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[54] **QUICK-OPENING AND QUICK-CLOSING CIRCUIT BREAKER WITH TOGGLE ACTION, AND A CONCENTRIC DOUBLE SHAFT**
 20 Claims, 13 Drawing Figs.

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 [51] Int. Cl. **H01h 3/46**
 [50] Field of Search **200/153.7,**
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 287/53 H, 53; 74/548; 338/134; 317/103

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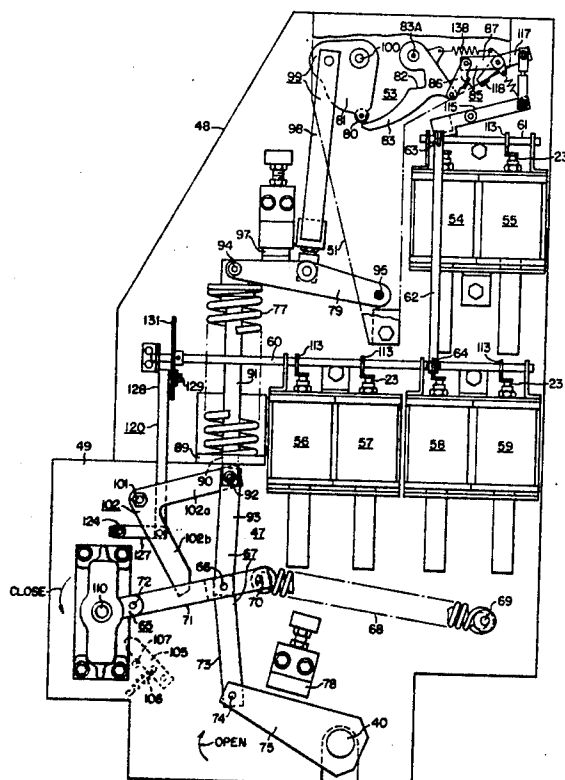
ABSTRACT: A quick-opening and quick-closing circuit breaker is provided having a high-speed operating mechanism including a closing spring and an opening spring. A crank arm operator is provided to tension both the closing and opening springs, so that by the rotation of a driving crank mechanism, a charging of the closing spring and a simultaneous charging of the opening spring takes place. Upon the attainment of a one-half revolution of the driving rotatable operator, the opening spring is tensioned and latched, and the closing spring is permitted to contract and quickly effect closing of the operating mechanism, while at the same time maintaining the latched condition of the charged opening spring.

Tipping means is provided for releasing the latching of the charged opening spring, either by manual or electrical tripping, and upon the actuation of the tripping means, the latching means of the opening spring is released to effect a quick-opening operation of the circuit breaker.

A housing construction is provided, particularly adaptable for submersible applications, wherein a concentric crank-arm-operating mechanism projects through the sidewall of the housing structure, with the one concentric shaft actuating a tripping mechanism. For a certain application, an operating wheel may be provided, which, in one position, will actuate one of the concentric shafts, and which when reversed to its other position, will operate the other concentric shaft for tripping operations, for example.

A rotatable main operating shaft, extending lengthwise of the breaker structure, may simultaneously effect the opening and closing movements of a plurality of interrupting structures, for example, controlling a three-phase circuit.

An additional feature of the circuit breaker construction is the use of separately mounted mechanism plates, which result in accurate registration of the several fixed-shaft positions, and the provision of ready maintenance therefor.



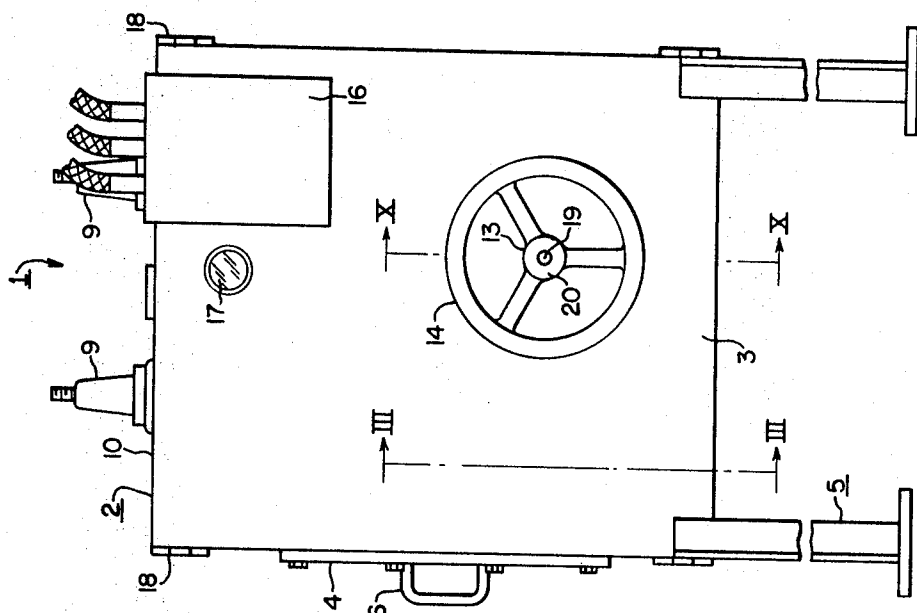


FIG. 1.

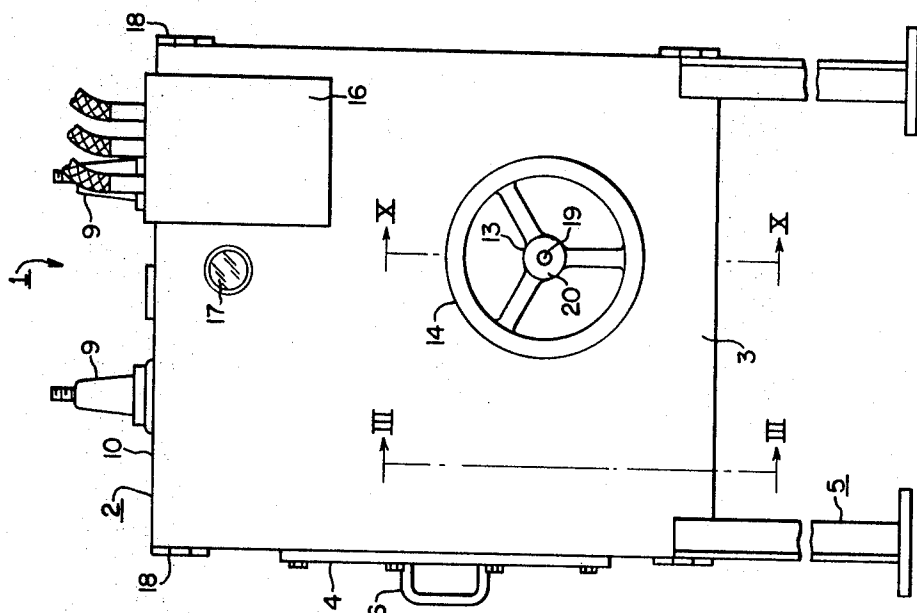


FIG. 2.

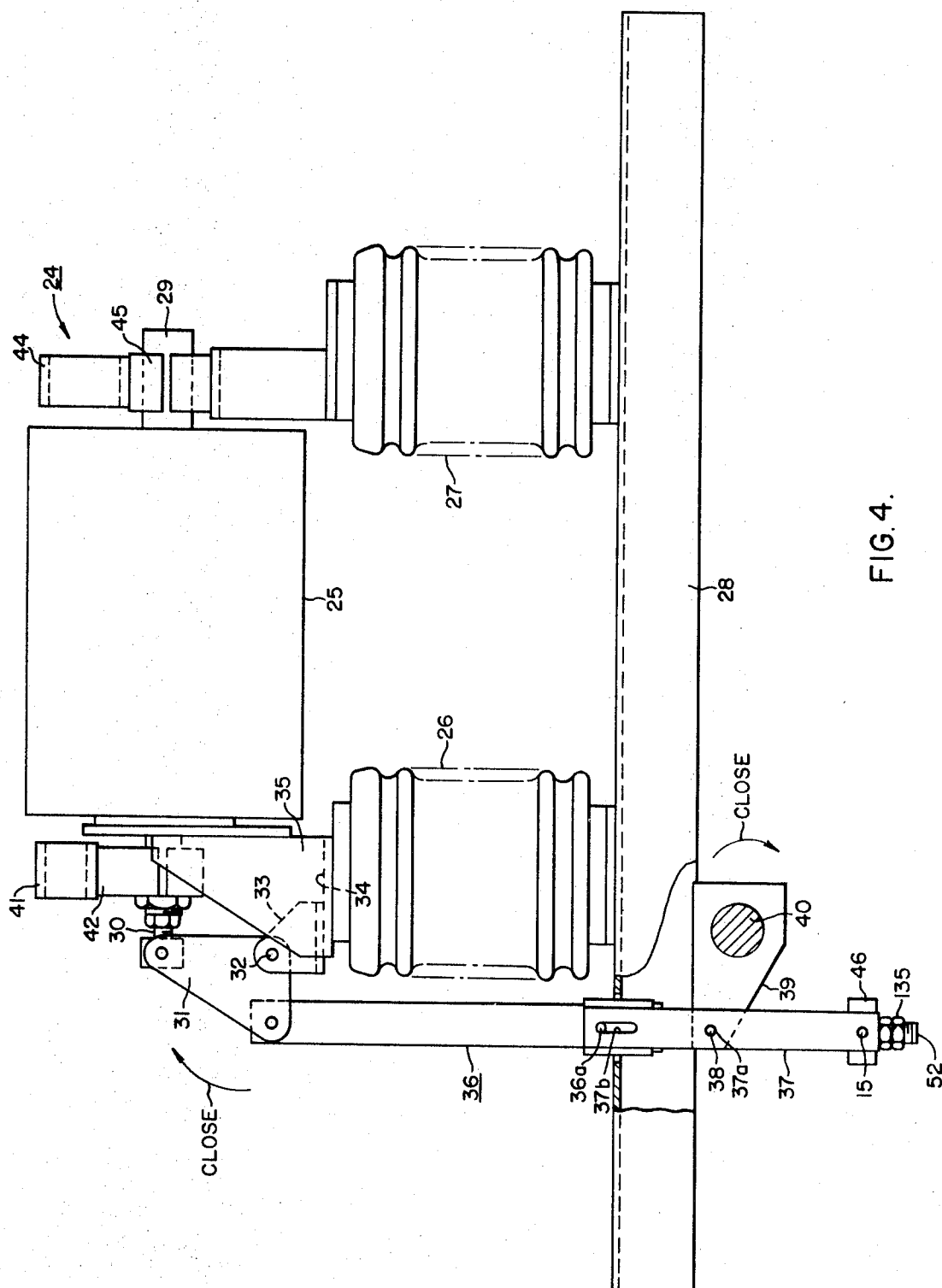


FIG. 5.

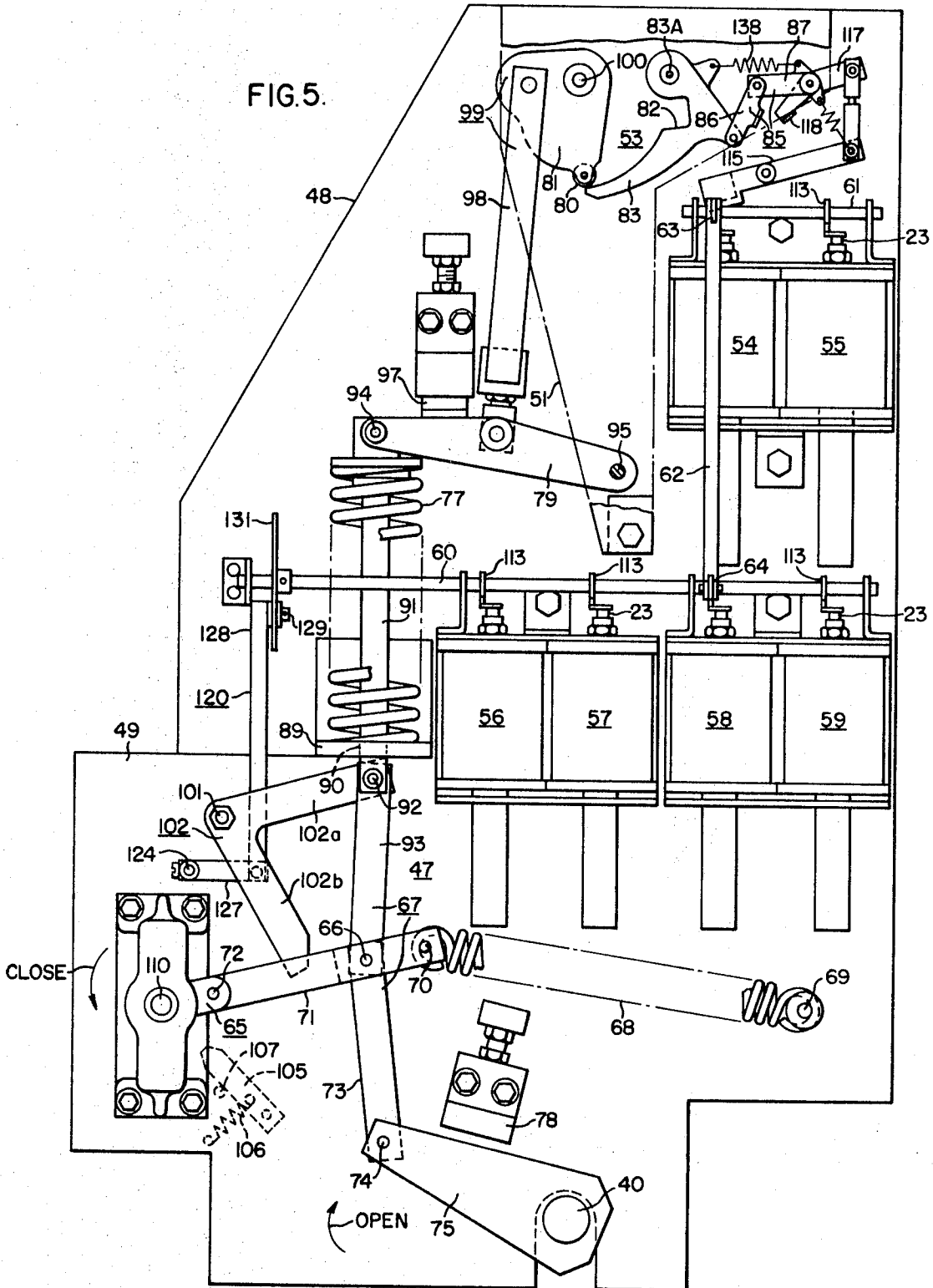


FIG. 6.

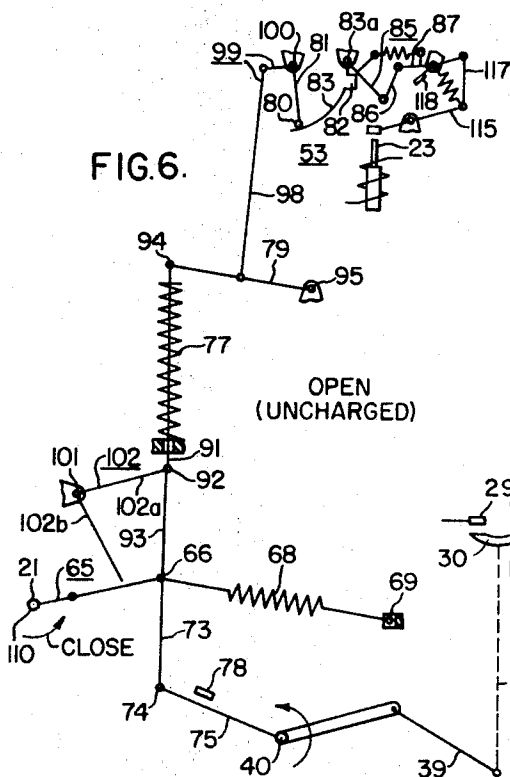


FIG. 7.

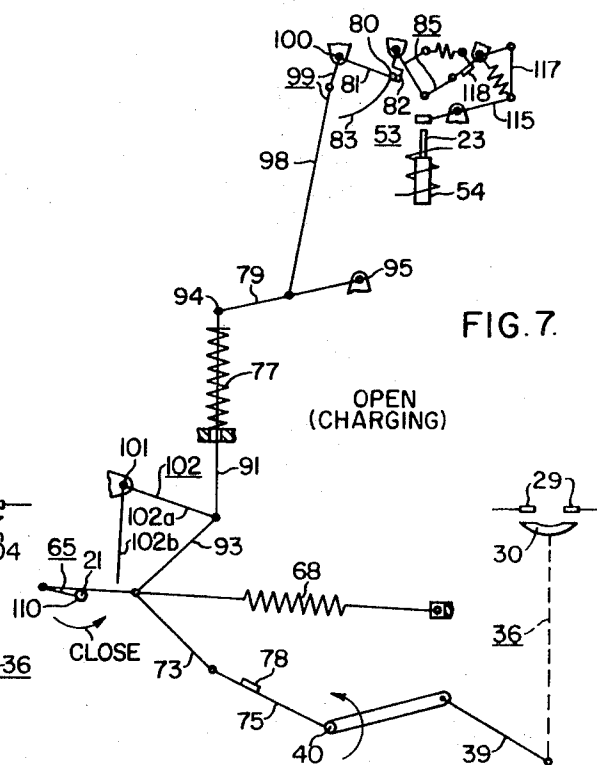


FIG. 8.

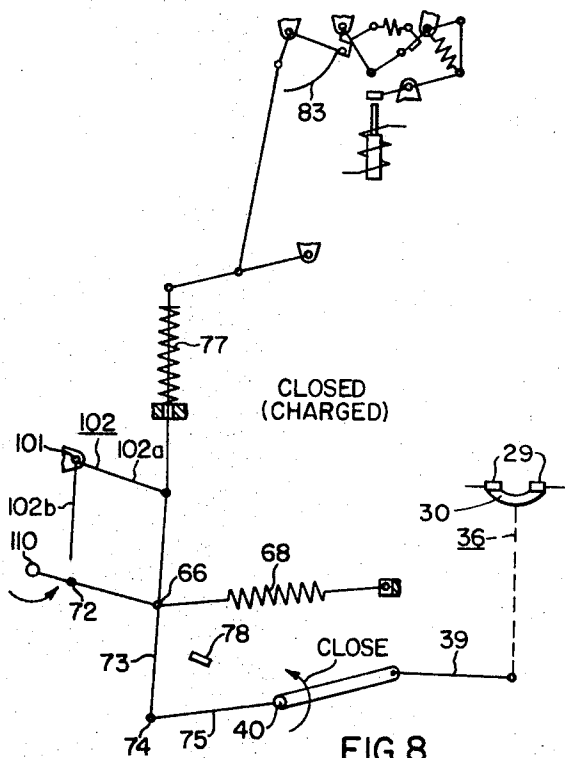
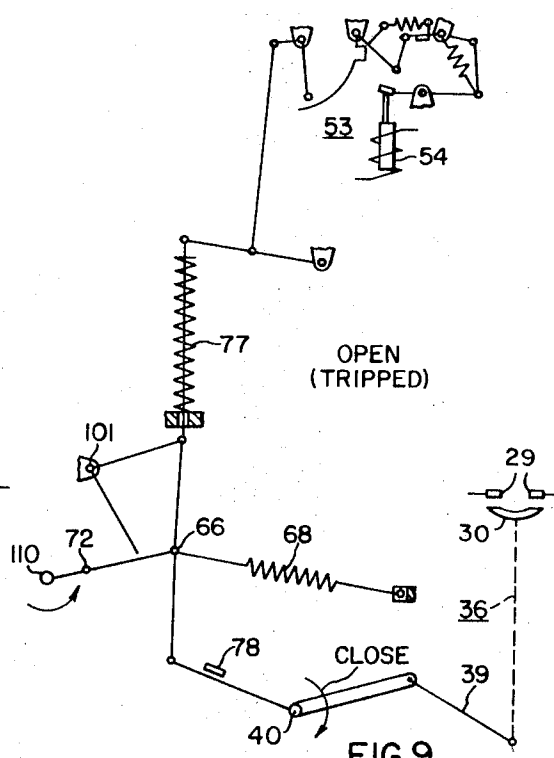
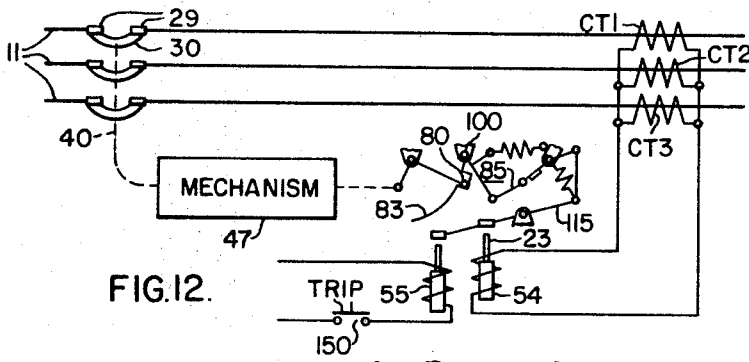
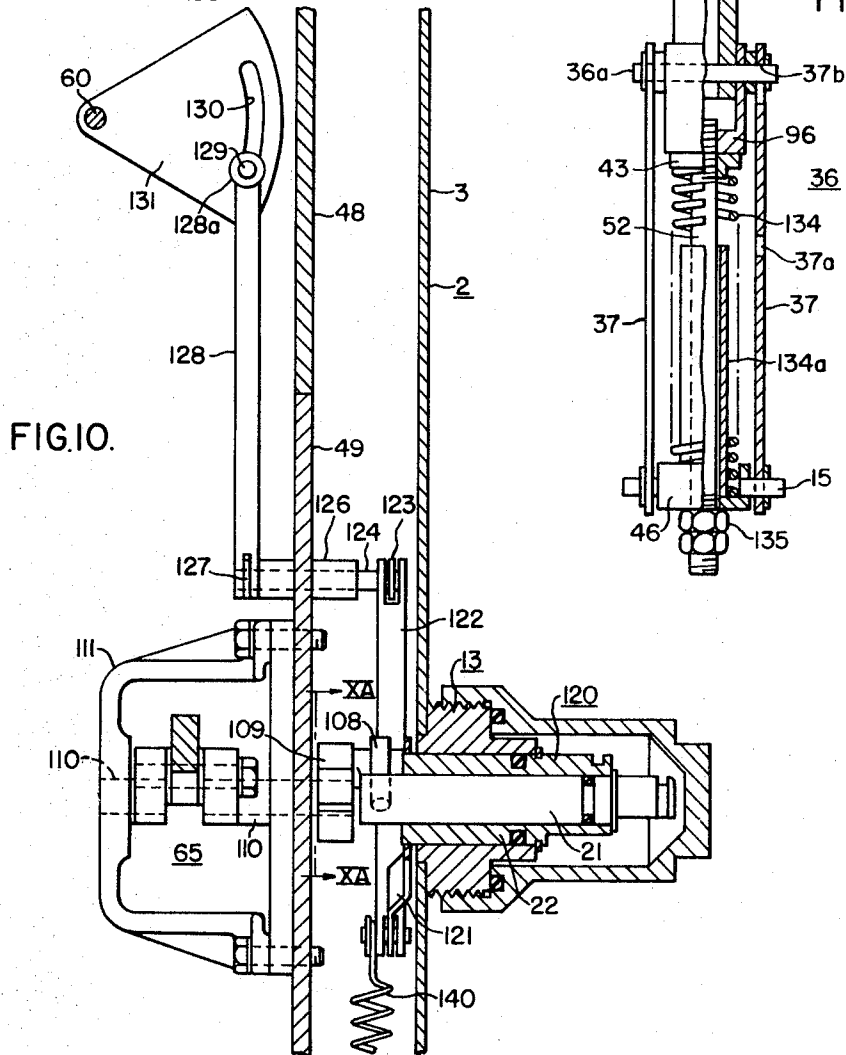
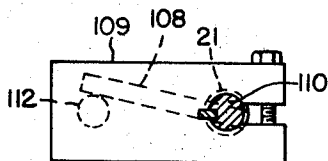


FIG. 9.





QUICK-OPENING AND QUICK-CLOSING CIRCUIT BREAKER WITH TOGGLE ACTION, AND A CONCENTRIC DOUBLE SHAFT

CROSS-REFERENCES TO RELATED APPLICATIONS

Applicant is not aware of any related applications pertinent to the present invention.

BACKGROUND OF THE INVENTION

Generally, in prior art circuit breaker constructions, a pneumatic, motor, or solenoid operator has been provided to effect the closing of a circuit breaker structure, while at the same time charging a plurality of opening springs, which are latched in their closed position. Generally, as well known by those skilled in the art, a tripping mechanism has been provided, responsive to overload conditions, or to a desired manual operation, to effect release of the latching means to permit the opening or accelerating springs to effect a quick opening of the circuit breaker construction. As a result, there has been necessitated a plurality of energizing mechanism, somewhat independently related, and providing a complicated and generally costly construction.

It is desirable, however, for the control of three-phase distribution systems and particularly for the control of lateral feeders, to provide a simple and trouble-free relatively cheap circuit breaker construction, which may, if desired, be manually closed, while at the same time energizing the opening springs. For one particular application, to accommodate a submersible construction, it is desired to provide a circuit breaker, which may be placed down within a vault in the distribution system of a large city, for example, and manually closed by means of a handcrank, or a rope and handwheel. Preferably, in such a submersible construction, it is desired to provide a sealed circuit breaker construction, for, occasionally, such installations become flooded with water, and even during such times must be maintained in a reliable operating condition.

SUMMARY OF THE INVENTION

According to one feature of the present invention, there is provided a novel opening and closing mechanism linkage, which may be operated by a single rotatable driving crank arm assembly. The construction is such that upon the rotation of the aforesaid driving crank arm assembly, a closing spring is tensioned, and at the same time, an opening or accelerating spring is similarly tensioned. The construction is such that upon an overcenter positioning of the crank arm assembly, the closing spring is suddenly released to effect a quick-closing operation of the circuit breaker, while at the same time maintaining the latched relatively stationary position of the opening, or accelerating spring. In the closed circuit position of the interrupter, however, the latching means, provided in association with the opening spring, is responsive to the current conditions passing through the interrupter, and upon the occurrence of an excess current condition, will effect actuation of a tripping means to effect release of the latching arrangement for the opening or accelerating spring. When this occurs, the unlatching of the opening spring will quickly effect, through the provided linkage, a quick-opening operation of the circuit breaker structure involving, generally, a number of simultaneously actuated circuit breaker units.

According to another feature of the present invention, a concentric crank arm assembly is provided through the wall of the circuit breaker enclosure, so that the actuation of one concentric shaft, or sleeve will effect the charging of the closing and opening springs, whereas the rotation of the other concentric shaft, or sleeve will effect a tripping operation, all effected manually, for example.

According to another aspect of the present invention, there is provided a novel mechanism alignment structure involving subassemblies of separate mechanism plates, so that an accurate positioning of the shaft location, and internal adjustment

may be readily provided. Additionally, the construction is such as to facilitate assembly time, and moreover insure an accurate alignment of all pivot axes and adjustments.

A general object of the present invention is to provide a quick-opening and quick-closing circuit breaker construction involving relatively few parts of relatively cheap construction.

Another object of the present invention is the provision of a high-speed opening and closing mechanism for a circuit breaker.

Still a further object of the present invention is the provision of a high-speed opening and closing circuit breaker construction involving a minimum number of links for the circuit breaker mechanism.

Another object of the present invention is the provision of a high-speed opening and closing circuit breaker involving a concentric crank arm shaft arrangement, in which operation and tripping of the circuit breaker may take place through a sidewall of the enclosure, for example.

Still a further object of the present invention is the provision of a high-speed opening and closing circuit breaker construction capable of accurate and simplified adjustment.

Another object of the present invention is the provision of a quick-opening and quick-closing circuit breaker of compact dimensions, and adaptable for facilitated maintenance.

Another object of the present invention is the provision of a simplified, relatively cheap circuit breaker construction in which manual operation may be readily provided.

Further objects and advantages will readily become apparent upon reading the following application, taken in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of a quick-opening and quick-closing circuit breaker construction, adaptable for submersible applications and involving the principles of the present invention;

FIG. 2 is an end elevational view of the circuit breaker construction of FIG. 1;

FIG. 3 is a fragmentary vertical sectional view taken through the circuit breaker mechanism, and a single pole unit of FIG. 2, the view being generally taken along the line III-III of FIG. 2;

FIG. 4 is a longitudinal side elevational view taken through one of the pole units, substantially along the line IV-IV of FIG. 3;

FIG. 5 is a front view of the circuit breaker mechanism, taken generally along the line V-V of FIG. 3, and illustrating the position of the mechanism parts in the fully open-circuit position of the interrupter;

FIGS. 6-9 diagrammatically indicate the various positions of the mechanism links, and the charged and relaxed condition of the opening and closing springs;

FIG. 10 is a vertical sectional view taken through the concentric rotatable crank arm operator extending through the right sidewall of the circuit breaker enclosure, the view being taken substantially along the line X-X of FIG. 2 and a weatherproof cap replacing the operating wheel.

FIG. 10A is a detail fragmentary view of the driving crank arrangement, the view being taken along the line 10A-10A of FIG. 10;

FIG. 11 is an enlarged sectional view taken through the operating rod assembly; and

FIG. 12 is a diagrammatic view of the electrical tripping circuits.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIGS. 1 and 2 illustrate the external appearance of the circuit breaker structure 1, with FIG. 1 illustrating a front elevational view thereof, and FIG. 2 illustrating an end elevational view, as viewed from the right-hand end of FIG. 1. It will be observed that a circuit breaker enclosure 2 is provided, which may, for certain applications, be of a sealed construction in-

volving stainless steel sideplates 3 and a removable door 4, the structure being supported by a floor stand, generally designated by the reference numeral 5. With reference to FIG. 1, it will be observed that the removable door 4 has handles 6 welded thereto, and may be bolted into a position covering a manhole. Three pairs of terminal bushings 7-9 extend through the upper cover 10 of the generally box-shaped circuit breaker enclosure 2, for controlling a three-phase circuit 11 (FIG. 12). Extending through the right-hand end of the circuit breaker enclosure 2 is a hub assembly 13 (FIG. 10) to accommodate a tripping, or resetting operating wheel 14, which may be used for either tripping the circuit breaker 1 open, or effecting a closing of the contact structure thereof.

A connector box 16 is provided adjacent the right-hand end of the circuit breaker enclosure 2 to accommodate control cables, which may extend to associated circuits, and may be used to effect a remote tripping operation of the circuit breaker structure, as more fully described hereinafter.

An indicator window 17 may be provided, so that one may, from an external position, view the interior of the circuit breaker enclosure 2 to determine whether the contact structure is in the open or closed-circuit position.

Lifting lugs 18 may be provided at the ends of the circuit breaker enclosure 2 so that the circuit breaker 1 may be bodily lifted, and placed in its desired location.

As more fully brought out hereinafter, the operating wheel 14 may be used in one position to effect a closing of the circuit breaker structure, and when removed and reversed, it may be used to effect a tripping operation of the circuit breaker. This may be obtained by providing different dimensional bores 19 provided in the hub structure 20 of the operating wheel 14 to either operate a central operating shaft 21, or in the other position of the operating wheel 14, to operate a tripping sleeve 22 (FIG. 10), for example.

With reference to FIG. 3 of the drawings, it will be noted that there is shown one of three pole units 24. Each pole unit 24 may, for example, comprise a so-called vacuum "bottle," or vacuum-interrupting unit 25. FIG. 4 may be referred to in this connection to illustrate the general positioning of the vacuum interrupter unit 25 bridging a pair of upstanding supporting insulators 26, 27, the latter being mounted on a horizontally extending stationary support channel 28. As well known by those skilled in the art, generally, in vacuum interrupter units, abutting contacts are employed, one of the contacts being fixedly mounted interiorly of the evacuated envelope on the inner extremity of a stationary contact stud 29, whereas the other cooperable movable abutting contact is reciprocally moved longitudinally of the unit by a movable operating rod 30, sealed by a flexible diaphragm (not shown), and actuated externally of the vacuum unit 25 by means, in this particular instance, comprising a pair of laterally spaced triangularly configured lever arms 31, and stationarily pivotally supported at 32 on an upstanding U-shaped stationary support bracket 33. This support bracket 33, in turn, is affixed to the bight portion 34 of an upwardly extending U-shaped support bracket 35, in turn mounted upon the upper end of the standoff insulator 26. Generally, clockwise rotation of the lever arms 31, as viewed in FIG. 4, will effect inward movement of the movable contact 30 to cause closing contacting engagement interiorly of the evacuated envelope of the vacuum interrupter unit 25, whereas counterclockwise rotative travel of the triangularly shaped operating levers 31, as caused by downward motion of the operating rod assembly 36, will cause opening of the separable contact structure. With further reference directed to FIG. 3 of the drawings, it will be observed that the operating rod assembly 36 is connected by a pair of upstanding links 37 to the off-jutting pins 38, secured to operating crank arms 39 affixed to a rotatable main operating shaft 40, as by welding, the latter extending lengthwise of the circuit breaker enclosure 2, and journaled in suitable bearing plates, not shown.

Extending from the lower end of one of each pair of terminal bushings 7-9 is a flexible conducting strap 41, which is

secured to a support block 42 affixed to the movable contact 30 of the circuit-interrupting unit 25. Similarly, another flexible conducting strap 44 is affixed to the associated terminal bushing 9, and is suitably secured to a contact block 45 affixed to the stationary contact end of the circuit breaker unit 25, all as more clearly shown in FIGS. 3 and 4 of the drawings.

Generally, the construction is such that clockwise rotation of the main operating shaft 40, as viewed in FIG. 5 of the drawings, effects, through the several pairs of welded crank arms 39 affixed thereto, the downward movement of the operating rod assemblies 36 to thereby cause a counterclockwise rotative opening motion of the lever arms 31 (FIG. 4) to effect a contact-opening movement within the vacuum interrupter units 25.

It is to be clearly understood, however, that although the described construction utilizes a plurality of vacuum-type interrupter units 25, nevertheless other types of interrupting structures may be used in place of such vacuum units 25, such as an air-break circuit-interrupting unit, for example, of the spaced-plate type having, of course, ample current-interrupting capacity. In the described arrangement, the vacuum interrupter units 25 are capable of interrupting currents of, for example, 12,000 amperes, and are, in addition, capable of carrying continuously 600-amperes load current, for example, with a design voltage of 15 kv. for the particular distribution circuit 11 (FIG. 12) involved. Naturally, for other voltage and current ratings, suitable alternative interrupting units could be used in place of the described vacuum interrupter units 25.

MECHANISM LINKAGE (47)

Referring to the drawings, and more particularly to FIGS. 3 and 5 thereof, it will be noted that there is provided an upper mechanism support plate 48 and a lower mechanism support plate 49 mounted in juxtaposition relation upon spacers 50 secured to the inner side of the sideplate 3 of the sealed casing 2.

Secured to the upper mechanism support plate 48 is a pair of generally triangular supporting plates 51, upon which is supported for operative movement a latching mechanism 53, more fully described hereinafter. Additionally mounted upon the upper mechanism support plate 48 is a plurality of tripping coils 54-59, each of which has a plunger or armature 23 interiorly thereof, which is moved upwardly upon energization of the respective trip coil to effect tripping rotation of a rotatable trip shaft 60. The upper two tripping coils 54, 55 have their plungers 23 engageable with an upper rotatable tripping shaft 61, and a link 62, secured to two crank arms 63, 64, causes simultaneous motion of the two rotatable tripping shafts 60, 61.

Generally, the mechanism linkage 47 comprises a driving crank arm assembly 65, which is actuated through a sealed shaft 21 externally of the circuit breaker housing 2 by the driving wheel 14 (FIG. 2). As viewed in FIG. 5, the driving crank arm assembly 65 effects leftward movement of the knee pivot pin 66 of a driving toggle, generally designated by the reference numeral 67. A closing tension spring 68 is fixedly secured at its right-hand end to a fixed support 69. The left-hand end of the closing tension spring 68 is secured to a pin 70 secured adjacent the right-hand end of a bifurcated floating link 71, the left-hand end of which is pivotally secured, as at 72, to the free end of the driving crank arm assembly 65. The driving toggle 67 comprises two toggle links, namely a first toggle link 73 having its upper end pivotally connected to the knee pin 66, and having its lower end pivotally connected to the free end 74 of a driving crank arm 75, which is affixed to the rotatable main driving shaft 40, as by welding, the latter extending longitudinally of the circuit breaker, as shown more clearly in FIG. 3 of the drawings.

With reference to the diagrammatic view of FIG. 6, it will be observed that counterclockwise operative movement of the driving crank arm assembly 65 effects simultaneous tensioning, or charging of the closing spring 68, and also compression

of an opening spring 77, all as illustrated diagrammatically in FIG. 7 of the drawings. During this initial closing movement, the driving crank arm 75 remains relatively stationary adjacent its stop 78. When the driving crank arm assembly 65 approaches its halfway position, as illustrated in FIG. 7, it will be observed that both the closing spring 68 and the opening spring 77 are charged, and a supporting lever arm 79 is latched in a stationary position by the interengagement of a roller 80 secured to a rotatable latching toggle link 81, which is caused to move into a recess 82 afforded by a rotatable latching lever arm 83, which, in turn, is maintained in a relatively fixed releasable position by a tripping toggle 85 comprising a pair of tripping toggle links 86, 87, which move to an overcenter position. This is diagrammatically illustrated in FIG. 7 of the drawings.

It will be observed that the opening or accelerating spring 77 is a compression spring having its lower end seated upon a fixed bracket 89 secured to the upper mechanism support plate 48. The bracket 89 has an opening 90 therethrough, through which reciprocally moves the pull link or pull rod 91, the lower end of which is pivotally secured, as at 92, adjacent the upper end of the second driving toggle link 93. The upper end of the pull rod 91 is pivotally secured, as at 94, adjacent the free end of the rotatable latching lever arm 79 pivotally mounted at a fixed pivot 95, the pivot pin 95 extending through the two triangular supporting plates 51 (FIG. 3). An adjustable stop 97 (FIG. 5) is supplied to limit the clockwise rotative movement of the rotatable latching lever 79. Pivotally connected adjacent the midportion of the rotatable lever 79 is a floating link 98 constituting one toggle link of a latching toggle 99, comprising the aforesaid floating toggle link 98 and a second toggle link 81, the latter being pivotally supported at a fixed pivot 100.

Pivotally secured to a fixed pivot 101 is a bell crank-shaped arm 102 having the free end of one arm 102a pivotally secured to the upper end of the second driving toggle link 93 and also to the lower end of the pull rod 91. The other arm 102b of the bell crank-shaped overtravel-preventing arm 102 is moved adjacent a position where continued rotative movement of the driving crank arm assembly 65 is prevented by the interference position of the free extremity of the arm 102b in the charged position of the breaker, as evidenced by the diagrammatic position of FIG. 8 of the drawings. It will be observed that in the position, as illustrated in FIG. 8 of the drawings, that the driving pivot location 72 is just below the free end of the bell crank-shaped arm 102b, so that the driving crank arm 65 cannot further continue its rotative travel, which, if allowed to occur, would cause the contacts 29, 30 to open.

Additionally, there is provided a pivotal catch arm 105 (FIG. 5), biased by a tension spring 106 against a stop 107 to insure that the driving crank arm assembly 65 only rotates in a counterclockwise direction, as viewed in FIGS. 5 and 8.

With reference to FIG. 5 and the diagrammatic views of FIGS. 6-9, the general sequence of the closing movement of the circuit breaker structure 1 will now be described. The driving wheel 14, located externally of the circuit breaker casing 2, is manually rotated, as by a rope, or a crank, to effect rotation of the central driving shaft 21, the inner end of which has an offset driving crank portion 108 (FIG. 10). This engages a crank arm portion 109 affixed to the right-hand end of a split driving shaft 110, the latter partially being rotatively supported by a U-shaped bracket 111, as illustrated more clearly in FIG. 10 of the drawings. Thus, the drive shaft 21 has a lost-motion or "free" connection 112 (FIG. 10A) with the inner drive shaft 110, so that upon the closing spring 68 attaining its maximum charged condition (FIG. 7), the inner crank arm 65 is free to move overcenter to the position illustrated in FIG. 8 of the drawings free of the inner crank arm portion 108 of the outer sealed drive shaft 21.

When this occurs, the position of the parts is illustrated in the diagrammatic view of FIG. 8, with the circuit breaker contacts 29, 30 closed, and the opening spring 77 charged and latched in its charged condition. The circuit breaker 1 is now

ready to be opened upon release of the latching means 53. As stated hereinbefore, energization of any of the six tripping coils 54-59 will cause its respective plunger 23 to move upwardly and to engage a crank arm 113 affixed to the rotatable tripping rod 60 or 61. The rotation of the interconnected tripping rods 60, 61 will cause clockwise rotation of a tripping lever 115, the right-hand end of which will cause downward tripping motion of a pivotally mounted lever 117, the other free end 118 of which causes a collapse of the tripping toggle 85 to the position illustrated in FIGS. 5 and 6 of the drawings.

This will permit the latching lever 83 to move in a counterclockwise direction about its fixed pivot 83A releasing the roller 80, and permitting the latter to rotate with the toggle link 81 in a clockwise direction, as viewed in FIG. 5. The release of the rotatable latching arm 79 will permit upward opening movement of the pull rod 91, as caused by expansion of the compression opening spring 77, and the upward movement of the pull rod 91 will cause the driving toggle 67 likewise to move bodily upwardly, thereby causing an opening operation of the circuit breaker 1. This is illustrated in the diagrammatic view of FIG. 9.

Attention may now be directed to a means 120 for effecting manual tripping of the breaker 1 from a position externally of the circuit breaker casing 2. If the driving wheel 14 is removed and replaced in an inverted position, so that the enlarged bearing opening thereof fits over the tripping sleeve 22 (FIG. 10), the latter being concentric with the sealed driving shaft 21, it will be observed that by rotation of the driving wheel 14, corresponding tripping rotation of the tripping sleeve 22 is effected. With attention directed to FIG. 10 of the drawings, it will be observed that the inner end of the tripping sleeve 22 has affixed thereto a tripping arm 121, which is pivotally secured to a trip link 122, the upper end of which is pivotally connected to a crank arm portion 123 of a tripping shaft 124. The tripping shaft 124 extends through a bearing sleeve 126 provided in the lower mechanism support plate 49. The inner end of the tripping shaft 124 has an arm 127 affixed thereto, which has its outer free end pivotally connected to a tripping link 128, the upper end of which has a guide pin 129 guided by an elongated slot 130 provided in a segment 131 fixedly supported on the rotatable trip shaft 60. FIG. 5 additionally shows the tripping segment 131, which permits the tripping coils 54-59 to effect tripping rotation of the rotatable trip rod 60 independently of the guide pin 129 affixed to the upper end 128a of the tripping rod 128 (FIG. 10). Thus, the circuit breaker may be opened either by electrical means or by the manual tripping means 120. The electrical means comprises the energization of any of the six tripping coils 54-59. The manual tripping means 120 is effected by the use of the driving wheel 14, as mounted in an inverted position. In more detail, the driving wheel 14 has a relatively enlarged bearing portion on one side thereof, which accommodates the tripping sleeve 22, whereas the other side of the driving wheel 14 has a relatively smaller bearing portion, or bore opening, which accommodates the central driving shaft 21. Thus, the same wheel 14 may be used either for a manual charging of the mechanism or, in its inverted position, as a manual tripping means 120.

The aforesaid description describes an application of the present invention to a submersible three-phase distribution system breaker 1 utilizing vacuum-type circuit interrupters 25. Such circuit breakers provide protection of three-phase lateral taps and will coordinate with current-limiting fuses (not shown) installed with either large three-phase distribution transformers, or circuit breakers with overcurrent relays installed at the distribution substation for the main three-phase feeders.

In the event of a lateral feeder fault, the breaker 1 will trip, isolating the faulted lateral. The faulted cable section can then be manually sectionalized, and service promptly restored to the remaining unfaulted portion of the lateral by manually closing the breaker 1, by means of a handcrank or a rope and handwheel 14. Looping the lateral feeders minimizes the portion of the lateral, which must be out of service during repair

of the faulted section. Since the faulted section must be manually sectionalized, the same operating personnel can quickly manually reclose the tripped circuit breaker 1.

A time overcurrent control is included for the submersible housing 2 and will operate for a fault on any phase. The control is solid state, and energized by a minimum trip relay, and in turn energizes an SCR, which operates the breaker trip coil. All energy for the control is provided by the bushing current transformers CT1—CT3; thus no batteries, potential source, or control wiring external to the breaker is required.

For a particular application, the circuit breaker 1 of the present invention may be adapted to a voltage of 15 kv. with a continuous current rating of 600 amperes and with an interrupting capacity RMS symmetrical of 12,000 amperes. The basic insulation level may be 95 kv.

Such a vacuum circuit breaker 1 of the type described may be supplied for a reconstruction program in a downtown large metropolitan area. Preferably, it is of submersible design utilizing, for example, a stainless steel housing 2 sealed against moisture. As stated hereinbefore, it is a three-phase manually closed, stored energy, shunt trip device consisting of a single housing with three mechanically ganged 600-ampere vacuum interrupters 25, for example, rated at 12,000 amperes. The interrupters are opened by a stored energy mechanism 47, spring operated, and released by a shunt trip coil 54—59. Sensing is accomplished through three current transformers CT1, CT2, CT3 with time overcurrent tripping from a solid-state timing scheme. The switch 1 is a nonautomatic reclosing device normally closed by means of a manual closing mechanism 47, which may be either a handle or a rope-operated wheel 14. Manual tripping 120 is provided. The mechanism 47 has an overtoggle spring action, such that it is electrically and mechanically trip free.

A gasket covers an access plate 4 which is provided for inspection and maintenance. Preferably, the primary bushings 7—9 are 600 ampere epoxy type suitable for 600-ampere. Esna connectors to accommodate the necessary cable.

The operating rod assembly 36 provides attachment between the movable stud 30 of the current interrupter 25 and the main operating shaft 40 of the breaker 1. Each breaker is equipped with three such operating rods 36. Internal to the operating rod is a spring 134, the adjustment 135 of which provides for an overtravel to assure proper contact pressure on the butt-type contacts 29, 30 of the interrupter assembly 25, and allows for some contact wear of the contact surfaces. The rotation of the main operating shaft 40 imparts a vertical motion to the operating rod 36, upward for closing of the interrupter 25, and downward for the opening operation.

FIG. 11 illustrates the details of the connecting operating rod 36 extending from the triangular operating levers 31, connected to the separable contact structure, with the other end of the resilient operating rod assembly 36 being connected to the actuating crank arm 39 affixed to the longitudinally extending operating shaft 40. It will be noted that the operating rod 36 is connected to the longitudinally extending operating shaft 40 through an overtravel compression spring 134 by means of two operating links 37 and a spring cup 46 as herein described. A spring guide rod 52 is connected to the operating rod end 96 and locked in place by the spring seat 43. The spring guide 52 extends through the overtravel compression spring 134, spring guide sleeve 134a and spring cup 46. The lower end of the spring guide rod 52 is threaded to accommodate a pair of adjusting nuts 135.

The operating links 37 are connected to the longitudinally extending operating shaft 40 by pins 38 passing through holes 37a. Thus, when the operating shaft 40 is rotated in a counter-clockwise direction, as viewed in FIG. 5, the overtravel spring assembly 36 and operating rod 36b is moved in an upward direction causing the contacts in the vacuum interrupter 25 to close. When the contacts touch, the motion of the operating rod 36b is stopped. However, the operating shaft 40 continues to rotate through a slight angle. This motion moves the spring cup 46 away from the adjusting nuts 135 thereby increasing

the compression of the overtravel spring 134. The method of assembly provides a constant force on the butt-type contacts 29, 30 by allowing for this wear.

On opening, the operating shaft 40 is rotated in a clockwise direction allowing the operating links 37 to move in a downward direction. However, contact movement does not take place until the spring cup 46 strikes the adjusting nuts 135. This provides an impact opening force on the contacts insuring proper opening forces and speeds.

From the foregoing description it will be apparent that closing rotative travel of the main operating shaft 40 will carry with it the pairs of crank arms, which through the pairs of actuating links, will cause upward movement of the spring cups compressing the contact compression springs and moving the transversely disposed pivot pin 36a downwardly within the slots 37b, meanwhile imposing the desired amount of contact pressure across the abutting contacts disposed interiorly within the vacuum interrupter units 25.

As mentioned hereinbefore, the circuit breaker 1 may be opened or closed by mechanical means externally of the circuit breaker 1 by means of two concentric shafts 21, 22, which emerge from the right-hand end of the breaker housing 2. The central, or smaller shaft 21 is turned in a clockwise direction for a full 360° travel to move the interrupter assembly 25 from the open to the closed position. The outer, or larger hollow shaft 22 is turned approximately 30° in a clockwise direction to move the interrupter assembly 25 from the closed to the open position. The mechanism 47 is so arranged that it is impossible to effect a false operation by repeating either the opening or the closing action of either of the cranks. Likewise, it is impossible to turn either crank in an incorrect direction. During the closing operation, the various functional parts of the mechanism perform in the following way: As the closing shaft 21 is rotated (from outside the cabinet), an internal projection 108 on the shaft 21 engages an arm 109 attached to the crank assembly 65. As the crank assembly 65 begins to rotate, it carries with it the end of the arm assembly 71. As mentioned, the extreme end of the arm assembly 71 is attached to the closing spring 68, and a pivot point 66 near the free end of the arm assembly 71 is attached to two movable arms 73, 93. The lower of these two arms 73 is attached to turn to the end of the contact operator rod assembly arm 75. In the closed position, this arm is held in the closed position, or in contact with the lower stop 78. The upper arm 93 is attached, in turn, to the lower end of the main pull rod 91. Thus, as the crank 65 is turned, carrying with it the arm assembly 71, the closing spring 68 is extended, and the two movable arms 73, 93 begin to fold toward the crank assembly 65, causing the pull rod 91 to be drawn downwardly, compressing the opening spring 77 and storing energy for opening the interrupters 25.

As the cranking operation is continued, the arm assembly 71 extends the closing spring 68, thus supplying the energy which will be used to close the interrupter assemblies 25. The extension of the closing spring 68, and the compression of the opening spring 77 continues through approximately one-half crank revolution. As the upper end of the closing spring 77 is moved downwardly it carries with it the reset yoke assembly 79, moving it away from the upper stop 97. As the reset yoke assembly 79 is moved downwardly it in turn carries with it the reset arm assembly 98. This latter action causes a rotation of the toggle link 81 about its fixed point 100. Also, an indicator flag assembly (not shown), which can be viewed through the indicator window 17 from the outside of the cabinet 2 is moved to indicate the particular position of the interrupters 25. As the toggle link 81 continues to rotate, the roller 80 on its free end moves into a recess 82 in the latch and bearing assembly 83. When the motion of the crank assembly 65 has been completed, such that the roller 80 falls into this recess 82, the latch spring 138 pulls the latch and bearing assembly 83 more fully into position allowing the tripping toggle links 85 to fall into the locked position. This action prevents rotation in either direction of the latching toggle link 81, and thereby any further motion of the reset yoke assembly 79.

This locking action occurs immediately prior to the instant at which the crank arm assembly 65 reaches its full extent of travel. Thus, the lower end of the pull rod 91 and the upper end of the upper toggle link 98 have been locked into position, in preparation for the closing operation of the interrupters 25. Further rotation of the crank arm assembly 65 allows the closing spring 68 to continue the rotation of the crank 65 independently of the action of the closing shaft 21 externally of the cabinet 2. The fast action of the closing spring 68, returning to its closed position, forces the crank 65 to return to its starting position, as shown in FIG. 8, at which point it is stopped by the reset arm 102b from continuing any further motion. Also, the crank mechanism 65 moves past the catch 105, which will prevent its reverse rotation. Since the arm assembly 65 has been moved back to its starting position, and the upper arm 93 linked to the pull rod 91 is fixed at its upper end 92, the lower arm 73 exerts a downward force on the crank arm 75, causing operator rod assembly 40 to rotate to the closed position, carrying with it all three operator rods 36, which, in turn, close all three interrupter assemblies 25. The breaker 1 is now in the closed position, as shown in FIG. 8.

OPENING OPERATION

The opening of the circuit breaker 1 can be accomplished by either mechanical (manual) or electrical means. As indicated above, the opening shaft 22 is the outer of the two concentric shafts 21, 22, and is turned through approximately 30° to accomplish the opening operation. Integral with the operating shaft 22, and internal to the breaker enclosure 2, is a trip arm assembly 121. Through this trip arm 121, a spring 140 exerts a force on the tripping shaft 124 holding it in position against the opening operation. The turning of the trip shaft 124 against this spring 140 actuates a linkage to the trip rod assembly 128, moving it upwardly. As the trip rod assembly 128 moves upward, its upper end 128a follows a slot 130 in the trip rod guide assembly; at the end of this slot 130 the motion of the trip rod assembly 128 causes a rotation, through the several links, to the main trip assembly 115. This main trip assembly 115 has attached to it six levers, one for each of the trip coils 54-59. The motion of the trip assembly 87 was locked by the closing operation. The rotation of the trip assembly 118 thus releases the toggle lock 85, which releases in turn the latch and bearing assembly 99, allowing the toggle link 81 to rotate and permitting the upper end of the yoke assembly 79 to be forced up against the top stop 97 by the action of the opening spring 77. As the pull rod 91 is drawn upwardly, it carries with it the two hinged arms 73, 93, which attach to the contact operator rod assembly 75, carrying that assembly up against the bottom stop 78 and moving all three current interrupters 25 to the open-circuit position.

FIG. 12 diagrammatically illustrates the electrical tripping arrangement used with the quick-opening and quick-closing operating mechanism of the present invention. It will be noted that there is provided a plurality of current transformers CT1, CT2, CT3, which are responsive to fault current conditions passing through the phase leads. A fault current condition in any one of the phase leads will cause an energization of a tripping solenoid, causing the plunger 23 of the latter to move upwardly striking the trip release arm 115 and causing a breaking of the first tripping toggle. Additionally, a manually operable tripping button 150 may be provided at a remote location, which, when pressed, will energize another tripping coil 55 and cause a similar tripping operation to take place. FIG. 12 uses a block diagram to indicate generally the entire operating mechanism 47 with only the releasable latching portion 53 thereof illustrated.

From the foregoing description, it will be apparent that there has been provided a simple and reliable circuit breaker having a mechanism 47, which may be either operated manually; or in certain instances, if desired, a motor-operated mechanism (not shown) could take the place of the manually operated wheel 14, as shown in FIG. 1. It will be observed that

the mechanism 47 provides for a quick-opening and also a quick-closing of the circuit breaker 1 with a minimum number of parts, and also means for preventing the incorrect rotation of the operating shafts 21, 22.

A single wheel 14 may be provided, which in one position effects the manual closing operation of the mechanism 47, and in the inverted position, effects a manual tripping of the mechanism 47. The entire housing 2 is adaptable for submersible applications, and may be lowered into vaults in streets of large metropolitan areas. It will be furthermore observed that the entire structure 1 is of minimum dimensions for a three-phase application, with the vacuum interrupters 25 mounted in a compact relationship and simultaneously actuated by a longitudinally extending rotatable main operating shaft 40.

Although there has been illustrated and described a specific structure, it is to be clearly understood that the same was merely for the purpose of illustration, and that changes and modifications may readily be made therein by those skilled in the art, without departing from the spirit and scope of the invention.

I claim as my invention:

1. A quick-opening and quick-closing circuit breaker including separable contacts separable to establish an arc, a quick-opening and quick-closing operating mechanism including a rotatable driving crank arm, a driving toggle having said rotatable crank arm connected to the knee pin thereof, a closing spring connected adjacent said knee pin and charged by the rotation of said rotatable crank arm, said driving toggle including first and second toggle links connected together at said knee pin, the other end of the first toggle link being connected to said separable contacts, the other end of the second toggle link being pivotally connected to a pull link, an opening spring connected to the pull link and charged upon pulling motion exerted on said pull link by collapsing motion of said driving toggle as effected by closing motion of the driving crank arm, latching means for latching said pull link in its pulled condition with the opening spring charged, and means for releasing the latching means and causing the opening spring to open the separable contacts.

2. The quick-opening and quick-closing circuit breaker of claim 1, wherein the driving toggle is essentially straightened following relaxing of the closing spring and completion of the rotation of the rotatable driving crank arm.

3. The quick-opening and quick-closing circuit breaker of claim 1, wherein a rotatable operating shaft extends along the circuit breaker, a second driving crank arm is affixed to the rotatable operating shaft, the other end of the first toggle link is pivotally connected to the free end of the second driving crank arm, and a plurality of separable contact means are operated from the same said rotatable operating shaft.

4. The quick-opening and quick-closing circuit breaker of claim 1, wherein a pivotally mounted latching lever is pivotally connected to the pull link, and said latching means is pivotally connected to said pivotally mounted latching lever.

5. An operating mechanism for a circuit breaker comprising a driving toggle having a closing spring and a driving link secured thereto adjacent the knee pin portion thereof, one end of one of the driving toggle links connected to the separable contact structure of the circuit breaker and the opposed end of the other driving toggle link connected to a pull rod having an opening spring charged by the inward motion thereof toward the driving toggle, and releasable latching means for releasably latching the pull rod in its inward retracted position.

6. The combination of claim 5, wherein a crank arm assembly is connected to the driving link, and is adaptable for free motion following one-half of its driving rotatable travel.

7. The combination of claim 5, wherein a pivotally mounted latching arm is connected to the remote end of the pull rod.

8. The combination of claim 6, wherein a bell crank-shaped lever is responsively connected to the driving toggle, and has a stop portion to prevent overtravel rotative movement of the crank arm assembly.

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9. In combination, a circuit breaker casing, a concentric double-shaft arrangement extending through a wall of the circuit breaker casing, a single reversible driving wheel having two hub bore openings of different diameters on the opposite sides thereof so that a selective operation of said concentric double-shaft arrangement may be effected, one of the shafts causing operation of the circuit breaker mechanism, and the other concentric shaft causing a tripping operation of the circuit breaker.

10. The combination of claim 9, wherein the central shaft is the mechanism operating shaft, and the outer concentric shaft is the tripping shaft.

11. The combination of claim 9, wherein the central shaft is the mechanism operating shaft and has an inner offset crank portion.

12. The combination of claim 11, wherein a lost-motion connection is provided between the offset crank portion and the interiorly disposed operating mechanism.

13. The combination of claim 5, wherein a crank arm assembly is connected to the driving link, and a concentric double-shaft arrangement extends through the wall of the circuit breaker casing with one concentric shaft operating the crank arm assembly.

14. The combination of claim 13, wherein a lost-motion connection is provided between said one concentric shaft and the crank arm assembly.

15. The quick-closing and quick-opening circuit breaker of claim 1, wherein means responsive to motion of the driving toggle is interposed in the path of travel of the rotatable crank arm to prevent continued rotation of the crank arm and consequent possible bouncing of the separable contacts.

16. The combination of claim 15, wherein a generally bell-crank-shaped lever is pivotally supported on a stationary pivot and has one arm thereof pivotally connected to one of the toggle links, the other arm constituting the interposing arm.

17. In combination, a circuit breaker casing, a concentric double-shaft arrangement extending through a wall of the circuit breaker casing, one of said shafts operating the circuit breaker mechanism, the other concentric shaft operating the circuit breaker tripping mechanism; a driving wheel having two hub bore openings of different diameters, whereby a selective operation of said shafts may be possible.

18. The combination of claim 17, wherein the central shaft is the mechanism operating shaft, and the outer concentric shaft is the tripping shaft.

19. The combination of claim 17, wherein the central shaft is the mechanism operating shaft and has an inner offset crank portion.

20. The combination of claim 19, wherein a lost-motion connection is provided between the offset crank portion and the interiorly disposed operating mechanism.

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