAVING INERTIAL DELAY

Filed April 22, 1968 5 Sheets-Sheet 5

FIG. 10.

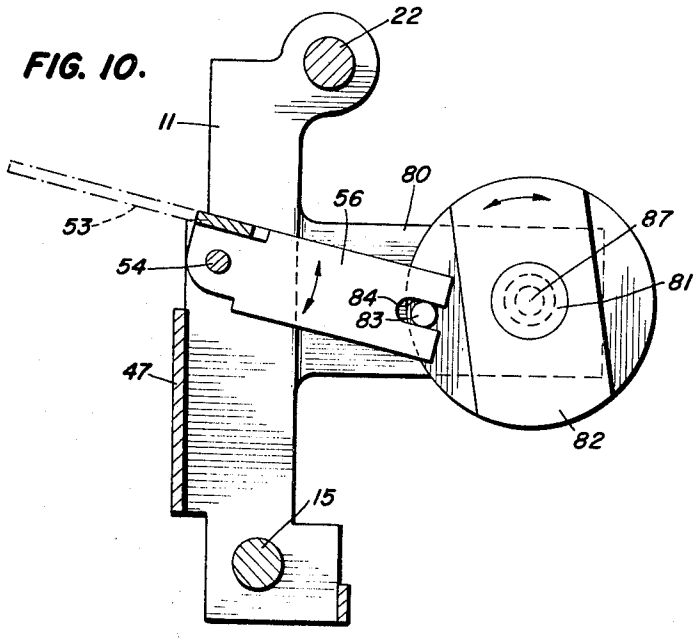
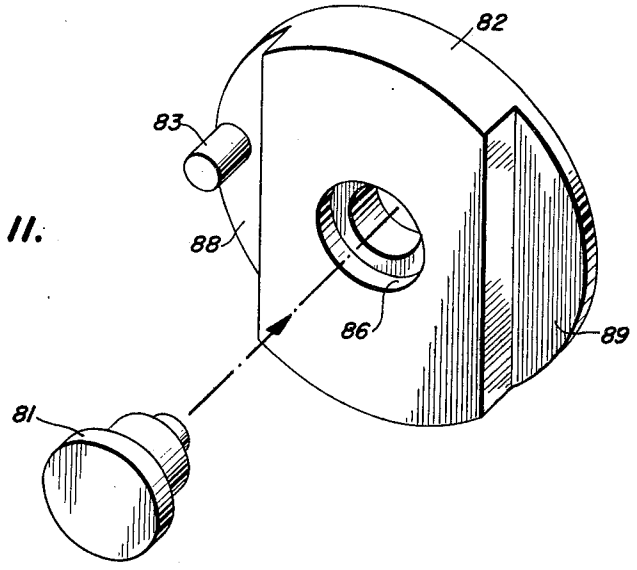


FIG. 11.



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3,497,838

CIRCUIT BREAKER HAVING INERTIAL DELAY

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Continuation-in-part of application Ser. No. 545,434, Apr. 26, 1966. This application Apr. 22, 1968, Ser. No. 729,486

Int. Cl. H01h 7/08, 43/02

U.S. Cl. 335—64 10 Claims

ABSTRACT OF THE DISCLOSURE

An electromagnetic circuit breaker has improved operating characteristics in that it is less susceptible to being tripped by very short duration overload currents. The circuit breaker is provided with an armature mechanically coupled to a balanced inertia wheel so that the dynamic mass of the armature is effectively increased. The inertia wheel introduces an initial mechanical delay into the circuit breaker for overload currents exceeding about 400% of rated current.

This application is a continuation-in-part of copending application Ser. No. 545,434, filed Apr. 26, 1966 which is in turn a continuation-in-part of the then copending application Ser. No. 377,993, filed June 25, 1964, now U.S. Patent 3,251,232.

The present invention is directed to an improved electromagnetic circuit breaker which will not trip out when subjected to high amplitude current for a short time. The circuit breaker incorporates a balanced inertia wheel for effectively increasing the inertia of the circuit breaker armature to introduce a time delay before the breaker trips out when subjected to very high overload currents.

As is well known, circuit breakers are used in numerous devices where it is desired to protect electrical equipment against overload. Important advantages include the fact that the conventional electromagnetic circuit breaker is resettable and may be tripped repeatedly without any necessity for replacement or repair. However, one of the disadvantages of the electromagnetic circuit breakers is that they have a tendency to trip out when subjected to high amplitude current for a short time. This is often referred to as nuisance tripping and occurs in some cases in conjunction with the starting of certain types of electrical motors and inductive and capacitive loads.

The present invention provides a device for overcoming this nuisance tripping so that the circuit breaker is substantially insensitive to very high amplitude currents which last for only a short time. At the same time, the device of the present invention preserves the other advantageous features of the more conventional circuit breaker including its response to small overloads and to large overloads of long duration. This is accomplished by introducing into the circuit breaker in a simple and inexpensive manner, an increased mechanical delay which only has a significant effect for overloads in excess of about 400% of rated current for the breaker. As the result, the breaker has the capacity to take electrical pulses of higher amplitude and/or longer electrical pulse duration before tripping.

The increase in capacity is achieved through the provision of an inertial wheel in the breaker to introduce an additional time delay. That is, a certain predetermined amount of force is required to move the armature, operate the mechanism, and open the contacts in a conventional circuit breaker. The provision of a balanced inertia wheel in the circuit breaker increases the dynamic mass of the breaker mechanism but does not change the amount

of force required to operate the breaker. Thus, since the force required to operate the mechanism is essentially the same with or without the inertia wheel, but the dynamic mass of the mechanism is increased by the mass of the inertia wheel, the acceleration is decreased. The result is that a mechanical time delay is introduced into the circuit breaker which, in many cases of high amplitude current, is sufficiently long to prevent the breaker from tripping and allow the short duration high surge of current to pass. If, however, the surge of current continues for some reason, the circuit breaker of the present invention will trip.

When subjected to overload currents at or below about 400% of the rated current, the circuit breaker of the present invention maintains the specified calibration of a circuit breaker not having an inertia wheel. This is because the inertia wheel is balanced and does not exert any appreciable force on the armature. It is only at currents above 400% of rated current that the inertia wheel begins to have a significant affect on the trip time of the breaker.

It is therefore one object of the present invention to provide a circuit breaker having improved operating characteristics.

Another object of the present invention is to provide a circuit breaker having increased capacity to take electrical pulses of higher amplitude and/or longer electrical duration, as compared with similar conventional circuit breakers.

Another object of the present invention is to provide a circuit breaker having an increased time delay for overload currents in excess of about 400% of rated current.

Another object of the present invention is to provide a simplified and inexpensive arrangement for incorporating, in a circuit breaker, an additional mechanical time delay without at the same time significantly modifying the amount of force required to trip the breaker.

Another object of the present invention is to provide a circuit breaker with a balanced inertia wheel coupled to the breaker armature, thereby effectively increasing the dynamic mass of the armature.

These and further objects and advantages of the invention will be more apparent upon reference to the following specification, claims and appended drawings wherein:

FIGURE 1 is a perspective view of a circuit breaker in its housing constructed in accordance with the present invention;

FIGURE 2 is a side view of the breaker of FIGURE 1 with the housing removed, showing the breaker mechanism in relatched open position with the contacts open;

FIGURE 3 is a partial sectional view similar to that of FIGURE 2, showing the mechanism in a position where the contacts are closed;

FIGURE 4 is a partial sectional view similar to FIGURES 2 and 3, showing the mechanism in an intermediate or tripped open position;

FIGURE 5 is a vertical cross section taken along line 5—5 of FIGURE 2;

FIGURE 6 is an enlarged section taken along lines 6—6 of FIGURE 2, but showing the threaded ferrule in place;

FIGURE 7 is an enlarged perspective view showing the detail of the sear pin and striker bar assembly;

FIGURE 8 is a detailed view showing engagement of the sear pin and striker bar assembly with the forked lever of the breaker of FIGURE 1;

FIGURE 9 is an enlarged perspective view of the electromagnet armature bell crank assembly;

FIGURE 10 is an enlarged view of the inertia wheel mounted on its support; and

FIGURE 11 is an exploded view showing the details of the inertia wheel and axle rivet on which it rotates.

Referring to the drawings, the novel circuit breaker of the present invention, illustrated in FIGURE 1, comprises a housing **10**, which is formed of a molded plastic having good electrical insulating properties. Supported in the housing **10** is a frame **11** upon which is mounted the operating elements of the circuit breaker to move a movable contact **12** into and out of engagement with a fired contact **13**.

Movable contact **12** is secured to a lever **14** pivotally and slidably mounted on the frame by a pin **15** passing through an elongated opening **16** in the lever. Pin **15** is mounted on the frame **11**, intermediate its ends while the ends extend beyond the frame and fit snugly into cooperating recesses **17**, molded in the housing halves **10** and **10'** as seen in FIGURE 5. A spring **18** is wound around pin **15** and is provided with a biasing arm **19** bearing against the lever **14** and with a reaction arm **20** bearing against the frame **11**. Portions of the frame **11** are omitted in FIGURES 3 and 4 for the sake of clarity. The entire frame **11** is illustrated in FIGURE 2.

An actuating lever **21** is pivotally mounted on the frame **11** by a pin **22**. The pin **22** is mounted in the frame intermediate its ends while the ends extend beyond the frame and fit snugly into cooperating recesses **22'** molded in the housing **10** as best seen in FIGURE 5. A spring **23** is wound around the pin **22** and has a biasing arm **24** bearing against a pin **25** and also a reaction arm **26** bearing against the frame **11**. Pivotally mounted on pin **25** is an L-shaped link **27** and this link is pivotally connected to a spaced pair of links **28** by pin **29**. The links **28** are pivotally connected by a pin **30** to straddle the lever **14**.

Rotatably supported in link **27** at the bend of the L is the shaft of a sear pin **31** which sear pin is provided with a reduced section **32** between the links which is provided by grinding a flat sufrace **32** on the shaft **31** (FIGURE 7) which acts as a sear for edge **42** of a forked cam lever **40**. An arm or striker bar **33** is mounted rigidly and non-rotatably on shaft **31** and carries a tab **34** bent up from the end of the arm. One end of shaft **31** is square to accommodate the square hole in arm **33**. After assembly, the end of shaft **31** is peened tight against arm **33**, permanently keying the shaft and arm together. A spring **35** is wound around shaft **31** and is provided with arms **36** and **37** bearing respectively against a stop **38** integral with one arm of link **27** and against an extension **39** of arm **33**. The spring is wound to urge extension **39** against the stop.

Forked lever **40** is pivotally mounted on pin **25** between the parallel arms of link **27**. One leg **41** of the fork is provided with an edge portion **42** for engagement with the sear portion **32** of shaft **31**, and the other leg **43** of the fork is provided with a curved cam section **44** for engagement with a pin **45** carried by links **28**. Between the legs at the end of cam section **44** is a locking recess **46**.

Frame **11** is provided with a shelf **47** on which is mounted an electromagnet **48** having a winding, one end of which is connected in series with a terminal **49** and the other end in series with a braided flexible copper wire **50** secured to lever **14**, for completing a circuit through movable contact **12**, fixed contact **13**, and contact support **51** to terminal **52**. An armature **53** is pivotally mounted on the frame by a pin **54** and is secured to an armature lever **55** to form therewith a bell crank **56** shown in detail in FIGURE 9. A spring **57** is mounted on pin **54** to bias the bell crank **56** toward the position shown in FIGURE 2. The free end of the armature lever forms an arcuate trigger cam surface **58**. In the closed contact position, the linkage is in the position shown in FIGURE 3 with the tab portion **34** adjacent the arcuate trigger cam surface **58** at the end of armature lever **55**.

Referring to FIGURES 10 and 11, the armature bell crank **56** pivots about pin **54** secured to frame **11**. Slot **84** in the bell crank receives a projection or pin **83** mounted on a brass inertia wheel **82**. Wheel **82** is mounted for rotation on an axle rivet **81** which pases through a central aperture **86** in the wheel and through a suitable aperture in a flat support plate **80** soldered or otherwise rigidly attached to frame **11**. Wheel **82** is preferably balanced about its rotational axis **87** and is cut away as at **88** and **89** so that the bell crank **56** acts through the center of the wheel. In this way, the wheel is completely balanced so that it can be rotated by the bell crank without exerting any substantial retarding force on the crank, other than that due to rotary inertia of the wheel.

The housing is formed of two mirror image sections **10** and **10'** (FIGURES 1 and 5) which are secured together by rivets **62** passing through openings in the housing. One of the sections, such as section **10**, is provided with an elongated groove **70** and the other section is provided with an elongated tongue which is snugly received in the groove. This tongue-in-groove arrangement is for the purpose of accurately aligning the housing sections in assembly.

Each housing section is provided with recesses **63** molded in the meeting faces. The recesses **63** are provided with an enlarged portion **64**. When the sections are secured together as shown in FIGURE 5, the recesses **63** combine to provide openings which receive threaded metal ferrules **65** (FIGURE 6) with hexagonal heads by which the assembly is secured to a support. The recesses **66** combined to provide openings for the reception of the threaded terminals **49** and **52**.

In operation, on overload, the electromagnet **48** is energized to a point where it attracts armature **53** and causes the bell crank **56** to rotate counterclockwise about pin **54**. Slot **84** in the leg of the bell crank shown in FIGURE 9, engages with crank pin **83** of the inertia wheel **82**. The inertia wheel **82** is attached to the support plate **80** by axle rivet **1** but freely rotates about the rivet.

Before the armature **53** can rotate to a point where it will trip the breaker mechanism, it has to rotate the balanced inertia wheel **82** in a clockwise direction in FIGURE 10. Under conditions of high current overload through the electromagnet **48**, the inertia wheel **82** increases the length of time it takes to rotate the armature **53** as compared to a circuit breaker not having an inertia wheel. However, under conditions of low current overload, the inertia wheel **82** does not restrict the travel of armature **53** via the bell crank and the time required for the armature **53** to rotate is substantially the same as a similar breaker not having an inertia wheel.

When armature **53** rotates counterclockwise, the armature lever **55** (FIGURE 9) brings the trigger cam surface **58** into contact with tab **34** to rotate striker bar **33** and shaft **31**. Rotation of shaft **31** presents the reduced section **32** to the edge **42** of the fork **40**, allowing the fork **40** to rotate counterclockwise about pin **25** to release pin **45** from recess **46** as illustrated in FIGURE 4. The release of pin **45** allows the linkage to collapse and the lever **14** to pivot about pin **15** to separate the contacts **12** and **13**. The arc drawn by the separating contacts is extinguished by its reaction to the arc chutes **59** and **60** in the usual manner. Vent opening **67** is provided in the casing **10** closely adjacent the arc chutes and serves as a pressure release for the gases produced by arcing. The force of spring **23** reacts against pin **25** to rotate the lever **21** to the position shown in FIGURE 2. The movement of pin **25** about pin **22**, under the urging of spring **23**, realigns links **27** and **28** and fork **40** to replace pin **45** in recess **46** as shown in FIGURE 2. In order to close the contacts, the handle is rotated clockwise about pin **22** to force the linkage down to rotate lever **14**. When the contacts close, they become a pivot about which lever **14** is rotated against the force of spring **18** to load the spring and linkage for future toggle action.

It is apparent from the above that the present invention provides an improved circuit breaker, particularly insensitive to short duration high overloads. A balanced inertia wheel effectively increases the dynamic inertia of the bell

crank **56** and its armature **53** and is particularly effective at overloads exceeding 400% of the rated current to increase the trip time of the circuit breaker. That is, according to the basic formula $F=MA$, the increase in mass afforded by the inertia wheel **82** under the influence of the same tripping force, reduces the acceleration of the armature so that it takes longer to move to a position where the breaker is tripped. The inertia device of this invention is of relatively simple and inexpensive construction and requires no modification of the basic circuit breaker mechanism. At the same time, it substantially increases the capacity of the breaker to resist overload currents and substantially reduces the so-called nuisance tripping previously encountered in conventional circuit breakers.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is, therefore, to be considered in all respects as illustrative and not rectrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. In a circuit breaker having an electromagnet and a contact trip mechanism, a bell crank pivoted adjacent said electromagnet including a first portion forming an armature for said electromagnet, said bell crank including a second portion for actuating said trip mechanism after a predetermined amount of movement of said crank, and pivotally mounted balanced inertia means coupled to said bell crank for effectively increasing its dynamic mass to overload currents in excess of about 400% of the rated current through said electromagnet.

2. Apparatus according to claim **1** wherein said inertia means comprises a balanced inertia wheel mounted for rotation about a fixed axis.

3. Apparatus according to claim **1** wherein said inertia means comprises a balanced inertia wheel mounted for rotation about a fixed axis adjacent said bell crank, and a projection on said wheel, said bell crank having a slot slidably receiving said projection.

4. Apparatus according to claim **3** wherein said wheel is cut away, said projection being on said cut away portion of said wheel whereby said crank acts on said wheel through its center.

5. Apparatus according to claim **4** wherein said wheel

is rotatably mounted in the pivotal plane of said bell crank.

6. A circuit breaker for protecting against electrical overloads comprising an electromagnet, a pair of contacts, a toggle mechanism coupled to one of said contacts for moving said one contact away from the other of said contacts, an armature pivoted adjacent said electromagnet and including means for tripping said toggle mechanism, and pivotally mounted balanced inertia means coupled to said armature for increasing the trip time of said breaker for currents through said electromagnet in excess of approximately 400% of its rate current.

7. A breaker according to claim **6** wherein said inertia means comprises a balanced inertia wheel mounted for rotation about a fixed axis adjacent said armature.

8. A circuit breaker comprising an electrically insulating housing, an electromagnet mounted in said housing, a pair of contacts in said housing, a toggle mechanism in said housing for moving one of said contacts away from the other, said toggle mechanism including a sear, a bell crank pivoted adjacent said electromagnet for tripping said sear, a portion of said bell crank forming an armature for said electromagnet, a balanced inertia wheel mounted for rotation about a fixed axis in said housing, and means coupling said bell crank to said inertia wheel whereby pivotal movement of said bell crank causes said inertia wheel to rotate.

9. A circuit breaker according to claim **8** wherein said wheel carries a projection, said bell crank having a slot slidably received in said projection.

10. A circuit breaker according to claim **8** wherein said wheel is rotatably mounted in the pivotal plane of said bell crank.

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