March 7, 1944. H. C. GRAVES, JR 2,343,548

CIRCUIT BREAKER LOCKING DEVICE

Filed Aug. 8, 1942 4 Sheets-Sheet 1

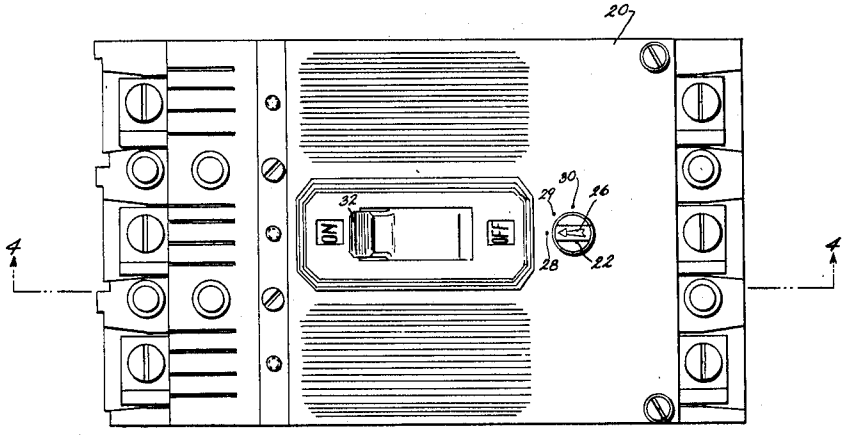

Fig. 1

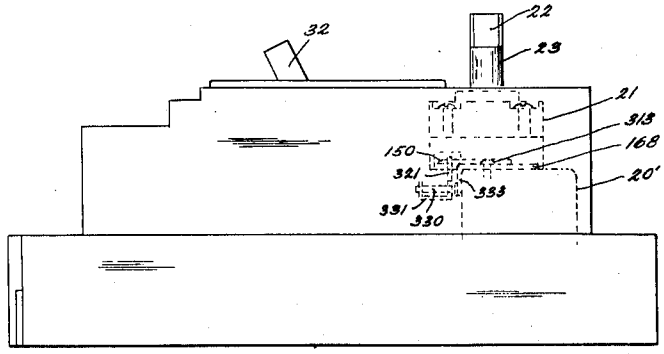

Fig. 2

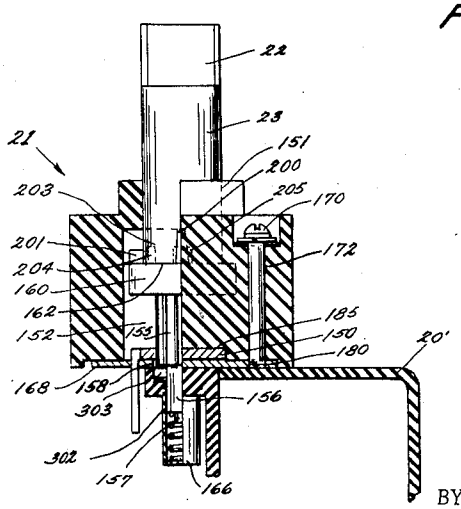

Fig. 3

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CIRCUIT BREAKER LOCKING DEVICE

Filed Aug. 8, 1942 4 Sheets-Sheet 2

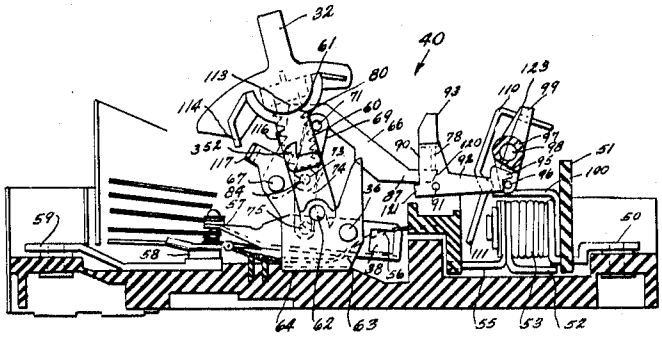

Fig. 4

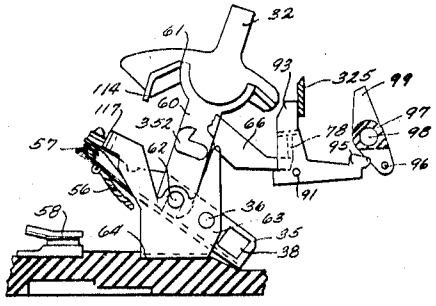

Fig. 5

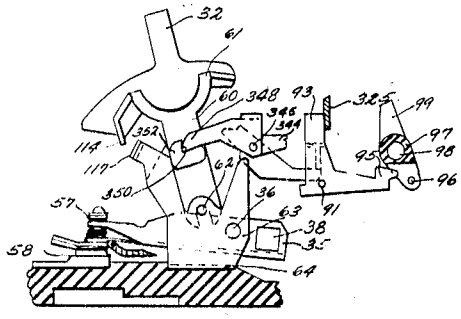

Fig. 6

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CIRCUIT BREAKER LOCKING DEVICE

Filed Aug. 8, 1942 4 Sheets-Sheet 3

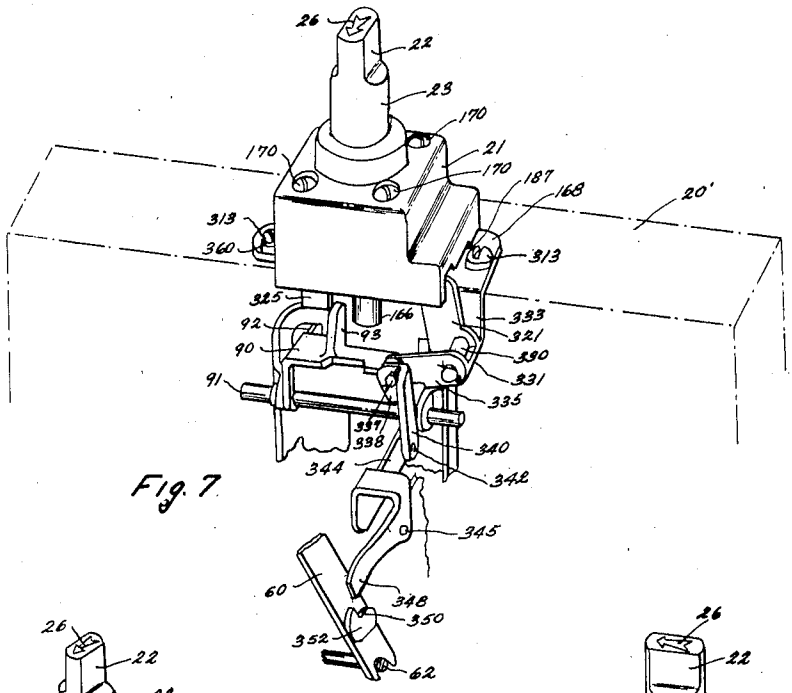

Fig. 7

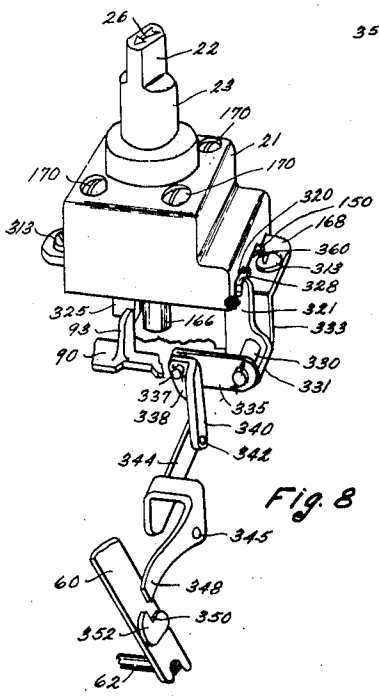

Fig. 8

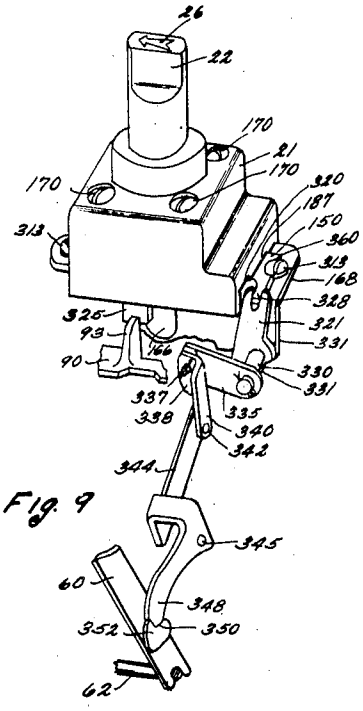

Fig. 9

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CIRCUIT BREAKER LOCKING DEVICE

Filed Aug. 8, 1942 4 Sheets-Sheet 4

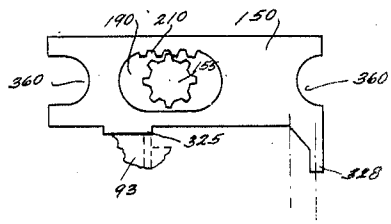

Fig. 11

Fig. 10

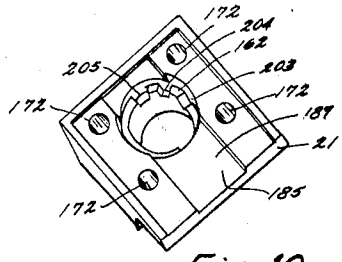

Fig. 10a

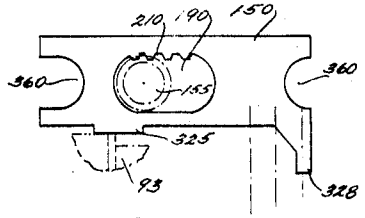

Fig. 12

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Patented Mar. 7, 1944

2,343,548

UNITED STATES PATENT OFFICE

2,343,548

CIRCUIT BREAKER LOCKING DEVICE

Herbert C. Graves, Jr., West Chester, Pa., assignor to I-T-E Circuit Breaker Company, Philadelphia, Pa., a corporation of Pennsylvania

Application August 8, 1942, Serial No. 454,164

7 Claims. (Cl. 200—109)

My invention relates to circuit breakers and more particularly to locking devices therefore which will, when desired, prevent either manual or automatic operation thereof to open circuit position under selected conditions.

The primary purpose of a circuit breaker, as is well known, is to provide means for automatic or manual closing and interrupting of a circuit under specific predetermined conditions.

However, in the operation of devices which may at times be subjected to unexpected shocks or jars or in the operations of devices which it may, under certain conditions, be necessary to maintain in operation irrespective of possible damage, it becomes necessary to provide means to prevent automatic or even manual opening of the circuit breaker.

Thus, in the operation of electrical installations on naval craft during battle or manoeuvre conditions, it is far more important that an electrical device or system be maintained in operation irrespective of any damage that may occur thereto than that a protective device be opened on the occurrence of a fault.

Also in the operation of naval craft, it may be desirable or necessary under certain conditions that means be provided so that a circuit breaker will be prevented from opening under the shock of gun fire (either impact or recoil).

Under such conditions, it may be fatal to the continued effectiveness of the vessel should the circuit breaker open accidentally owing to the jarring effect of gun fire or even should it open to protect a particular device.

An object of my invention is thus to provide means which may be operated to prevent either or both the automatic or manual opening of a circuit breaker at times when the continued operation of the circuit which the circuit breaker is designed to protect is more important than the damage which may occur thereto through the possibility of a fault.

Such locking device to be effective must, however, be adapted in each case to the particular construction and operation of the circuit breaker in connection with which it is to operate. Preferably, the locking device should be so arranged that the same members may be selectively used to lock the circuit breaker against automatic or manual tripping.

At times, for instance, it may be desirable that a circuit breaker should not trip automatically while, however, manual tripping should be possible.

Also, in certain types of circuit breakers, it may be possible that the jar of gun fire (either impact or recoil) may cause the operating arm thereof to swing over to open position. In such case the element of the locking device which prevents manual opening of the circuit breaker serves the far more important function of preventing the operating arm from being swung over owing either to its own inertia under the influence of a violent jar or to any other cause.

In either case, however, the locking device must be so arranged that it may readily be operable to any selected position by even an unskilled operator and without any delay.

A further object of my invention, therefore, is the provision of a locking device for a circuit breaker wherein a single locking element may be used selectively to prevent the automatic or manual opening of the circuit breaker.

Still another object of my invention is the provision in a locking device of a single manual operating means therefor which may be readily operated to place the locking elements of the locking device in either of the selected positions above mentioned.

The successful operation of a locking device which is utilized to prevent a circuit breaker from opening under a succession of jars or impacts depends, however, on the fact that the locking device itself be jar proof.

Accordingly, a further object of my invention is the provision of operating elements for my locking device so that a plurality of motions in axes or planes normal to each other are necessary for the performance of the locking function and are also necessary to perform the unlocking function.

A more specific corollary object of my invention is the arrangement of the operating shaft of my locking device in such a manner that it must first be moved longitudinally, then rotated, and then moved longitudinally in the opposite direction before it is in locking position.

Similarly, to unlock the same, it is necessary to move it longitudinally again, then rotate it, and then it must move longitudinally in the opposite direction.

It is thus beyond the realm of probability that any rapid succession of jars or impacts would produce the exact series of movements which would be necessary to effect unlocking.

When in the locked position, the locking element itself is secure against rotation. Should any jar or impact cause the locking element to move longitudinally, a spring element is provided

to urge the operating shaft of the locking device back to its original position.

It would be necessary for the jar or impact to provide at least two forces acting at right angles to each other,—one to cause the shaft to move inwardly, and the other to cause it to rotate before the locking device could thus be accidentally opened. And these two forces must be timed to correspond with the compliance of the spring member which biases the locking device against such longitudinal movement.

Thus still another object of my invention is the arrangement of the operating shaft of my locking device in such a manner that it is itself biased into a locked position by a spring, the compliance of which is such that it seeks rapidly to return to its original position on the relaxation of pressure thereon.

A further object of my invention is the arrangement of my lock-in device and its locking element in close proximity to the circuit breaker elements with which they are to cooperate.

Still another object of my invention is the arrangement of my lock-in device so that it need not necessarily be mounted in close proximity to the circuit breaker elements with which it is intended to cooperate.

These and many other objects of my invention will become apparent, and where not apparent, will be pointed out in the following description and drawings in which:

Figure 1 is a top view of my circuit breaker showing the position of the lock-in device with respect thereto.

Figure 2 is a side view of the circuit breaker showing the arrangement of the lock-in device in dotted lines.

Figure 3 is a cross sectional view taken on line 3—3 of Figure 1, looking in the direction of the arrows.

Figure 4 is a cross sectional view of the operating elements of my circuit breaker taken on line 4—4 of Figure 1, looking in the direction of the arrows, and showing the operation of my circuit breaker when the locking device is moved out of locking position.

Figure 5 is a view corresponding to the central portion of Figure 4 showing however the locking element of the locking device moved to a position where it prevents automatic tripping of the circuit breaker.

Figure 6 is a view corresponding to that of Figure 5 showing the movement of the locking elements of my locking device to a position where they prevent both automatic and manual opening of the circuit breaker.

Figure 7 is a view in perspective of my locking device showing the position thereof which corresponds to the non-locking position shown in Figure 4.

Figure 8 is a view in perspective corresponding to that of Figure 7 showing, however, the position of the locking device wherein only the automatic tripping elements of the circuit breaker are locked and corresponds to the position of the locking elements shown in Figure 5.

Figure 9 is a view in perspective of my locking device showing the arrangement of the locking elements for full locking in of the circuit breaker to prevent both automatic and manual opening thereof and corresponds to the position of the locking elements shown in Figure 6.

Figure 10 is an exploded view in perspective of the elements of my locking device.

Figure 10a is a view in perspective showing the underside of the top of the lock-in housing.

Figure 11 is a top plan view of the principal locking element of my invention showing the position thereof when it is moved to a point where it locks only the automatic tripping elements of the circuit breaker.

Figure 12 is a view corresponding to that of Figure 11 showing however the movement of the locking elements to a position where they lock the circuit breaker against both automatic and manual opening.

Referring now to Figure 1, I have here shown the housing 20 of a three pole circuit breaker of a type which is designed to protect a circuit carrying as high as 600 amperes at 600 volts.

The locking device of my invention is encased in its own housing 21 which is mounted at one end of the inner housing of the circuit breaker 20' inside the outer housing 20. An operating handle 22 projects from the top of the housing 21 and through an opening in the outer housing 20 and is an extension of the operating shaft 23 (Figures 3 and 4). That is, the operating shaft 23 is milled on each side to produce the flat handle 22 which may readily be grasped.

The top face of the handle is provided with a suitable indication as, for instance, in the form of the arrow 26. Suitable markings are also provided in any appropriate position as, for instance, on the cover 20, to indicate the position of the locking device.

Thus, for instance, the location of the arrow 26 at the mark 28 indicates that the locking device is now inoperative. Rotation of the handle 22, so that the arrow points to the marking 29, indicates that the automatic tripping device of the circuit breaker has now been locked so that the circuit breaker will not now automatically trip while, however, it may be manually operated.

Rotation of the handle 22 so that the arrow 26 points to the marking 30 indicates that the locking device has been operated to a position where the circuit breaker is fully locked.

The markings are here merely indicated. In actual use, a plate may be provided indicating by appropriate descriptive legends the conditions of the locking device. The circuit breaker contained in the housing 20 is provided with an operating arm (hereinafter described) carrying at the end thereof the operating handle 32 which may be manually moved to the on or off position.

The three poles of the circuit breaker are interconnected so that the single operating handle operating in connection with the central pole will serve to operate each of the poles simultaneously.

As seen more particularly in Figure 4, each of the movable contact arms 35 is pivoted on the shaft 36. The same type of contact arm is used on each of the three poles. The arms are rigidly interconnected by the rectangular bar 38 to operate together.

Consequently, the operating mechanism 40, which is connected only to the central pole of the circuit breaker, serves to operate each of the poles simultaneously. The locking mechanism hence need only be mounted to engage the center pole.

The base plate 168 (hereinafter more fully described) of the lock-in device is secured on the upper surface of the interior housing 20 of the circuit breaker by a pair of bolts 313 which pass therethrough and enter into suitable tapped

openings in the housing 20'. As may readily be seen from Figure 2, the lock-in device is thus clear of the operating elements of the circuit breaker and is, in fact, mounted over the trip unit.

The circuit breaker has not here been shown in full. Only sufficient portions thereof have been illustrated to demonstrate the operation of the locking device.

Thus before a complete understanding of the operating device may be had, it will be necessary to describe the operation of the circuit breaker itself.

This description will be made only with respect to the central pole of the circuit breaker, it being understood that each of the other poles operates in exactly the same manner.

Current flows from the connection to the terminal 59 of the circuit breaker through the lead 52 into the solenoid coil 53, which is mounted on the support 51, flows through the coil, and thence to the lead 55. A connection is then made by the pig tail 56 to the movable contact element 57 mounted on the operating arm 35. Thence current flows through the stationary contact 58 to the opposite terminal 59.

The specific form of each of the elements here described and the specific manner of interengagement of the contacts 57 and 58 form no part of the present invention, and hence are only schematically and generally shown.

The movable contact arm 35 is manually operable to closed and open position by means of the handle 32 mounted on the principal arm 60. For structural purposes, the arm 60 is actually a U-shaped member, the base 61 of the U being arranged at the top and providing means for securing the handle 32 thereof and each of the opposite legs 60 being hinged at the hinge pin 62 mounted on opposite flanges 63 of the U-shaped supporting member 64.

A latching member 66 is pivotally mounted on the pin 67 supported between the opposite flanges 63 of the supporting member 64. One end of the link 69 of the operating toggle is pivotally carried by the pin 71 bearing against the apex of the latching member 66. The opposite end of the link 69 is connected by the knee pin 73 to the end of the other link 74 of the toggle. The end of the link 74 opposite the knee pin 73 is connected by the pin 75 to the contact carrying arm 35.

The position of the pin 71 of the link 69 is fixed by the fact that the latching member 66 is held at one end by the shaft 67 and at the other end is held by the latch 78.

A tension spring 80 is connected at one end to the knee pin 73 of the toggle 69—74 and at the opposite end is secured to the upper end 61 of the principal arm 60 immediately beneath the handle 32.

As may be seen, a plurality of springs 80 may be used, in the specific embodiment here shown, four such springs are used, two on each side.

In the closed position of the circuit breaker, the spring or springs 80 pass on the left hand side of the pin 71 and thus urge the knee pin 73 of the toggle towards further movement towards the left. This bias toward further movement toward the left, as here shown, serves further to extend the toggle 69—74 and thus serves to depress the pin 75 and hence depress the operating arm 35 so that the movable contact 57 is urged into close engagement with the stationary contact 58.

When the handle 32 is moved to the right, the principal arm 60 rotates clockwise about its pin 62. When the springs 80 pass to the right of the pin 71, then a collapsing force is exerted on the toggle 69—74 since the springs 80 now pull the knee pin 73 toward the left. The toggle will thus collapse toward the right and the pull of the springs 80 on the knee pins 73 will raise the links 74 and hence raise the operating arm 35 so that contact 57 is raised out of engagement with contact 58.

When, in the particular embodiment shown, the movement of the handle 32 to the left causes the springs 80 to pull the knee pin 73 toward the left and thus pulls the toggle substantially straight, further movement of the toggle beyond center in the opposite direction is, however, resisted by the pin 73 abutting against extension 84 of the latching member 66.

Movement to the right, as above described, causes collapse of the toggle and the opening of the circuit breaker contacts. Consequently, it will be seen that for manual opening of the circuit breaker it is necessary that the principal arm 60 thereof be moved to the right. Any element which may be interposed in the path of the movement of this arm to prevent movement thereof to the right will serve to prevent manual operation of the circuit breaker and will also serve to prevent the inertia imparted by any jar or impact from moving the arm 60 to the right.

The spring 80, by pulling upon the knee pin 73, also exerts an upward moment on the pin 71 mounted on the latching member 66. This upward moment which would result in the lifting of the end 87 of the latch member 66 and rotation thereof around the pin 67 is resisted by the latch 78. On release of the latch 78 the upward pull exerted by the springs 80 will thus serve to rotate the latching member 66 upwardly and cause the pin 71 to move counterclockwise with respect to pin 67.

In this counterclockwise movement, the pin 71 will pass to the opposite side of the spring 80 so that the spring will be in a position to exert unresisted collapsing pressure on the toggle 69—74, thus raising the pin 73 upwardly and thus pulling up the link 74 and causing the operating arm 35 to rotate upwardly to disengage the movable contact 57 from the stationary contact 58.

The latch 78 may constitute a pin or a flange mounted on the latch carrying arm 90. The arm 90 is pivotally mounted at 91 and consists of an auxiliary latching extension 92 extending to the right and a lock engaging arm 93 extending upwardly.

It will here be obvious that rotation of the arm 90 clockwise will move the latch 78 out of engagement with the end 87 of the latching member 66 and thus permit tripping of the circuit breaker. It will also be obvious that any element which engages the upper surface of the extension or arm 93 and thus prevents clockwise rotation thereof, will prevent the disengagement of the latch 78 from the end 87 of the latching member 66 and thus prevent automatic tripping of the circuit breaker.

My locking device hereinafter described is so arranged that a locking element may project immediately in back of the end of the arm 93 to prevent clockwise movement thereof and hence to prevent tripping of the circuit breaker. As will also be clear, the same element may also be used to operate a member into engagement with the principal arm 60 to prevent manual operation.

The latch 78 may be moved out of engagement

with the end 87 with the latching arm 66 by an overload which energizes the solenoid coil 53 to a sufficient extent.

The extension 92 of the latch carrying arm 90 is provided with an auxiliary latching member 95 which engages the auxiliary latch 96 mounted at the lower end of the arm 97 mounted on the rod 98 which is rotatable in a suitable journal of the circuit breaker housing.

The rod 98 carries an upward extension 99 behind which extends the hooked extension 110 of the solenoid armature 111. The said armature is pivoted on the end of the platform 100 carried by the support 51. Rotation of the rod 98 and of the armature 111 in a clockwise direction is resisted by suitable springs (not shown).

Should an overload occur which is sufficient in intensity to pull the armature 111 to the solenoid 53, the hooked extension 110 will cause arm 99 and shaft 98 to rotate in a counterclockwise direction. This will produce a simultaneous rotation of arm 97, thus pulling the latch 96 toward the right and out of engagement with the auxiliary latching member 95 on the extension 92 of the arm 90.

The latching arm 66 may thus rise out of engagement with the latch 78, since the arm 90 may now rotate freely clockwise. When the circuit breaker thus trips, the latching extension 66, as has above been pointed out is rotated violently upwardly and counterclockwise.

The member is, however, brought to a stop by the abutment of the portion 116 thereof against the stop 117, supported between the flanges 63 of the supporting member 64. To reset the latches it is necessary now to move the handle 32 to the right. The abutment 114 of the handle 32 engages against the portion 113 of the latching arm 66 and now rotates the same clockwise around its pin 67 as the principal operating member 60 and the handle 32 are rotated clockwise to the right.

The chamfered portion 120 of the end 87 of the latching arm 66 now strikes against the extension 121 on the arm 90 and rotates this extension in a counterclockwise direction, thus rotating the entire arm 90 counterclockwise and raising the end 95 thereof. The upper surface 123 of the end 95 now strikes against the underside of the latch 96 and thus rotates the arm 97 in a counterclockwise direction, until the latching pin 93 has been displaced sufficiently to snap under the latch engaging end 95.

The end 87 of the latching arm 66 now snaps beneath the latch 78 while at the same time the auxiliary latching member 95 comes to rest on the latch 96.

All of the latches are now reset and the circuit breaker may now be closed.

The locking device of my invention is designed to interpose a locking element immediately in back of the right surface of the arm 93 to prevent clockwise rotation of the latch carrying arm 90 from any cause. When the back surface of the arm 93 is thus blocked, such clockwise rotation cannot occur.

Likewise an additional locking element simultaneously operated also may be interposed behind the principal operating arm 60 to prevent manual operation.

Preliminary to the discussion of the locking device, itself, a further essential element of my invention should not be overlooked:

Previously, where locking devices were utilized to prevent operation of the automatic trip elements of a circuit breaker, such devices were interposed in the path of movement of the latch in such manner that the force of the tripping action was directly opposed by the positive locking force. This frequently resulted in breaking of the automatic trip elements or armatures or in the breaking of the locking device itself. My invention provides for a resilient connection between the automatic tripping operating elements and the operating latch itself so that nothing impedes the operation of the automatic tripping elements while, at the same time, the locking device may prevent the latch from being moved out of position.

Thus, as seen in Figures 4 to 6, when the locking element hereinafter described, is interposed above the upper surface of the arm 93, to prevent upward movement thereof, the trip unit may nevertheless freely operate to move the auxiliary latch 96 out of position without causing a tripping of the circuit breaker.

But as long as the principal latch 78 is maintained in position by the locking element interposed behind the right surface of the arm 93, this latch cannot move out of position and the circuit breaker cannot be automatically tripped.

Thus, as seen in Figure 5, the locking element 325 may be moved to a position where it engages against the upper surface of the arm 93 to prevent automatic tripping of the circuit breaker while, at the same time, the handle 32 may be operated to open position.

In Figure 5 it is seen that the automatic tripping action has been locked. Nevertheless, the manual operation may occur at will.

In Figure 6, the locking elements have been moved further so that one element still abuts against the upper surface of arm 93 to prevent automatic tripping while another element abuts against a member on the arm 60 thus preventing rotation thereof, and, therefore, preventing manual operation and also preventing any jar or impact from rocking the arm to open circuit position.

The locking device, as may be seen in Figures 3 and 10, comprises a principal operating shaft 23 mounted in the housing 21. As has above been pointed out, the upper end of the shaft is milled to form the handle 22. The shaft itself is rotatably journalled in the neck 151 of the housing 21 and extends into the interior 152 thereof.

A metallic insert is carried in the lower end of the operating shaft 23 and has formed thereon a pinion 155 below which is mounted the extension 156 having the additional smaller extension 157. The lower end of the operating shaft 23 immediately above the pinion 155 is provided with the collar 160. The upper surface of the collar 160, normally in the unlocked position of the locking device, bears against the inner annular ledge 162 at the upper end of the interior 152 of the casing of the locking device (see also Figure 10a). The operating shaft is urged upwardly so that the interengagement between the collar and the ledge above described takes place by means of the compression spring 165 mounted in the cylindrical member 166 which is positioned with respect to the opening 158 in the base plate 168 by being mounted in and passing through an opening 302 in the base of a depression 303 in an extension of the inner housing of the circuit breaker.

The base plate 168 is metallic and is secured on the upper surface of the interior housing 20' of the circuit breaker by a pair of bolts 313 which

pass therethrough and enter into suitable tapped openings in housing 20'.

The housing 21 including the neck 151 thereof and the elements forming the chamber 152 are a single molded integral element.

The housing 21 is provided with four longitudinal openings 172 at each of the corners thereof which extend entirely through the material thereof. These openings are countermored at the upper ends so that the heads of the bolts 170 may be recessed beneath the upper surface of the housing. The counterbores when the bolts are in place are preferably filled with wax so as to present a flush surface and prevent accidental removal of the bolts.

The base plate 168 is provided with a plurality of threaded perforations 180 to receive the ends of the bolts 170 and thus securely integrate the lock-in device.

The bottom surface of the housing which surrounds the chamber 152 is notched at 185 to permit the locking element 150 to pass therethrough. This notch, as may be seen in Figures 7 and 10, communicates with the outside of the housing forming the slot 187 through which the locking element emerges.

The locking device of my invention may be readily assembled and each of the parts may readily be interchanged with other parts of a similar device thus facilitating replacement and repair. The assembling procedure is quite simple. The spring 165 is inserted in the base of the cylinder 166. The handle end 22 of the operating shaft 23 is inserted first in the chamber 152 and pushed up through the neck 151 thereof so that the handle member emerges through the top. The locking element is then, while the locking device is held upside down, laid down in the slot 185 so that the slot 190 in the locking element registers with the pinion 155. Appropriate care is taken to see that the proper portion of the slot 190 of the locking member 150 comes into contact with the pinion 155 while the shaft 23 is in a predetermined position (the interrelationship of the various positions of the locking member with the various positions of the shaft will hereinafter be pointed out).

The extensions 156 and 157 of the operating shaft 23 are then inserted in the cylinder 166 and the spring thereby compressed while the bolts 170 are screwed into the openings 130 in the base.

The spring 165 is positioned in the cylinder 166 by its engagement around the extension 157 and the pressure thereof against the end of extension 156. The spring is thus compressed between the end of extension 156 and the base of the cylinder 166, and thus urges the operating shaft upwardly so that the collar 160 engages against the ledge 162. As may readily be seen in Figures 3 and 10a, the ledge 162 is an annular ledge surrounding a portion of the interior of the chamber 152 at the upper end thereof and extends around the interior of the chamber for approximately 260 degrees. As may also be seen in Figures 10 and 3, the collar 160 of the operating shaft 23 is provided with a pair of extensions 200 and 201.

The unlocked position of the operating shaft 23 is shown. The extension 200 registers in the annular area 203 of approximately 100° between the ends of the annular ledge 162. This extension which is much longer than the extension 201 serves to limit the degree of rotation of which the operating shaft is capable to 90°. This is so since the extension 200 itself occupies about 10° of the inner annular periphery.

The small extension 201 is adapted to successively to register in the notches 204 and 205. In order to rotate the operating shaft 23 from the position shown in Figure 3 to the intermediate locking position where only the automatic trip device is blocked, it is now necessary to grasp the handle end 22 of the shaft 23 and push the shaft inwardly against the bias of the spring 165 until the upper end of the extension 201 is clear of the ledge 162. It is obvious from Figure 3 that the operating shaft cannot be rotated towards the left. It may, however, be in this condition rotated to the right while the end of the extension 201 bears against the inner surface of the ledge 162. When the extension 201 comes opposite the notch 204 during this rotation, the spring 165 will be free to push the operating shaft 23 outwardly so that the extension 201 enters into the notch 204.

At the same time, as is hereinafter more specifically described, the locking member 150 has been moved to the position shown in Figures 5, 8 and 11.

When it is desired to block even the manual operation, then again, depression of the handle end 22 and further rotation to the right will cause the extension 201 to enter into the notch 205. At the same time, the locking member is moved to the positions shown in Figures 6, 9 and 12.

Likewise, at the same time, the extension 200 has been rotated to the position originally occupied in Figure 3 by the extension 201. Consequently, now the operating shaft can be rotated only in a reverse direction towards the left.

Should it be desired now to release the locking action, it is necessary to depress the handle end 22 and rotate the same in the reverse direction until the spring 165 forces the handle out once more.

The operator need not necessarily successively perform both the automatic locking action and the manual locking action but may proceed to the manual locking action immediately by simply depressing the handle end 22 and holding the same depressed until he has rotated it 90° when it can rotate no further. whereupon, release of the handle end will permit the spring 165 to force the operating shaft 23 outwardly so that the extension 201 enters the notch 205.

Should the operator, however, desire to block only the automatic trip, he depresses the handle end 22, rotates it slightly, and then, while continuing to rotate through 45°, no longer exerts an inward pressure on the handle end; whereupon, when the extension 201 comes opposite the notch 204, the spring 165 will force the handle end outwardly once more since the extension may now enter the notch 204.

The slot 190 in the locking member 150 is provided on one side with a rack (see Figure 10) which registers with the pinion 155. Consequently, rotation of the pinion 155, owing to rotation of the operating shaft 23, will result in the sliding of the lock element 150 in and out.

The locking element is fixed against rotation, as above described, and can only move longitudinally owing to the fact that it is confined between the notch 185 at the lower end of the housing 21 and the upper surface of the base plate 168. Thus, on rotation of the operating shaft 23 in an appropriate manner, the locking element 150 may emerge from or be retracted into the

slot 187, which is formed by the end of the notch 185.

The exploded view of Figure 10 shows each of the elements of the locking device.

An additional notch 320 is provided to permit the bifurcated flange member 321 to move in and out with respect to the locking device. The locking element 150 is provided with a dependent flange 325 which extends downwardly through the slot 326 in the base plate 168. As will be seen from Figures 3, 7, and 10, the base plate 168 extends beyond the upper surface of the inner housing 20 so that the flange 325 may extend downwardly.

When now the operating shaft 23 is depressed and then rotated in the manner previously described through 45°, the dependent flange 325 moves behind the outwardly extending arm 93 in the manner shown in Figures 5 and 11 to block the rotation of this arm and hence to prevent the main latch 78 from being disengaged. Upon a reverse movement through 45°, the flange 325 will be moved out of blocking engagement with the upper back end of the arm 93 so that the automatic tripping operation may occur under appropriate circumstances.

The outer end of the locking member 150 is provided with the extension 328 which is captured between the tines of the bifurcated crank member 321 which rotates on the pin 330, carried in the opening 332 of the dependent flange 333 of the base plate 168 and is connected by the integral eccentric extension 331 to the arm 335; the outer end of arm 335 is by the pin 337 rotatably connected to the flange 338 of the link 340.

Thus, it will be seen that movement of the locking element 150 from the position shown in Figure 7 to the position shown in Figure 9 will result in a corresponding outward movement of the lug or extension 328. The outward movement of the extension 328 results in rotation of the arm 321 in a clockwise direction (with respect to Figures 7 to 9).

This results in a corresponding movement in a clockwise direction of the arm 335 and consequently in a raising of this arm. By reason of the rotatable connection between the arm 335 and the link 340, the link 340 is thereby raised. The link 340 is, by the pin 342, rotatably connected to the end of the lever 344 which lever is in turn rotatably mounted on the fixed pin 345.

Thus, when the locking element 150 is moved from the position of Figure 7 to the position of Figure 9, the consequent raising of the link 340 results in rotation of the arm 344 about its fulcrum 345 so that the end 348 of the lever is depressed to engage the notch 350 in the latching member 352 mounted on the principal arm 60.

Thus, when the handle 22 is depressed and rotated through 90°, thus rotating the operating shaft 23 through 90°, the lever 344 is rotated around its pivot 345 to depress the end 348 thereof to engage the notch 350 on the member 352 mounted on the principal arm 60. This engagement, as will be seen from Figure 6, will prevent the movement of the arm 60 manually or otherwise to a position where the circuit breaker is open and will thus serve to maintain the circuit breaker positively in closed position.

In order to provide for the movement of the locking element in a confined space without extending the base 168 on either side further than is absolutely necessary to permit the insertion of the securing bolts 313, the ends of the locking element 150 are notched at 360, 360.

From Figures 7, 8, and 9, it will thus be seen that the locking element 150 may have a full movement from one side to the other without inteference from the heads of the bolts 313 since the cut outs 360 register with these bolt heads at either limit of rotation.

By means of the construction herein set forth and particularly by means of the linkage previously described for interconnecting the locking element 150 with the lever 344, the locking device need not necessarily be mounted opposite the arm 60 which it is intended to lock. The locking device thus may be mounted at any convenient location with respect to the circuit breaker panel and connected by linkages of the type herein described to operate the actual engaging element which may prevent manual operation of the circuit breaker. Similarly, in cases where it may be desirable or appropriate, the locking elements for engaging the automatic tripping latch and for preventing the operation thereof may be connected thereto by similar linkages so that the locking device is not limited to any specific location on the panel.

The locking device is itself made jar proof by the plurlity of motions which are necessary to unlock the same.

Should the locking device be in the fully locked position of Figures 9, 6 and 12, then the motions necessary to unlock the same are (first) an inward motion of the handle 22 against the bias of the spring 165; (secondly), a counterclockwise motion, with respect to Figure 9, is necessary until the extension 201 arrives opposite the notch 204 or opposite the area 203 when the outward bias of the spring will be effective to drive the operating shaft outwardly once more.

Any jar or impact which the circuit breaker may suffer would be scarcely likely to produce this complex series of motions simultaneously. Should a jar in one direction cause the operating shaft, when in the position of Figure 9, to move inwardly to disengage the extension 201 from the notch 205; then to unlock the unit, a second jar will be necessary of a nature to cause rotative movement of the operating shaft 23. Furthermore, this second jar must occur immediately after the first jarring motion and at an interval consonant with the compliance of the spring 165. If it occurs too soon after the first jar, then the spring 165 will not have yet been fully compressed so that the extension 201 is not yet fully withdrawn from the notch 205 and cannot yet rotate.

Should it occur an instant too late, then the spring 165, which has already been compressed, is now expanded and the extension 201 is being forced back into the notch 205 so that again the operating shaft cannot rotate.

The coincidence of fortuitous circumstances necessary to produce successive motions longitudinally and then rotationally both within an exact but extremely short time interval is so improbable as to render such a result, to all intents and purposes, impossible.

Accordingly, by this means, the locking device is itself rendered jar proof so that it will always maintain the circuit breaker in locked position when the locking device has been set.

Obviously, the locking device is arranged so that the locking element 150 may be moved to a position where it is clear of all of the operating elements and hence will interfere in no way with

the operation of the circuit breaker. When it is desired to utilize the locking device, a simple depression of the handle and rotation thereof through either 45° or 90° will result either in the locking out of the automatic tripping device or the locking in of the circuit breaker so that it cannot open at all.

The lock-in device may be closed on an overload by first re-setting the latches in the open position of the circuit breaker; then moving the locking device to engage the trip elements; then closing the circuit breaker and moving the locking device to engage the operating arm.

Immediately upon the termination of circumstances which made necessary the locking in of the circuit breaker, the locking device may be moved to unlocked position by a simple pushing in of the handle and a rotation back through 90°.

Thus, when, for instance, the vessel in which the circuit breaker is utilized enters into engagement with an enemy or enters into dangerous waters, the locking device may be set to full locking position or to a position which simply locks out the automatic trip. Should damage occur during an engagement, it is, of course, much more important the electrical apparatus on the vessel be utilized to the fullest degree irrespective of any damage that may occur thereto owing to an overload. Furthermore, it is important that any jar or impact should not render the electrical apparatus inoperative. Immediately upon termination of the engagement or upon the arrival of the vessel in safe waters, it is important the locking device be rendered inoperative without undue relay so that if a fault or damage has occurred, the circuit breaker may then trip open.

The locking device of my invention may immediately, without any complicated motions and within a fraction of a second, then be moved from locking to unlocking position.

While I have described the advantages of my locking device with respect to naval craft, it has many uses in connection with circuit breakers used in many other types of structures and in many other types of operations where, at some stage in a process or operation, it is essential that the circuit should not be tripped or jarred open; or where it is essential that the process continue to the last possible moment irrespective of damage to the electrical equipment which the circuit breaker is designed to protect.

In the foregoing, I have described my invention in connection with a preferred embodiment thereof and have set forth the same in connection with a type of circuit breaker with which it is best adapted to function.

Many variations of the locking device itself and many variations of its adaptation to different types of circuit breakers will now be obvious to those skilled in the art. Therefore, I prefer to be bound not by the specific disclosure herein, but only by the appended claims.

I claim:

1. A circuit interrupter having an operating arm and a tripping mechanism; a locking device engageable with said tripping mechanism in one position thereof; engageable with said tripping mechanism in a second position thereof; and disengageable from said tripping mechanism in a third position thereof; an additional locking member separate from said locking device and engageable with said operating arm; connecting link members between said locking device and said additional locking member; movement of said locking device resulting in movement of said additional locking member.

2. A circuit interrupter having an operating arm and a tripping mechanism; a locking device engageable with said tripping mechanism in one position thereof; engageable with said tripping mechanism in a second position thereof; and disengageable from said tripping mechanism in a third position thereof; an additional locking member separate from said locking device and engageable with said operating arm; connecting link members between said locking device and said additional locking member; movement of said locking device resulting in movement of said additional locking member; said additional locking member engaging said operating arm when said locking device is in said first position, and being disengaged therefrom when said locking device is in said second and third positions.

3. A circuit interrupter having an operating arm and a tripping mechanism; a locking device engageable with said tripping mechanism in one position thereof; engageable with said tripping mechanism in a second position thereof; and disengageable from said tripping mechanism in a third position thereof; an additional locking member engageable with said operating arm; connecting members between said locking device and said additional locking member; movement of said locking device resulting in movement of said additional locking member; said additional locking member comprising a pivoted lever; and means on said operating arm engageable by an end of said lever; said connecting members comprising a crank operable by said locking device, a connection between said crank and said lever.

4. A circuit interrupter having an operating arm and a tripping mechanism; a locking device engageable on longitudinal movement with said tripping mechanism in one position thereof; engageable with said tripping mechanism in a second position thereof; and disengageable from said tripping mechanism in a third position thereof; an additional locking member engageable with said operating arm; connecting link members between said locking device and said additional locking member; movement of said locking device resulting in movement of said additional locking link member; said additional locking link member comprising a pivoted lever; and means on said operating arm engageable by an end of said lever.

5. A circuit interrupter having an operating arm and a tripping mechanism; a locking device engageable on longitudinal movement with said tripping mechanism in one position thereof; engageable with said tripping mechanism in a second position thereof; and disengageable from said tripping mechanism in a third position thereof; an additional locking member engageable with said operating arm; connecting members between said locking device and said additional locking member; movement of said locking device resulting in movement of said additional locking member; said additional locking member comprising a pivoted lever; and means on said operating arm engageable by an end of said lever; said connecting members comprising a crank operable by said locking device, a connection between said crank and said lever.

6. A circuit interrupter having an operating arm and a tripping mechanism; a locking device having an extension engageable with said tripping mechanism in one position thereof; said extension being also engageable with said tripping

mechanism in a second position thereof; said extension being disengaged from said tripping mechanism in a third position thereof; and an additional locking member engageable with said operating arm; an additional extension on said locking device and means interengaging said additional extension and said additional locking member; said last mentioned means comprising a bifurcated crank arm engaging said additional extension and a connection from said crank arm to said additional locking member.

7. In a circuit interrupter, an operating arm and a tripping mechanism; a locking device engageable with said tripping mechanism to lock said mechanism against tripping; a locking lever controlled by said locking device; said locking lever being pivotally mounted; one end of said lever being selectively movable on rotation of said lever about its pivot into and out of engagement with said arm; and a member carried by said operating arm for engaging said end of said lever when said lever is moved to engage said operating arm; and means for operating said locking device to rotate said lever into and out of engagement with said operating arm.

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