July 18, 1961 R. E. FRINK 2,993,105

CIRCUIT BREAKER

Filed Dec. 13, 1957 3 Sheets-Sheet 1

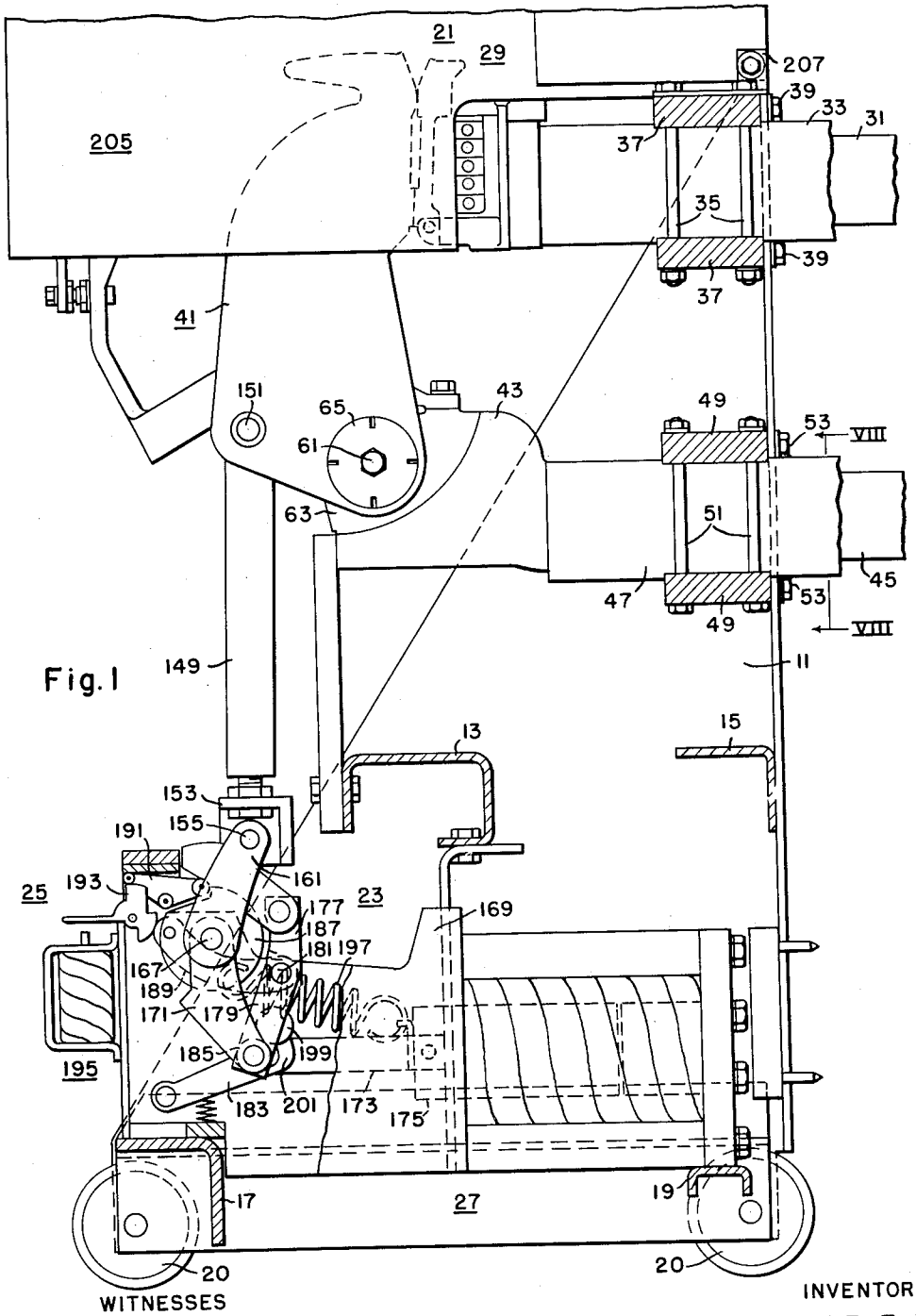

Fig. 1

WITNESSES

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CIRCUIT BREAKER

Filed Dec. 13, 1957 3 Sheets-Sheet 2

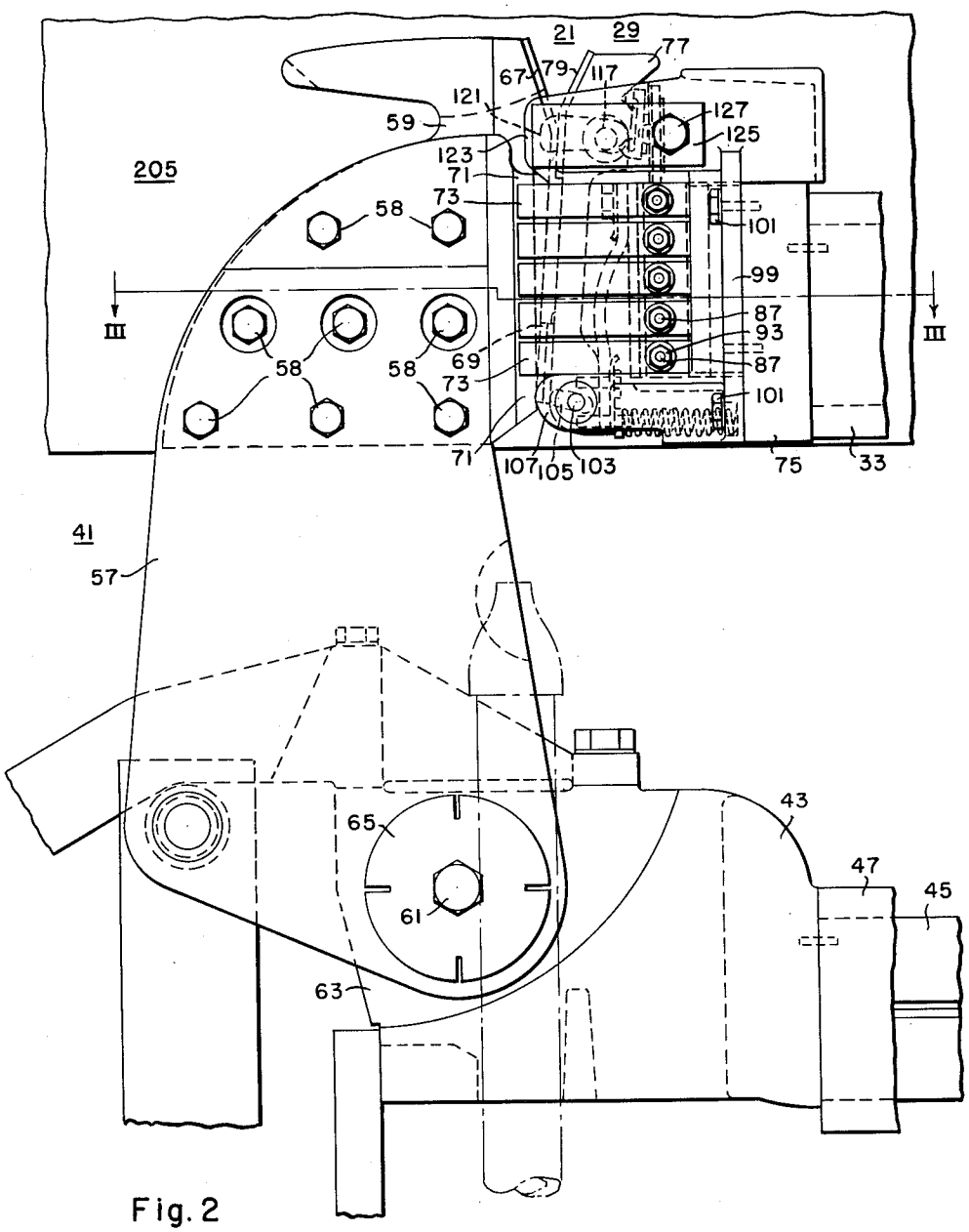

Fig. 2

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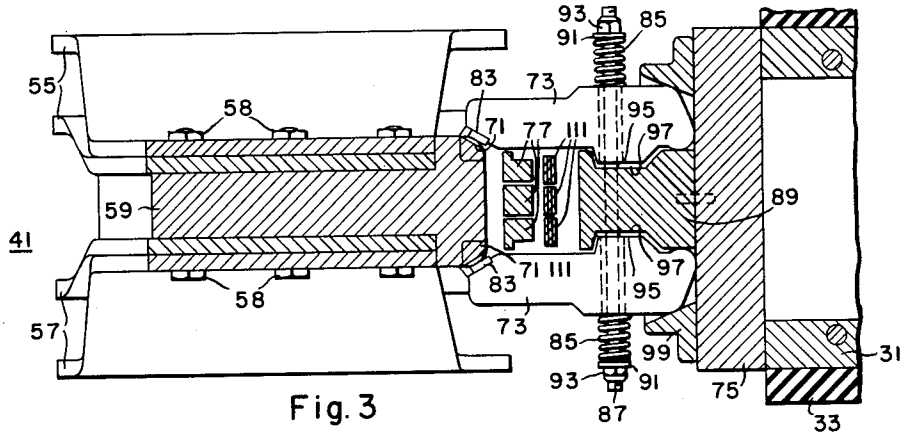


Fig. 3

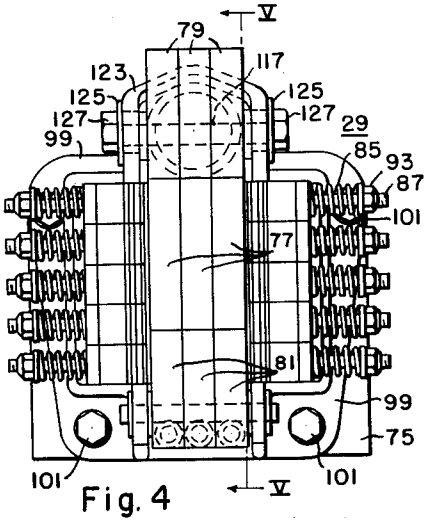


Fig. 4

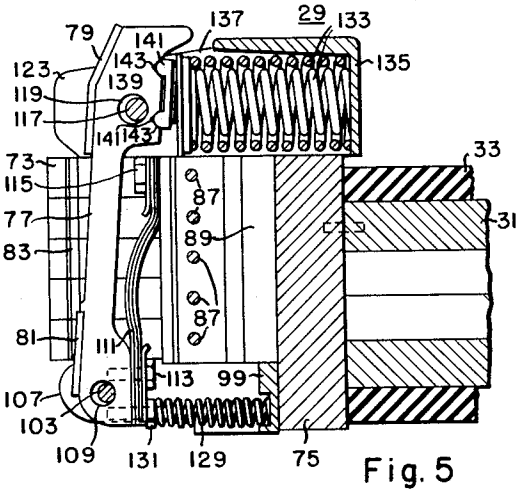


Fig. 5

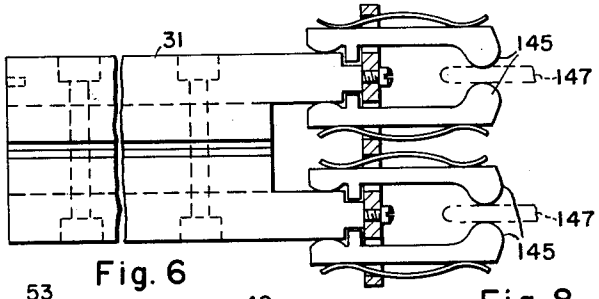


Fig. 6

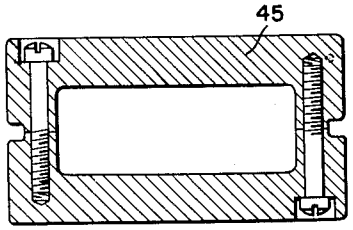
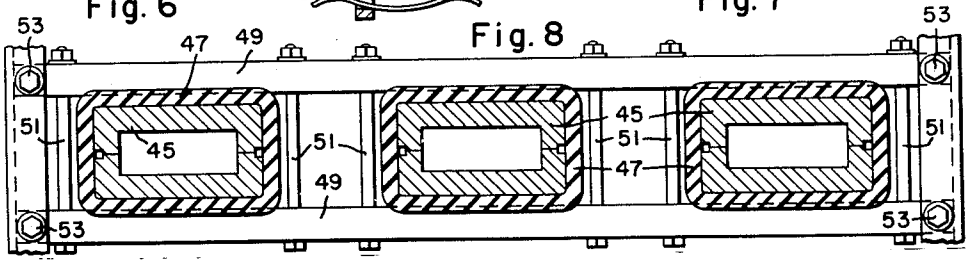


Fig. 7

Fig. 8



United States Patent Office 2,993,105 Patented July 18, 1961

2,993,105

CIRCUIT BREAKER

Russell E. Frink, Forest Hills, Pa., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Filed Dec. 13, 1957, Ser. No. 702,576
3 Claims. (Cl. 200—166)

This invention relates to circuit breakers and more particularly to contact structures and mountings for air circuit breakers.

An object of the invention is to provide a circuit breaker embodying an improved contact structure that is compact and has a high momentary and continuous current-carrying capacity.

Another object of the invention is to provide a circuit breaker embodying an improved contact structure having high interrupting and current-carrying capacities.

Another object of the invention is to provide a circuit breaker embodying an improved contact structure having main, secondary and arcing contacts for heavy duty, which contact structure is so compact that all of the separating contacts may be located within an arc chute to prevent the arc from restriking outside of the arc chute where it will not be extinguished.

The invention has been illustrated by showing a contact structure and mounting arrangement therefor, designed for a magnetic air circuit breaker having a momentary current rating of 100,000 amperes, a continuous current-carrying rating of 3,000 amperes, and an interrupting rating of 50,000 amperes, but the invention may be used with advantage in circuit breakers of other ratings. In such heavy duty circuit breakers, it has been found that: (1) There should be main, secondary and arcing contacts in order to keep the main contacts in good condition to conduct the heavy currents, (2) The physical size of the contact assembly in the direction along the length of the moving contact arm should be as small as possible compared to the length of the moving contact arm to provide a maximum rate of contact separation, and to keep the separating main contacts from being significantly closer together at any point during their separation than are the separating arcing contacts, so that there will be little chance that the arc will restrike across the gap between the main contacts rather than to remain on the arcing contacts, and (3) The contact assembly should be so small that the main, secondary and arcing contacts may all be positioned up within the arc chute of the circuit breaker, so that if the arc should restrike between any of the contacts, due to the switching of capacitor banks or to abnormal circuit conditions, the restrikes will be confined to the arc chute where the arc will be extinguished by the arc-extinguishing structure provided. Accordingly, other objects of the invention are to provide for these features.

Another object of the invention is to mount the contact structure on insulated terminal studs having a compact and efficient arrangement for conducting the heavy currents to the contacts.

Other objects and advantages of the invention will be pointed out in the following description and illustrated in the accompanying drawings, which disclose, by way of example, the principle of the invention and the best mode, which has been contemplated, of applying that principle.

In said drawings:

FIG. 1 is a side elevational view, partly in section, of a circuit breaker embodying the principles of the invention.

FIG. 2 is an enlarged elevational view, partly in section, showing the improved contact structure in the closed-contact position;

FIG. 3 is a horizontal sectional view taken through the contact structure on line III—III of FIG. 2;

FIG. 4 is a front elevational view of the stationary contact structure;

FIG. 5 is an elevational sectional view through the stationary contact structure taken on line V—V of FIG. 4;

FIG. 6 is a side elevational view showing one of the terminal studs having contact fingers thereon for plugging the breaker into a cubicle;

FIG. 7 is a vertical sectional view taken through one of the terminal studs; and

FIG. 8 is an elevational sectional view taken on line VIII—VIII of FIG. 1 and showing the terminal studs and the mounting means therefor.

The invention is illustrated as applied to a circuit breaker of the general type disclosed in Patent No. 2,717,292, issued September 6, 1955, to Russell E. Frink and Paul Olson and assigned to the assignee of the present invention.

The circuit breaker shown in the aforementioned patent is of the roll-out type and is mounted on a wheeled truck to facilitate movement of the breaker into and out of a cubicle in order to connect and disconnect the breaker in an electrical circuit.

Referring to FIG. 1 of the drawings, the circuit breaker is of the three pole type (only one pole being shown) and is mounted in a rigid frame comprising spaced triangular side plates **11** (only one being shown) rigidly secured together by cross members **13**, **15**, **17** and **19** to form a rigid frame. The frame, together with the circuit breaker, is mounted on wheels **20** to facilitate rolling the breaker into and out of a cubicle.

The circuit breaker comprises generally a set of separable contact means **21** for each pole, a common operating mechanism **23**, a trip device **25** and closing means **27**.

The contact structure comprises generally a stationary contact assembly **29** rigidly mounted on the inner end of an upper terminal stud **31** of hollow rectangular shape. The terminal stud **31** is encased in insulating material **33** and is rigidly clamped by means of bolts **35** between supporting aluminum cross bars **37** which extend across the three poles of the breaker and are secured by means of bolts **39** to the spaced side plates **11** of the frame. The contact structure also includes a movable switch arm **41** pivotally supported on a casting **43** rigidly secured to the inner end of a lower terminal stud **45** which also is of hollow rectangular shape. The lower terminal stud **45** (FIGS. 7 and 8) is surrounded by insulating material **47** and is rigidly clamped between supporting cross bars **49** by means of bolts **51**. The cross bars **49** extend across all of the poles and are secured to the side plates **11** by means of bolts **53** (FIG. 8).

The terminal studs **31** and **45** are made hollow to provide greater conductivity by reduction of the skin effect. A substantial reduction in the overall height of the breaker is effected by making the terminal studs rectangular rather than round, and supporting them between the cross bars **37** and **49** eliminates metal flanges on the bushings.

The movable switch arm consists of two pairs of arms **55** and **57** (FIG. 3) bolted together at their upper ends by means of bolts **58** (FIG. 2) with a movable contact member **59** between them. The lower ends of the pairs of switch arms **55** and **57** are spaced apart as shown in FIG. 3 and each pair is pivotally supported by means of pins **61** (only one being shown) supported in projection **63** (FIGS. 1 and 2) on the casting **43**. Spring washers **65** disposed on the outer sides of each pair of switch arms **55** and **57** provide good contact pressure between the switch arms and the projections **63**. The movable switch member **59** has an arcing contact **67** (FIG. 2) rigidly secured to the upper end thereof and a secondary contact **69** rigidly secured thereto adjacent the lower end

thereof. Arc resisting main movable contact strips 71 are rigidly secured to the opposite edges of the contact member 59 for engagement with main stationary contact fingers 73.

The stationary contact assembly 29 is mounted on a conducting block 75 rigidly secured to the inner end of the upper terminal stud 31 and comprises a plurality of stationary contact fingers 73 and a plurality of stationary contact fingers 77 which at their upper ends have stationary arcing contacts 79 rigidly mounted thereon for cooperating with the movable arcing contact 67. Stationary secondary contacts 81 are mounted on the lower ends of the fingers 77. Each of the main stationary contact fingers 73 has an arc resisting contact 83 rigidly secured thereto for cooperating with the movable main contact strips 71. The main stationary contact fingers 73 are biased inwardly to provide pressure by springs 85 surrounding rods 87 which extend horizontally through openings in the contact fingers 73 and through an opening in a contact support member 89 rigidly secured to the block 75. The springs 85 are compressed between the contact fingers 73 and washers 91 which are retained in place by nuts 93 threaded onto the outer ends of the rods 87. The springs 85 press rounded inner ends of the main contact fingers against the contact support member 89 to provide good electrical contact. Each of the contact fingers 73 is provided with an inwardly projecting portion 95 which extends into recesses 97 in the contact support members 89 to prevent longitudinal movement of the fingers.

The main contact fingers 73 are positioned in two vertical opposed rows, with half of the fingers in each row. The length of the rows runs, in the same general direction as the length of the moving switch arm and in the same direction as the height, rather than the width of the arc chute. This keeps the width of the stationary contact assembly to a minimum and makes it possible to position the main contacts within the arc chute, in spite of the large number of main contact members required for the heavy currents. In the specific embodiment shown for the purposes of illustration, there are ten main contact members 73, and if these ten main contacts had been put in a single horizontal row, generally perpendicular to the length of the moving switch arm, the width of the assembly would be too great to be positioned in the portion of the arc chute which is lined with arc-resisting material and which is effective to act upon the arc to extinguish it.

The contact fingers 77 are pivotally and slidably supported at their lower ends by a rod 103 having its end supported in slots 105 (FIG. 2) in forwardly extending projections 107 of a cage 99. The contact fingers 77 are provided with openings 109 which are larger than the diameter of the rod 103 to provide for individual movement of the contact fingers. Flexible conductors 111 secured by means of bolts 113 to the contact fingers 77 and by bolts 115 to the contact support member 89 electrically connect the fingers 77 through the member 89 and the block 75 to the terminal stud 31.

The upper ends of the contact fingers 77 are controlled in their movement by a rod 117 (FIGS. 2, 4 and 5) extending through openings 119 in the fingers. The openings 119 are somewhat larger than the diameter of the rod 117 to provide for individual movement of the fingers 77. The ends of the rod 117 engage in enlarged slots 121 (FIG. 2) in projections 123 of the retaining cage 99 and the rod 117 is retained in position by small retaining plates 125 secured to opposite sides of the projection 123 by means of bolts 127 and engaging the ends of the rod 117.

The lower ends of the contact fingers 77 are individually biased for secondary contact pressure by means of springs 129 compressed between spring seats in the retaining cage 99 and spring guides 131 on the contact fingers. The upper ends of the contact fingers 77 are biased by a pair of springs 133 (FIG. 5) compressed between a spring seat on a portion 135 of the retaining cage 99 and a movable spring seat 137. A pressure equalizing member 139 in the shape of an equilateral triangle is provided with a projection 141 on each of its apices which engage in notches 143 in the contact fingers 77. The equalizer 139 is also provided with a socket (not shown) at its geometric center which is engaged by a projection (also not shown) on the movable spring seat 137. The upper projection 141 on the pressure equalizer 139 engages a notch 143 in the center one of the contact fingers 77 and the lower projections engage the notches 143 for the outer fingers 77 thus equalizing the pressure of the springs 133 on all three of the fingers 77.

The use of the spring-biased main, secondary and arcing contacts, as at 73, 81 and 79, all on the stationary contact assembly, has the advantage that the moving contact assembly is greatly simplified in that one rigid structure includes the moving main, secondary and arcing contacts, which may all be brazed to a common contact member. Thus, the main contact surfaces 71, the secondary contact surfaces 69 and arcing contact surfaces 67 are rigid with each other and with the moving switch arm 57, and there is no need on the moving contact assembly for any biasing springs, any sliding contact surfaces, or any flexible current conductors.

Each of the terminal studs 31 and 45 are provided with a plurality of pairs of spring biased contact fingers 145 as shown in FIG. 6, for engaging fixed contacts 147 having flat side surfaces to connect the breaker in an electrical circuit.

The use of the rectangular terminal studs 31 and 45 has the advantage that each of the two opposed parallel sides of the rectangle may directly support a plurality of pairs of the opposed contact fingers 145 in a straight row without the use of any intermediate member in the current path. This is true of both of the terminal studs 31 and 45. This keeps the number of joints in the current path to a minimum and facilitates the carrying of heavy currents. The outer contact finger 145 of each pair in the row directly engages at its inner end with the outer surface of one side of the hollow rectangle and the inner finger of each pair in each row similarly engages the inner surface of one side of the hollow rectangle.

The movable switch arm 41 (FIG. 1) for operating the movable contacts (there being a switch arm 41 for each pole of the breaker) is operatively connected by means of an insulating operating rod 149 to the operating mechanism 23. The upper ends of the operating rods 149 are pivotally connected by means of pivot pins 151 to the corresponding switch arms 41, and the lower ends of the operating rods are connected by suitable means to an angular crossbar 153 which is common to all of the poles of the breaker.

The specific structure of the operating mechanism, trip mechanism and the closing means shown are fully disclosed in Patent No. 2,515,994, issued July 18, 1950, to Joseph D. Findley, Alvin W. Ogg and Fritz E. Florschutz and assigned to the assignee of the present invention, for which reason only a brief description of these mechanisms is given herein.

The crossbar 153 is pivotally connected at its ends by pivot pins 155 (only one being shown) to an operating lever 161 which is pivotally mounted on a shaft 167 supported in the side members of a generally U-shaped frame 169. The frame 169 is supported on the cross members 13, 17 and 19 and is shown partly broken away more clearly to show the operating mechanism.

In addition to the operating lever 161, the operating mechanism consists of a closing lever 171 also pivotally mounted on the shaft 167 and connected by means of a link 173 to the moving armature 175 of the closing solenoid 27. The operating lever 161 and the closing lever 171 are connected by means of an underset thrust-transmitting toggle comprising toggle links 177 and 179 which are pivotally connected together by a knee pivot pin 181.

The toggle link **177** is pivotally connected to the operating lever **161** and the toggle link **174** is pivotally connected to the closing lever **177**.

The closing lever **171** is held in the closed position by a spring biased latch **183** which normally engages a roller **185** on the closing lever **171** and holds the latter in the position shown.

The toggle **177** and **179** is releasably held in a slightly underset position by a latch member **187** mounted on the shaft **167** for rotary movement relative thereto. A link **189** connects the latch member **187** to the knee of the toggle **177—179** and the latch member is normally releasably held in latching position by the latching and tripping mechanisms **25** thus holding the toggle **177—179** in thrust-transmitting position. The latch member **187** is held in latching position by an intermediate slip-off latch **191** which, in turn, is held in latching position by a trigger latch **193**. A tripping electromagnet **195** is provided to operate the latch mechanism and effect release of the operating mechanism and opening of the breaker.

When an overload current occurs, the tripping electromagnet **195** is energized and operates the latch mechanism to effect release of the latch member **187**. Upon release of the latch member **187**, the toggle **177—179** collapses permitting clockwise rotation of the operating lever **161** and opening movement of the switch arms **41** for the several poles of the breaker.

During the opening operation, the toggle **177—179** automatically is reset to thrust-transmitting position and the latch member **187** is reset and relatched. This is effected by spring means **197** which is connected under tension between the armature **175** of the closing solenoid **27** and the closing lever **171** at a point near the shaft **167**. When the toggle **177—179** collapses during an opening operation, a roller **199** on the toggle link **179** engages a nose **201** on the latch **183** and moves the latch to disengage it from the roller **185**. This releases the closing lever **171** whereupon the spring **197** moves the armature **175** and, through the link **173** connecting the armature to the closing lever **171**, moves the latter clockwise. This movement extends the toggle **177—179** to its thrust transmitting position and, through the link **189**, rotates the latch member **187** clockwise to its latching position, permitting resetting of the latch mechanism. Thereafter, the circuit breaker is closed by energization of the closing solenoid **27** from any suitable source. When energized, the solenoid attracts its armature **175** and, through the link **173**, rotates the closing lever **171** counterclockwise. Since, at this time, the toggle **177—179** is held in thrust transmitting position, the movement of the closing lever is transmitted therethrough and actuates the operating lever **161** and the rods **149** to close the contact means for the several poles of the breaker. As the mechanism reaches the closed position, the latch **183** re-engages the roller **185** and restrains the breaker mechanism in the closed contact position.

The separating contacts are all disposed well within an arc-extinguishing structure indicated generally at **205** (FIGS. 1 and 2) so that when the contacts separate and the moving contact means moves to the full open position, the arc drawn between the separating arcing contacts is drawn into the arc-extinguishing structure where it is quickly extinguished. The arc extinguisher **205** may be of the general type shown in Dickinson and Frink Patent No. 2,442,199, issued May 25, 1948, or in Frink Patent No. 2,769,065, issued October 30, 1956. As seen in FIG. 1, the arc-extinguisher **205** is pivotally mounted by means of spaced brackets **207** (only one being shown) secured to the upper crossbar **37** by the bolts **35** which clamp the upper terminal stud in position.

The invention provides an improved contact structure which increases the momentary and continuous current-carrying capacity in a small, compact contact arrangement which permits placing the entire separating contact structure inside the arc chute, hence, any restriking of the arc will occur between the contact structure and will be confined within the arc-extinguisher.

Certain features disclosed in this application are disclosed and claimed in a continuation of this application Serial No. 57,320, filed September 20, 1960, and assigned to the assignee of the instant application.

While the invention has been disclosed in accordance with the provisions of patent statutes, it is to be understood that various changes in the structural details and arrangement of parts may be made without departing from the spirit of the invention.

I claim as my invention:

1. In a circuit breaker, a frame comprising spaced side members, a pair of terminal members of hollow rectangular cross section, spaced cross bars mounted on and extending between said spaced side members, means rigidly clamping said terminal members between said crossbars, movable contact means pivotally mounted on the inner end of one of said terminal members, a stationary contact structure mounted on the inner end of the other of said terminal members, said stationary contact structure comprising a contact support member, a plurality of pairs of main stationary contact members disposed on opposite sides of said support member, a plurality of intermediate stationary contact members disposed between said pairs of main stationary contact members, and said movable contact means cooperating with said stationary contact structure to open and close said circuit.

2. In a circuit breaker, a frame, a terminal member of hollow rectangular cross section, insulating material around the terminal member and having flat opposed outer surfaces, a pair of spaced cross bars clamped against the said flat opposed outer surfaces of the insulating material and securing the hollow rectangular terminal member to the frame, a contact structure supported on the inner end of the terminal member, and two rows of opposed pairs of contact fingers supported on the outer end of the terminal member.

3. In a circuit breaker, a frame, one or more pairs of terminal members of hollow rectangular cross section, insulating material around each terminal member and having flat opposed outer surfaces, spaced cross bars clamped against the said flat opposed outer surfaces of the insulating material and securing the hollow rectangular terminal members to the frame, movable and stationary contact structures supported on the inner ends of said terminal members of hollow rectangular cross section, two rows of opposed pairs of contact fingers supported on the outer end of each of said terminal members, each pair of contact fingers in one row having a finger engaging the outer surface of one side of the associated hollow rectangle and another finger engaging the inner surface of the same side of the associated hollow rectangle, and each pair of contact fingers in the other row having a finger engaging the outer surface of another side of the associated hollow rectangle and another finger engaging the inner surface of the same other side of the associated hollow rectangle.

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