March 10, 1970 J. J. ORAVEC 3,500,275

AUTOMATIC CIRCUIT BREAKERS

Filed March 11, 1968

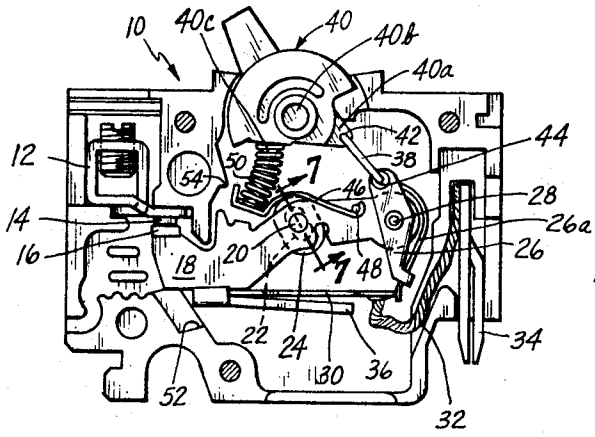

Fig. 1

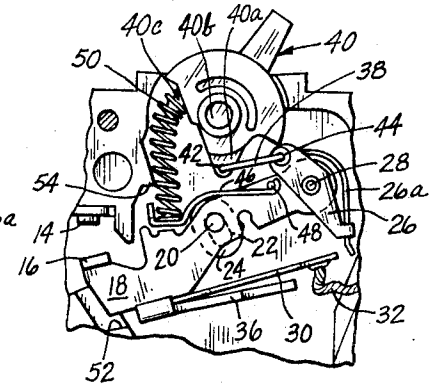

Fig. 2

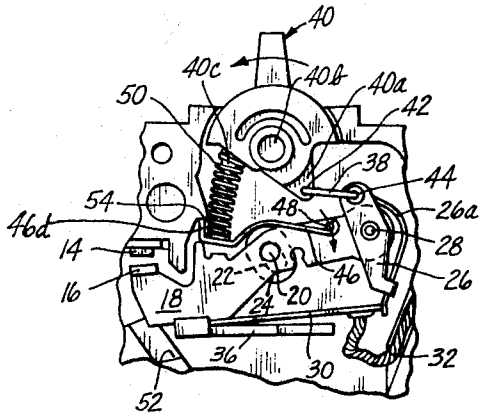

Fig. 3

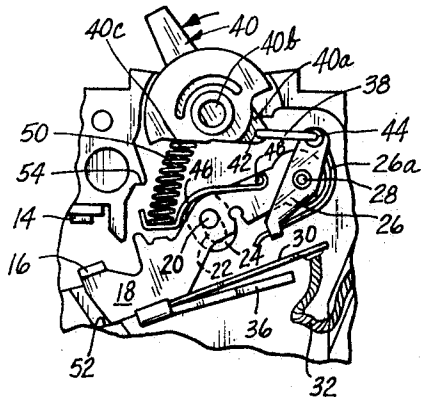

Fig. 4

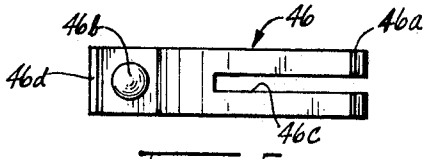

Fig. 5

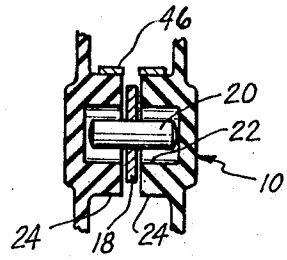

Fig. 7

Fig. 6

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AUTOMATIC CIRCUIT BREAKERS

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U.S. Cl. 337—75 8 Claims

ABSTRACT OF THE DISCLOSURE

An automatic circuit breaker having an elongated movable contact arm. A current responsive latch and an actuator are carried by the movable contact arm. One end of a resilient lever acts on the contact arm at a point between the pivot of the actuator and the main pivot of the contact arm itself. The resilient lever extends over a fulcrum; and the compression coil spring acts between the opposite end of the resilient lever and part of the operating handle. During the closing operation, the handle and its connecting toggle link gradually approach their erect condition and the handle applies progressively increasing compression on the coil spring which in turn transmits contact-closing bias to the contact arm via the resilient lever.

My present invention relates to automatic circuit breakers and more particularly to circuit breakers of the type in which an actuator is pivotally carried by the movable contact member and is latched thereto, under the control of a current-responsive device, and includes a manual operator to open and close the circuit breaker.

This invention relates to circuit breakers of the type in Patent No. 2,811,605 issued Oct. 29, 1957 to P. M. Christensen et al. and to Re. 24,388 issued Nov. 5, 1957, to P. M. Christensen on original Patent No. 2,789,179. A widely known and highly successful type of circuit breaker mechanism involves an elongated contact arm that is pivoted near it center, that carries a moving contact at one extremity and that has an operating linkage pivoted to its opposite extremity. This type of circuit breaker has seen enormous commercial success in the form shown in the above patent to Christensen et al. The operating linkage includes a pivoted operating handle, a pivoted actuator and a coupling link between the handle and the actuator. The handle and the link form an operating toggle. The contact arm carries a current responsive latching device that normally arrests the actuator so that the operating toggle consisting of rigid elements provides positive driving effort for operating the contact arm in the contact-closing direction and for holding the contact closed so long as the actuator is latched. An object of the present invention resides in providing contact pressure in the foregoing type of circuit breaker mechanism.

When the operating handle and the connecting link are operated as a toggle for closing the circuit breaker, the toggle gradually moves from a collapsed condition to an erect condition at which time the contacts are to be closed. It is desirable although not essential that the gradual motion of the toggle shall not cause gradual meeting of the moving contact with the companion contact of the circuit breaker, because such engagement coud result in "teasing" of the contacts. That condition can lead to welding and consequently to failure of the circuit breaker. The above Patent No. 2,811,605 discloses a means for avoiding the gradual or tease-closing of the contacts during the progressive motion of the toggle into erect condition. An object of the present invention resides in providing a novel toggle-operated circuit breaker which avoids tease-closing of the contacts in a new and effective manner.

A still further object of the present invention resides in providing a circuit breaker mechanism having a novel construction for applying resilient contact pressure, and for effecting snap-closing of the contacts during progressive erecting motion of the toggle, as well as effecting high speed opening of the contacts upon release of the overcurrent latch of the circuit breaker.

In the description that follows, an illustrative circuit breaker for achieving the foregoing objects includes an elongated contact arm pivoted near its midpoint, carrying a movable contact at one end for cooperation with a companion contact, carrying a current responsive latch, and carrying a pivoted actuator that is normally restrained by the latch. The actuator is operated into latch-pressure engagement with the current-responsive latch. Thereafter the actuator, the latch and the contact arm are operated as a unit in the contact closing direction by a toggle that becomes erect and then slightly overset when the contacts are closed. The toggle includes a pivoted operating handle as one link and a second link from the operating handle to the actuator. To this extent, the circuit breaker is entirely conventional. In the illustrative novel circuit breaker the following particular means is provided for developing contact pressure when the circuit breaker is closed, and for accommodating the "overtravel" of the toggle during the contact closing motion and after the contacts have actually made contact, so as to apply and maintain resilient contact pressure, and further to provide powerful contact-opening bias that is instantly available when the actuator is released in response to an overcurrent. The same parts additionally provide a novel means for causing snap-closing of the contacts. The resilient means that achieves all of the foregoing purposes include a compression coil spring and a resilient lever. One end of the resilient lever acts on the contact arm at a point between the pivot of the actuator and the main pivot of the contact arm itself. The resilient lever extends over a fulcrum; and the compression coil spring acts between the opposite end of the resilient level and a part of the operating handle. During the closing operation, the handle and its connecting toggle link gradually approach their erect condition and, during this motion, the handle applies progressively increasing compression on the coil spring which in turn transmits contact-closing bias to the contact arm via the resilient lever. The main pivot of the contact arm has a limited latitude of movement in a guide slot in the casing of the circuit breaker. As the toggle approaches its erect condition the contacts actually engage; and during the further motion of the toggle into its erect condition and slightly beyond, the coil spring and the spring lever apply and maintain resilient contact pressure. In case of an overcurrent the current-responsive latch releases the actuator; and when that occurs the end of the contact arm remote from the contact is no longer restrained by the operating toggle, with the result that the contact closing and biasing spring means becomes instantly available to drive the contact arm about the main pivot in the contact-opening direction.

An end part of the resilient lever is arranged to move toward a fixed stop in the casing during the contact closing motion. This stop is reached just before the contacts engage. The contact-closing operation of the operating toggle continues, while the compression in the coil spring increases. Just before the toggle is erect, the spring lever which was arrested by the stop has been withdrawn as a result of shifting of the contact arm and shifting of the resilient lever. This results in snap-closing of the contacts.

The nature of the invention and its further novel features and advantages will be more fully appreciated from the detailed description of the illustrative embodi-

ment which is shown in the accompanying drawings. In the drawings:

FIG. 1 is a lateral view of a circuit breaker embodying features of the invention, with one side cover removed to show the internal construction;

FIG. 2 is a fragmentary illustration of the mechanism of FIG. 1 in the normal, open condition of the circuit breaker;

FIG. 3 is another fragmentary view of the operating mechanism just before closing of the contacts;

FIG. 4 is a still further fragmentary view of the operating mechanism after automatic opening of the contacts in response to an overload, the operating handle being forcibly retained in its "on" position to illustrate trip-free operation;

FIGS. 5 and 6 are plan and lateral views, respectively, of a resilient member forming part of the mechanism in FIGS. 1 to 4; and

FIG. 7 is a fragmentary cross section of part of the mechanism as viewed from the section line 7—7 in FIG. 1.

Referring now to the drawings and in particular to FIG. 1, there is shown a circuit breaker of the form generally illustrated in U.S. Patent No. 2,811,605 Christensen et al., modified as indicated below to constitute the presently preferred embodiment of this invention. The illustrated circuit breaker has a two-part "sandwich" casing **10** of molded insulation, the front cover being removed in FIG. 1 for clarity. The circuit breaker includes a first terminal **12** having a stationary contact **14** that cooperates with a movable contact **16** united to elongated contact arm **18**. A rigid pivot pin **20** extends through the contact arm and is preferably fixed to it. Pin **20** is free to move through a limited distance along a path that slants slightly, downward to the right in FIG. 1, but is confined against right-to-left movement. For this purpose, the ends of pin **20** move in roughly oval cavities **22** in raised bosses **24** on the inside faces of casing **10**, as shown also in FIG. 7. A member **26** is carried by an insulated pivot **28** at the end of arm **18** remote from contact **16**. Member **26** includes an ambient temperature compensating bimetal **26***a* that is pivoted at its upper end and slidable lengthwise at the lower end of member **26**, providing a latching point. Member **26** and its bimetal **26***a* form what is commonly called an "actuator" or a "bell crank." A bimetal **30** is united at its left extremity to contact arm **18** and its right end forms a latch for an ambient compensating bimetal **26***a*. Flexible conductive braid **32** connects the right-hand end of bimetal **30** to a resilient plug-in terminal **34** secured in casing **10**. Bimetal **30** forms a current-responsive latch for actuator **26**, deflecting downward in the event of self-heating due to current flowing through the bimetal. A rigidly mounted soft iron pole-piece **36** is effective to deflect bimetal **30** downward in case of sudden bursts of short-circuit current.

Contact arm **18**, actuator **26** and bimetal **30** form a triangular unit that is operated clockwise by a U-shaped wire member **38** whose legs form pivots in actuator **26** and in an arm **40***a* of operating handle **40**. Link **38** and arm **40***a* form a toggle that has a knee **42**. In FIG. 1, this knee is above a straight line between pivots **40***b* of the handle and pivot **44** in the actuator, and is said to be overcentered or over-set. Handle **40** is arrested by casing **10** against further clockwise movement, and thus toggle **38**, **40***a* is arrested in its over-set configuration, as illustrated. In this "erect" condition (although slightly over-set), the toggle holds the circuit breaker closed.

A spring lever **46** has a hooked portion **46***a* (see also FIGS. 5 and 6) engaged about a pin **48** fixed in contact arm **18**. Spring lever **46** has a slot **46***c* that receives contact arm **18**, so that the two legs of the spring lever engage extremities of pin **48** at the opposite sides of arm **18**. At its opposite end spring lever **46** has a dimple **46***b* that is received in the lower end of compression coil spring **50**. The opposite end of spring **50** bears against handle **40** and is located by a handle projection **40***c*. Compression spring **50** acts along a line that is nearly through the pivot **40***b* of handle **40**. A small component of spring bias acts on handle **40** in the clockwise direction, inadequate to overcome the bearing friction of the handle and the force applied to the handle by the toggle **40***a*, **38**. Coil spring **50** also applies considerable force to lever **46**. Spring lever **46** is curved near its middle so as to rock about bosses **24**. Thus, downward pressure of coil spring **50** is converted to upward bias at pin **48**. This upward bias urges the triangular unit of arm **18**, actuator **26** and bimetal **30** upward about pivot **44**, for applying resilient pressure between contacts **14** and **16**. In the configuration of the parts in FIG. 1, main pivot **20** of contact arm **18** is spaced from the upper and lower extremities of passages **22**. See also FIG. 7.

Current flows through the circuit breaker from terminal **12** through contacts **14** and **16**, contact arm **18**, bimetal **30** and braid **32** to terminal **34**. Bimetal **30** deflects downward when heated.

The upward bias at pin **48** produces a clockwise bias on actuator **26**, and thus provides latch pressure. The release of actuator **26** by the bimetal cause the actuator to swing freely clockwise. Compression spring **50**, acting through spring lever **46**, drives the contact arm bodily upward until pin **20** reaches the top of passages **22** and thereafter spring **50** drives contact arm **18** counterclockwise about pin **20** to open the circuit breaker, as illustrated in FIG. 4. In FIG. 4, handle **40** is considered to be hand-held in its "on" position (as represented by the arrow). Otherwise spring **50** would become effective to snap the handle to its opposite extreme position. Then handle **40** is released, the handle assumes the position of FIG. 2; and when this occurs arm **40***a* draws link **38** to the left, to reset actuator **26** opposite the end of bimetal **30**. In the open condition of the circuit breaker both in FIG. 2 and in FIG. 4, contact arm **18** is limited against further motion in the contact-opening direction by engagement with a projection **52** of casing **10**.

The circuit breaker can be operated manually to open the contacts, simply by moving handle **40** from the position in FIG. 1 to that in FIG. 2. To close the circuit breaker, handle **40** is manually moved to the left, from its position in FIG. 2 to that of FIG. 1. During this motion of the handle, the toggle **38**, **40***a* is progressively moved from its collapsed condition in FIG. 2 toward its erect position, ultimately to be slightly overset as in FIG. 1. During this motion, movable contact **16** moves toward companion contact **14**. If the contacts were to be moving gradually at the time that they are nearly closed, then there is danger of "teasing" of the contacts occurring and correspondingly there is danger of contact welding or contact-erosion due to arcing. The illustrated circuit breaker avoids this danger, in a manner now to be described.

Spring lever **46** has an abutment end **46***d* that is cooperable with a projecting ledge **54** formed integral with the casing. During the closing motion of the mechanism as described above, abutment **46***d* engages ledge **54** so as to be arrested. and an arm extension **18***a* engages lever **46** so that closing travel of contact **16** is arrested. This occurs prior to the full-erection of toggle **38**, **40***a*. Continued operation of the toggle forces the right-hand extremity of lever **18** downward and slightly to the right as pin **20** moves in its passage **22**. Furthermore, resilient lever **46** is drawn downward, and is pulled to the right over bosses **24**. This action shifts abutment **46***d* to the right of shoulder **54**, allowing projection **18***a* and contact arm **18** to snap upward and close the contacts.

Spring **50** and lever **46** occupy readily available space in the casing without danger of interference in operation of other parts, and they perform the several functions of guarding against tease-closing of the contacts, providing a means for spring-powered closing of the contacts and for biasing the contacts together when closed, and a means for spring-powered opening of the contacts in

response to an overload as well as in manual opening operations. As a compression coil spring, element **50** is relatively a non-critical component that is easily assembled. It requires only the simplest means of location at its extremities. Furthermore, the incidence of breakage of such a coil spring is extremely rare, so that, the mechanism described has high reliability and represents a relatively simple and effective mechanism for the purposes described. A still further advantage of lever **46** and compression spring **50** is that it applies upward bias to contact arm **18** in all phases of the circuit breaker operation, a distinctive advantage in the circuit breaker disclosed in an application filed concurrently herewith, March 11, 1968, Ser. No. 712,041, by Thomas M. Cole.

The circuit breaker described in detail above and shown in the accompanying drawings represents the presently preferred embodiment of the invention in its various aspects. However, it will be appreciated that those skilled in the art will readily introduce modifications and will find varied application of the novel features; and consequently the invention should be construed broadly in accordance with its full spirit and scope.

I claim:

1. An automatic circuit breaker having an elongated movable contact arm carrying a movable contact, a companion contact engageable by said movable contact for closing a circuit through the circuit breaker, a current responsive latch carried by the movable contact arm, operating means including an actuator pivotally mounted on said contact arm and operatively connected thereto under control of said latch, for closing the circuit breaker, a pivot on which the movable contact arm is mounted and bearing means for said pivot accommodating limited movement of the pivot transverse to the pivotal axis, and spring means for biasing the contact arm in the contact closing direction in the closed condition of the circuit breaker and for biasing the contact arm in the open direction in the open condition of the circuit breaker and when it is unlatched, said spring means comprising a lever having one end acting on said contact arm between said pivot and said actuator and a compression coil spring acting on the opposite end of said lever, and means providing a fulcrum for said lever between the ends of the lever.

2. A circuit breaker in accordance with claim **1**, wherein said operating means includes a toggle comprising an operating handle and a connecting toggle link between said handle and said actuator, said compression spring having one end thereof acting against said lever and the opposite end thereof acting against said handle in the resetting direction when said toggle is buckled.

3. A circuit breaker in accordance with claim **1** wherein said lever is of resilient metal.

4. A circuit breaker in accordance with claim **1** further including an enclosure of molded insulation having complementary inward-extending bosses forming the fulcrum of said lever.

5. A circuit breaker in accordance with claim **1**, further including an enclosure of molded insulating having complementary inward-extending bosses forming the fulcrum of said lever, said bosses having elongated recesses for guiding said pivot through limited movement transverse of the length of said elongated contact arm.

6. A circuit breaker in accordance with claim **5** wherein said lever is resilient.

7. A circuit breaker in accordance with claim **6** wherein said enclosure includes an abutment on the contact arm engageable with the extremity of said lever adjacent said compression spring and wherein said enclosure includes an abutment engageable by an end portion of said lever during the closing motion of the contact arm but prior to contact engagement, said contact arm being operable to shift the lever free of engagement with said casing abutment prior to completion of a contact-closing operation, the contact arm then being operated by said spring and lever abruptly for snap-closing the contacts.

8. A circuit breaker in accordance with claim **1** further including an abutment engageable by a portion of said lever adjacent said compression spring, said extremity of the lever being arranged to obstruct a closing motion of the contact arm prior to completion of the contact closing operation of said operating means, operation of said operating means thereafter causing said extremity to shift free of said abutment, freeing the contact arm for snap-closing the contacts under the influence of said spring and lever.

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337—53, 59