Dec. 10, 1946. H. C. GRAVES, JR 2,412,259

CIRCUIT BREAKER MOUNTING AND CONNECTING STUD

Filed Aug. 25, 1942 5 Sheets-Sheet 1

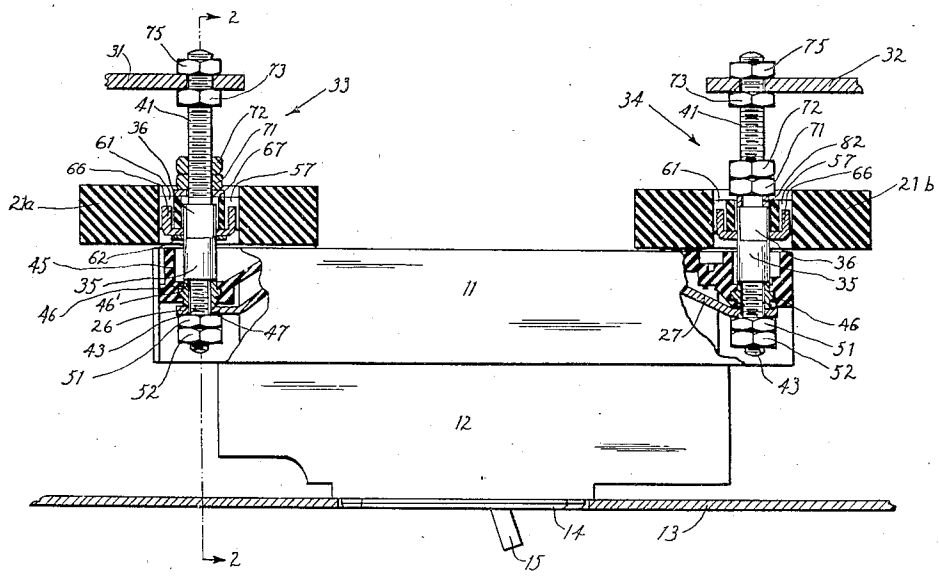

Fig. 1

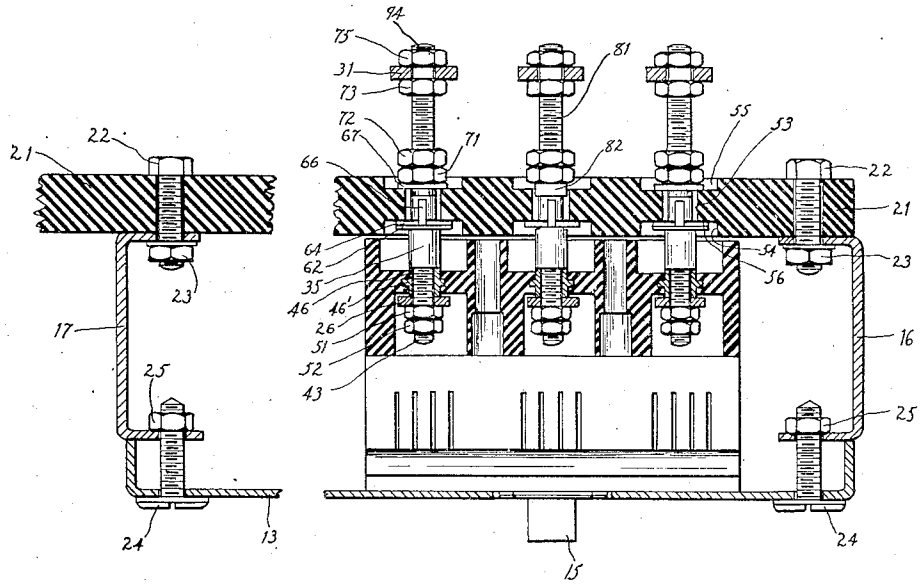

Fig. 2

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CIRCUIT BREAKER MOUNTING AND CONNECTING STUD

Filed Aug. 25, 1942 5 Sheets-Sheet 2

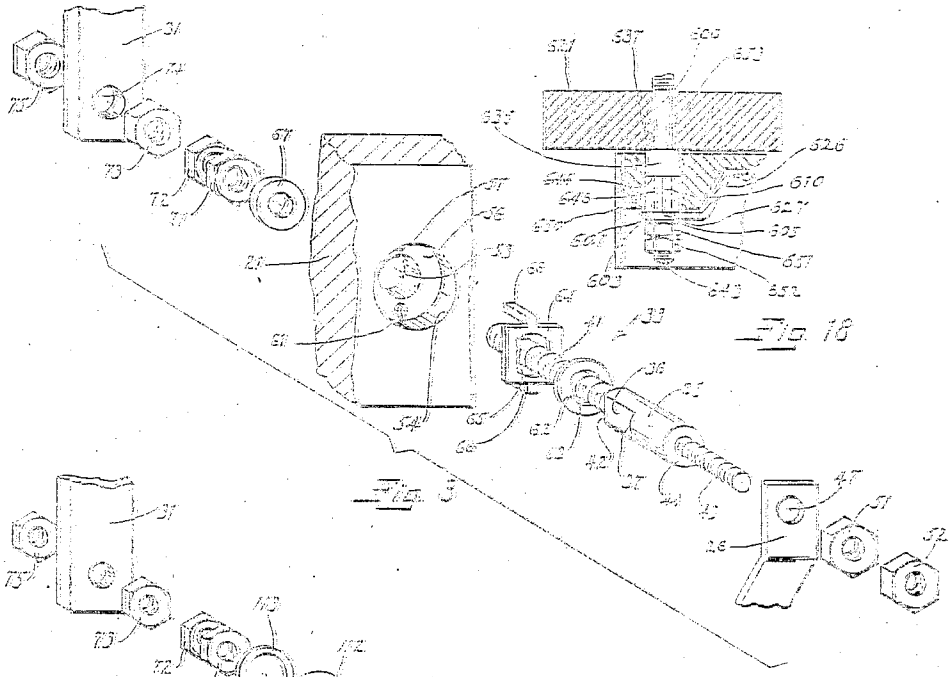

Fig. 1B

Fig. 3

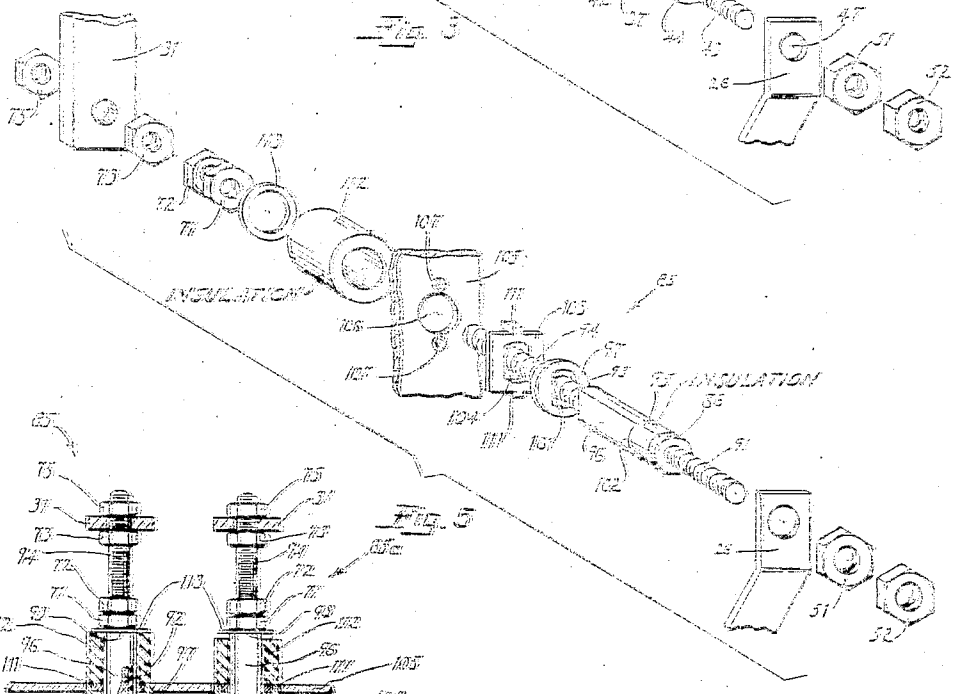

Fig. 5

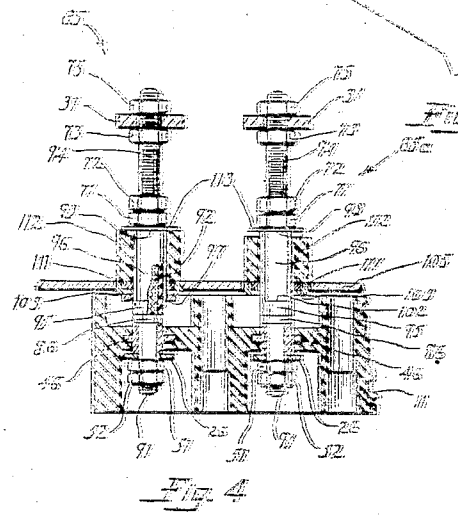

Fig. 4

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CIRCUIT BREAKER MOUNTING AND CONNECTING STUD

Filed Aug. 25, 1942 5 Sheets-Sheet 3

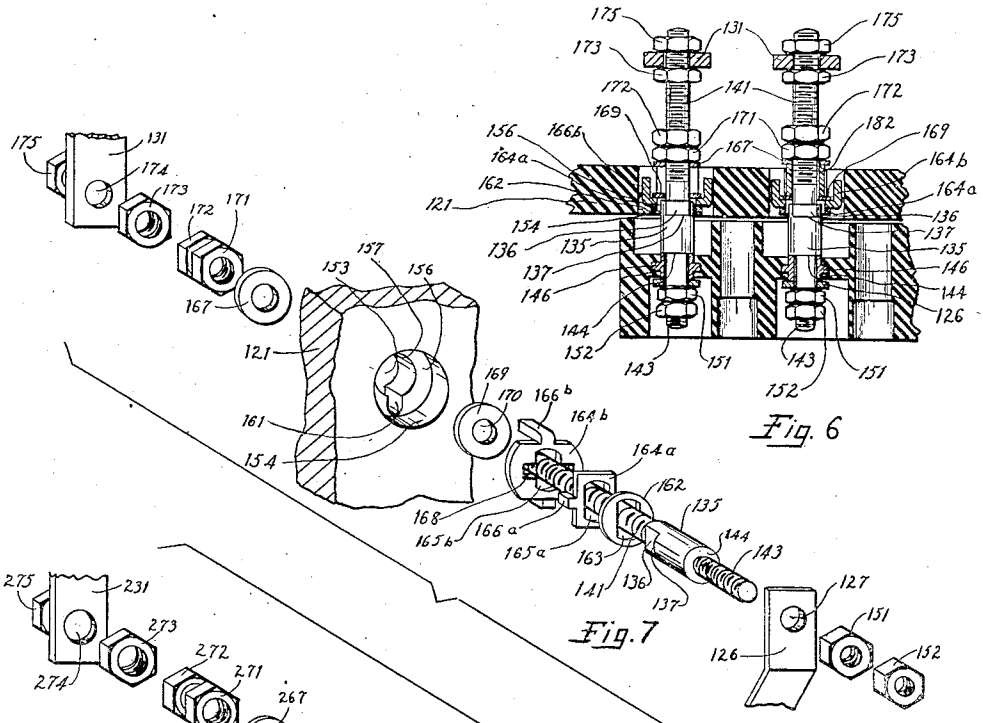

Fig. 6

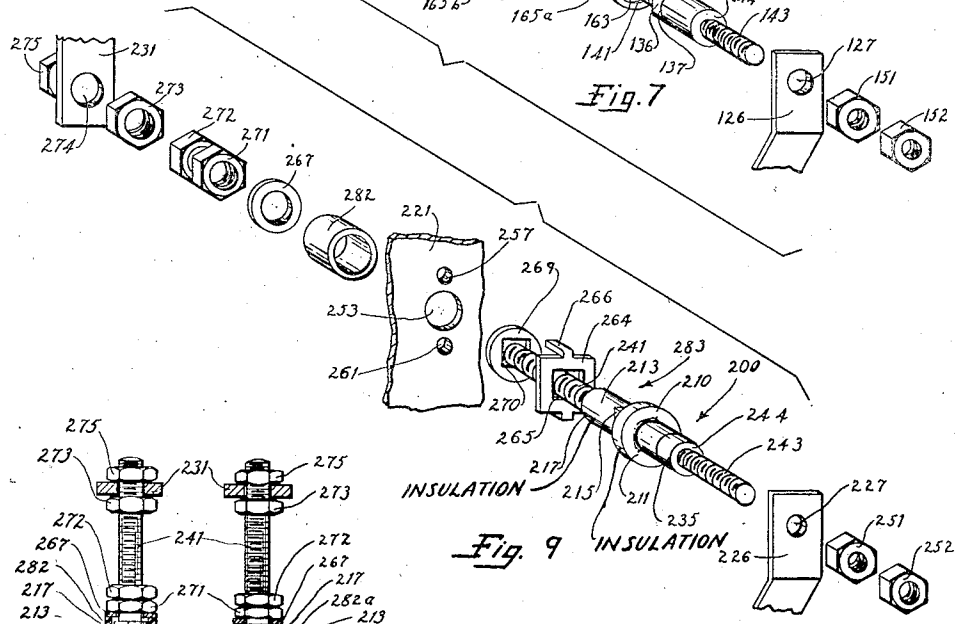

Fig. 7

Fig. 9

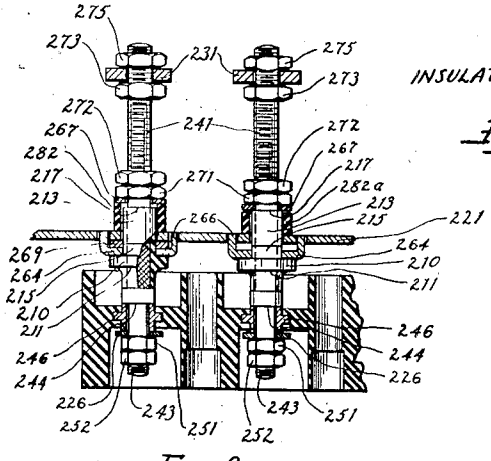

Fig. 8

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CIRCUIT BREAKER MOUNTING AND CONNECTING STUD

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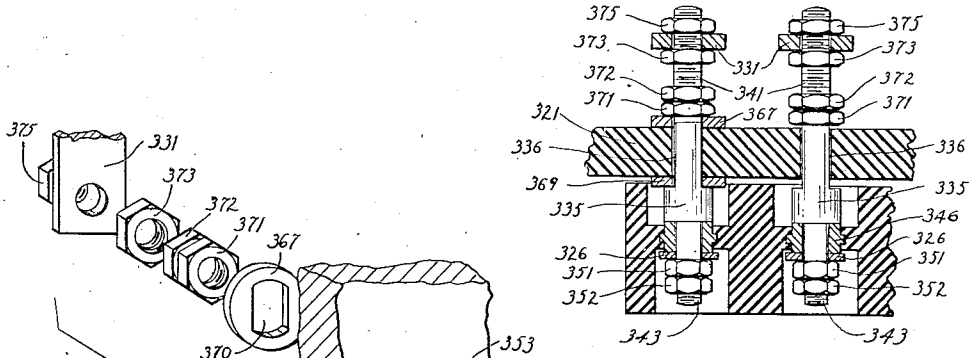

Fig. 10

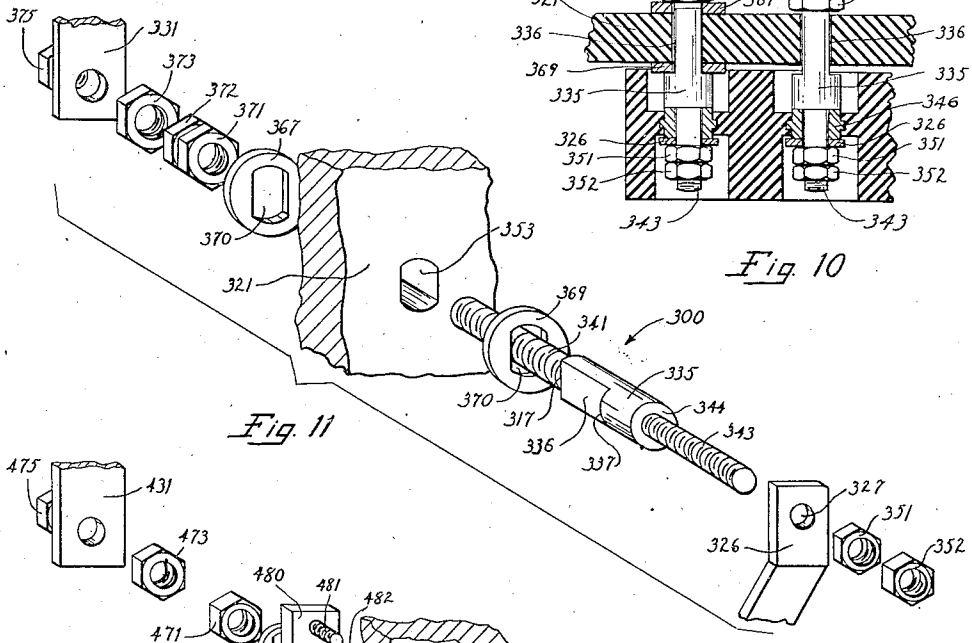

Fig. 11

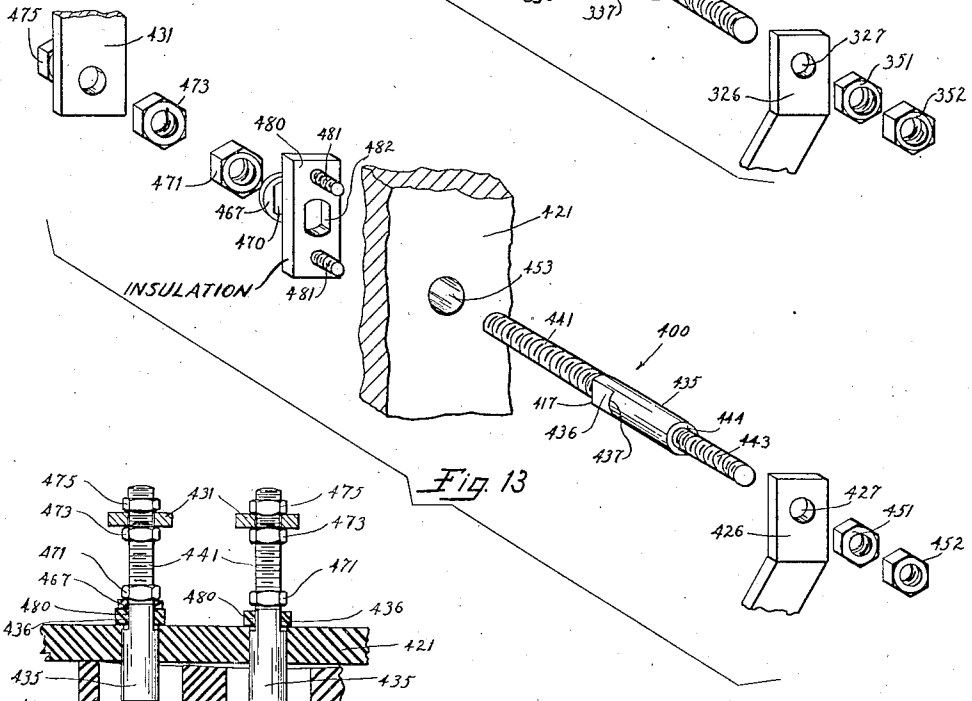

Fig. 13

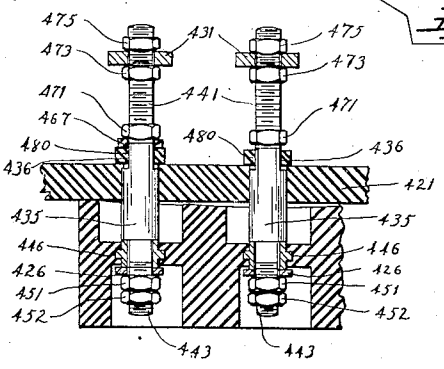

Fig. 12

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CIRCUIT BREAKER MOUNTING AND CONNECTING STUD

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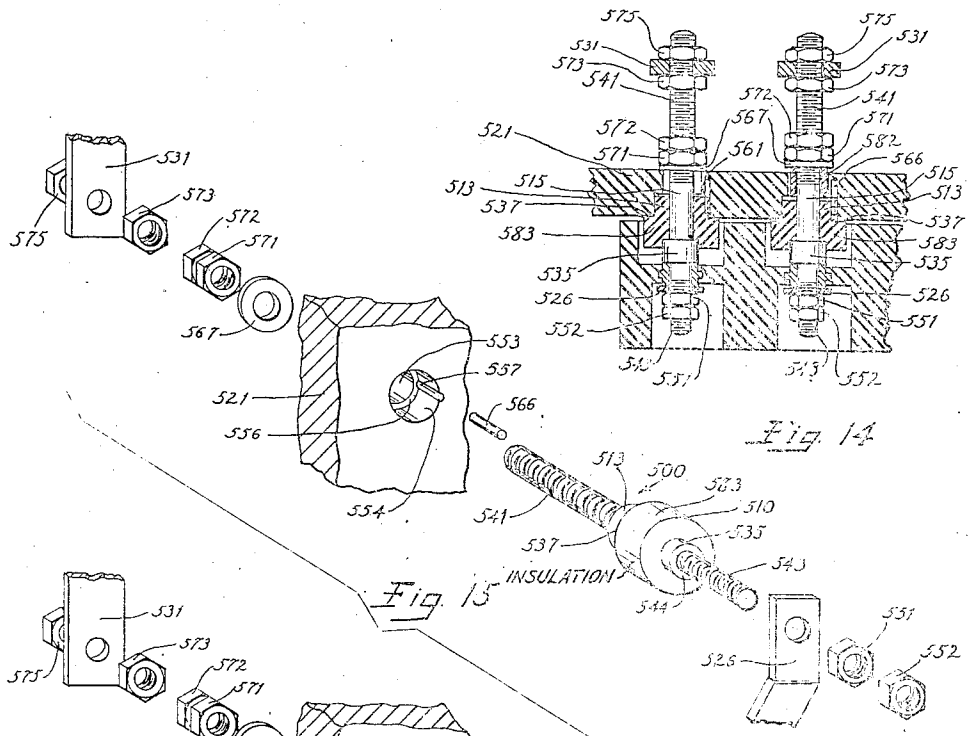

Fig. 14

Fig. 15

Fig. 17

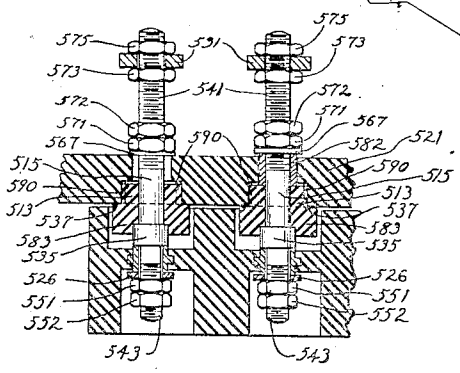

Fig. 16

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Patented Dec. 10, 1946

2,412,259

UNITED STATES PATENT OFFICE

2,412,259

CIRCUIT BREAKER MOUNTING AND CONNECTING STUD

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

Application August 25, 1942, Serial No. 455,978

1 Claim. (Cl. 287—20)

1

My invention relates to circuit interrupters and more particularly to a mounting means for supporting the same upon a switch board in a readily accessible and demountable manner.

The smaller types of circuit breakers are usually fully enclosed in housings of phenolic insulation which are so arranged as to cooperate with various types of mounting means for securement on switch boards.

Such frames or casings of phenolic material are rather stiff and inflexible and cannot ordinarily be manufactured to minutely accurate dimensions. It often occurs therefore that the rear face of the molding which rests against the panel of the switch board or which is supported by the various mounting means within the switch board is not a perfect plane.

Owing to the nature of the material, the openings in the moldings for the passage of mounting studs are not necessarily always in perfect alignment. Accordingly, the tightening of all supporting members when such a circuit breaker is mounted in the switch board may at times apply stresses to the molding which may tend to deform or break the same and thus interfere with the proper function of the interrupter.

My invention provides special mounting means which may readily be adjusted to securely position a circuit interrupter in such a casing on a frame without applying such bending or deforming stresses thereto where any misalignment or irregularity occurs.

My invention also contemplates the formation of a mounting stud and the arrangement thereof in such a manner that all of the parts thereof that must be manipulated to secure and detach the circuit breaker on the panel will be accessible from the front.

Accordingly, it is an object of my invention to provide novel means for mounting a circuit interrupter upon a switch board or panel which permits the removal of the circuit breaker for inspection or repair without requiring access to the circuit connections at the rear of the panel.

Another object of my invention is to provide mounting means for a circuit interrupter which, in addition, serve as the electrical conductors for connecting the circuit breaker terminals to the power and load terminals.

Another object of my invention is to provide circuit breaker mounting means comprising a plurality of studs having the load or line connections thereon and which are rigidly mounted upon a panel.

A further object of my invention is to provide

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means for mounting a circuit interrupter upon a panel board so that the removal of the circuit interrupter will not in any way affect the electrical connections of the line and load terminals.

A still further object of my invention is to provide a stud rigidly and non-rotatably supported upon a panel to which the circuit breaker may be mechanically and electrically connected.

Another and primary object of my invention is the formation of a mounting stud having adjustable members which will permit the stud to accommodate itself to planar variations in the molding of the circuit breaker housing or to any misalignment of the openings therein.

Still another and corollary object of my invention is the formation of a mounting stud for a circuit breaker in such a manner that the effective length of the stud for securing purposes may be varied by the insertion or replacement of adjusting members.

These and other objects of my invention will now be apparent in the following specification and drawings, in which:

Figure 1 is a side view of a circuit breaker and supporting panel showing two species of circuit breaker mounting means in section.

Figure 2 is an end sectional view of the multipole circuit breaker illustrated in Figure 1 taken along the line 2—2 and showing the two different species of Figure 1.

Figure 3 is an exploded view in perspective of the circuit breaker mounting means.

Figure 4 is a fragmentary cross sectional view of a modification of the two circuit breaker mounting means shown in Figure 2.

Figure 5 is an exploded perspective view of the apparatus illustrated at the left in Figure 4.

Figure 6 is a cross-sectional view corresponding to that of Figure 4 but showing a slightly different form of mounting means.

Figure 7 is an exploded view in perspective view of the mounting stud shown at the left in Figure 6 showing a construction wherein an additional floating element is provided which serves to prevent rotation of the stud.

Figure 8 is a cross-sectional view corresponding to those of Figures 4 and 6 showing, however, a slightly modified stud.

Figure 9 is an exploded view in perspective showing the modified mounting stud to the left end in Figure 8.

Figure 10 is a cross-sectional view corresponding to those of Figures 4 and 6 showing, however, a slightly modified mounting means.

Figure 11 is an exploded view in perspective

of the mounting stud shown at the left in Figure 10 showing a construction wherein an additional floating element is provided which serves to prevent rotation of the stud.

Figure 12 is a cross-sectional view corresponding to those of Figures 4 and 6 showing, however, a slightly modified mounting means.

Figure 13 is an exploded view in perspective of the mounting stud shown at the left in Figure 12 showing a construction wherein an additional floating element is provided which serves to prevent rotation of the stud.

Figure 14 is a cross-sectional view corresponding to those of Figures 4 and 6 showing, however, a slightly modified stud.

Figure 15 is an exploded view in perspective of the mounting stud shown at the left in Figure 14 showing a construction wherein an additional floating element is provided which serves to prevent rotation of the stud.

Figure 16 is a cross-sectional view corresponding to those of Figures 4 and 6 showing, however, a slightly modified stud.

Figure 17 is an exploded view in perspective of the mounting stud shown in Figure 16 showing a construction wherein an additional floating element is provided which serves to prevent rotation of the stud.

Figure 18 is a cross sectional view corresponding to the upper left hand stud assembly of Figure 1, but showing the use of a floating metal insert.

A typical panel board arrangement for small manually operable circuit breakers is illustrated in Figures 1 and 2 and comprises essentially a circuit breaker base 11 which contains the operative members of the circuit breaker mechanism and an enclosing cover 12 which is secured against the base 11 to form the completed unit.

The circuit breaker illustrated is a multi-pole unit the number of poles being dependent upon the particular application. This circuit breaker forms no part of the present invention and may, of course, comprise any unit which may be mounted upon the means to be described. The circuit breaker illustrated is contained within the body members 11 and 12 of phenolic insulation or the like.

A panel 13 provides the front face of the switch board and is perforated at 14 to permit the manual operating lever 15 to extend through. Any number of circuit breakers may of course be mounted beside each other to form the required panel board.

As illustrated in Figure 2, the panel board is built up between the two side panels 16 and 17 which are maintained in spaced relation by a plurality of insulating plates 21 secured to the rear flanges thereof, by a suitable number of bolts 22 which pass through perforations in the channel flanges and in the insulating panels, and are secured by nuts 23.

As illustrated in Figure 1, the rear bracing of insulation need not necessarily comprise a single insulating panel but may comprise two smaller panels 21*a* and 21*b* which extend along the outer edges of the circuit breaker. The front panel of the switch board is as illustrated a metal sheet 13, flanged at the ends to provide additional rigidity and secured to the flanges of the channels 16 and 17 by suitable bolts 24.

These bolts pass through holes in the panel 13 and in the flange of the channels 16 and 17 and engage in nuts 25 which are secured as by welding to the flanges of the channels. Each pole of the electrical circuit interrupter illustrated in Figures 1 and 2 is provided with a pair of terminals 26 and 27 which are electrically connected to the conductors 31 and 32 of the power and load circuits.

Thus a single pole of the circuit breaker is arranged to electrically connect terminals 26—27 when its operating contacts are in the closed position.

The electrical connection between the terminals 26 and 27 and their respective bus bars 31 and 32 is made through studs 33 and 34 which in addition serve to provide the necessary mechanical support for the circuit interrupter. Thus, as will be described, the studs 33 and 34 are non-rotatably positioned upon the insulating panels 21 or 21*a* and 21*b* and are spaced so that the circuit interrupters may be positioned thereon as illustrated and so that electrical contact between the line terminals 26 and 27 may be established therewith.

The various components of a single stud connection are best illustrated in Figure 3 which has been exploded to show the necessary relationships. Thus the stud connection 33 of Figure 1 comprises essentially a metallic cylindrical member 35 which is milled to form the flat surfaces 36 thereupon. The milling of these flat surfaces forms a shoulder 37 on each side of the stud.

The section 41 of the cylindrical member has been reduced in diameter and threaded up to the shoulder 42 formed by this reduced diameter section. At the opposite end of the cylindrical member, a reduced diameter section 43 is threaded and provides a shoulder 44. As illustrated in Figures 1 and 2, when the circuit interrupter is mounted upon the studs, the reduced diameter threaded section 43 extends through the body of phenolic insulation 45 and through a metallic insert 46 which has been molded into the main body of the circuit breaker.

The section 43 also extends through a perforation 47 in the line terminal 26 and good electrical and mechanical contact is secured at the line terminal by tightening nut 51 against the line terminal and locking it by the use of a second nut 52 (see also Figure 3).

The metallic insert 46 (Figures 1 and 2) extends beyond the phenolic insulation into which it is embedded and accordingly the shoulder 44 bears against one surface of the metallic insert and the line terminal 26 bears against the opposite surface. Hence the tightening of the nuts 51 and 52 will impose stresses which are carried entirely by the metallic member 46 and impose no material forces upon the weaker phenolic insulation of the circuit breaker body.

The member 46 is provided with a circular rib 46′ which precludes relative motion between the metallic insert and its associated framework of insulation.

The stud 33 is rigidly and non-rotatably supported upon the insulating panel 21 within a perforation 53 (see particularly Figure 3) which has been counterbored at 54 at one end and 55 at the other end thereof.

The internal angular flange 56 thus formed between the counterbores 54 and 55 has been drilled through at 57 and 61. In the mounting of the stud upon the panel 21 a washer 62 is first slipped over the cylindrical threaded portion 41. This washer 62 has a central opening 63 which corresponds with the cross-section of the milled portion of the stud and accordingly the washer

62 may be non-rotatably positioned against the shoulder 37.

A second washer 64 having a central opening 65 corresponding to the opening 63 in washer 62 is also slipped over the threaded end 41 and positioned upon the flats 36 against washer 62. The washer 64 is preferably a stamping which contains a pair of oppositely disposed extensions 66 which are positioned to engage in the perforations 57 and 61 in the flange 56 in the insulating plate 21.

Accordingly, when the cylindrical stud 33 is fitted with the washers 63 and 64 and passed through the perforation 53 so that the extensions 66 enter into their corresponding perforations, it may be seen that rotation of the stud will be impossible. The stud is then fixed to the panel 21 by slipping a washer 67 over the threaded end 41 so that it bears against the inner annular surface of flange 56 within counterbore 55 as illustrated in Figures 1 and 2 and the nut 71 is tightened against the washer 67.

It may be seen from Figures 1 and 2 that the axial length of the milled flats 36 is somewhat less than the sum of the thicknesses of the washers 62 and 64 and of the annular internal rib or flange 56 of the insulating plate 21.

Accordingly, as may be seen from Figures 1 and 2, when the nut 71 is tightened against washer 67, the washer will bear against the annular flange 56 within the counterbore 55 and the washer 64 will bear against the opposite surface of the flange 56 within the counterbore 54. This engagement is then locked by the use of a lock nut 72.

Accordingly, when this assembly is complete, the stud 33 is rigidly and non-rotatably supported upon the insulating panel 21.

The bus bar 31 may be connected to the threaded extension 41 of the stud by first positioning a nut 73 upon the stud as illustrated in Figures 1 and 2, and passing the bus bar 31 over the stud through perforation 74 and locking the bus bar by means of a second nut 75.

The tightening of nut 75 will provide good electrical contact between the bus bar and the stud. Since the stud is non-rotatably supported within the panel 21 it may be seen that the operations accompanying the removal of nuts 52 and 51 will in no way tend to loosen the nuts 73 and 75.

It therefore becomes possible to remove the circuit breaker from its mounted position illustrated in Figures 1 and 2 by first removing the front metallic panel 13 and employing a socket wrench to remove the nuts 52 and 51.

Similarly, the breaker may be replaced by simply slipping the openings in metallic insets 46 thereof over the threaded extensions 43 of the stud and securing the nuts 51 and 52. This operation will again have no effect upon the electrical connections of the bus bar 31 since the stud is non-rotatably supported.

As previously mentioned, it is quite possible that commercial phenolic moldings such as that employed upon the circuit breaker illustrated, may not have perfectly true surfaces. It has been found advisable, particularly in three-pole circuit interrupters to secure the base against the panel board in certain positions, that is, at certain stud locations and to prevent any clamping stress being imposed at other stud locations since it has been found that tight clamping at all stud locations would cause a warp in the molding which in turn would preclude proper operation of the circuit breaker or crack the phenolic casing thereof.

My mounting means therefore permits axial movement of one or more of the studs with respect to panel 21 in order that uneven or distorting clamping stresses may not be imposed upon the circuit breaker body. As an example, the stud 34 of Figure 1 and the stud 81 of Figure 2 have been shown with this type of connection.

In each of these illustrations, the washers 62 and 67 have been omitted and a bushing 82 having an outside diameter equal to that of the cylindrical portion 35 has been placed between the nut 71 and the shoulder 42 of the cylindrical portion 35. Otherwise the elements of the stud connection remain the same as illustrated in Figure 3.

The axial length of the bushing 82 is sufficient so that its outer annular surface extends beyond the surface of the annular flange 56 within the counterbore 55. Hence it may be seen that when the nut 71 is tightened, it is brought to bear against the bushing 82 which accordingly is forced against the shoulder 42. Hence there is no clamping action against the insulating panel 21 as a result of the tightening of the nut 71 and since, as illustrated in Figures 1 and 2, there is a clearance between the nut 71 and the surface of the flange 56 or between the washer 64 and the shoulder 37 or between both these sets of elements, depending upon the position of the stud axial movement of the stud is possible.

But since the extensions 66 of the washer 64 are longer than the clearance provided for this washer, no rotation of the stud is possible.

Accordingly, this construction permits the clamping of the line terminal such as 27 to the stud 34 since as previously mentioned the clamping of the line terminal does not impose any stress upon the body of phenolic insulation.

A modification of my circuit breaker mounting is shown in Figures 4 and 5 for mounting a circuit breaker on a metallic panel.

It is, of course, necessary when utilizing steel panels at the rear of a circuit interrupter to ensure that each of the studs which provides electrical and mechanical supporting means are insulated from the steel panel in order that the individual circuits may be isolated.

Referring to Figures 4 and 5, a portion of the circuit breaker terminal is illustrated and includes the insulating body 11 and the line terminal 31. The stud 85 comprises in this modification a circular flange 86 having on one side thereof an integral threaded extension 91 of reduced diameter. At the other side of the flange an integral reduced diameter section 92 is knurled up to the edge 93 and threaded at 94 to the end of the studs. The stud 85 contains a cylindrical layer of insulation 95 molded directly thereupon, the knurling providing a rigid bond between insulation and metal.

The insulation is milled to provide a pair of opposed flats 96 extending from the main cylindrical section 95.

The insulation terminates in the shoulder 93.

As illustrated in Figure 4, the circuit breaker is connected to the stud in a manner similar to that in Figures 1 and 2. Thus the threaded extension 91 of the stud extends through a metallic insert 46 and a pair of nuts 51 and 52 secure it to the circuit breaker terminal 26. At the other end, the nut 71 and lock nut 72 complete the mounting on the panel, and nuts 73 and 75 secure it to the bus 31.

A washer 97 having a perforation 101 corresponding with the cross-section of the milled portion 96 of the insulation is slipped over the milled insulating material to engage against the shoulder 102 and a washer 103 similar to washer 64 of Figure 3 and having a perforation 104 similar to that in washer 101 is also slipped over the insulating material and brought to bear against the surface of washer 97.

The insulating panel 21 has been replaced in this modification by the steel panel 105 which is perforated at 106 to permit the passage of the stud; and a pair of opposite perforations 107 are employed to engage the extensions 111 on washer 103.

Thus when the stud 85 is passed through the perforation 106 with the washers 97 and 103 properly positioned upon the insulating layer 96, it will be seen that the metallic panel 105 may not contact the metallic portions of the stud 85.

When the stud has been thus assembled, a bushing 112 of an insulating material is slipped over the stud. A washer 113 is then positioned against the insulating bushing 112 and the nut 71 is employed to tighten these elements. A lock nut 72 when positioned completes the assembly thereof. The nuts 71 and 72 cooperating with washer 113 press the bushing 112 against the metallic panel 105 and pull the stud 85 so that the entire unit is held securely to the panel 105. The flat sides 96 of the insulation and the flat sides of the perforation 104 in the washer 103 prevent the stud 85 from rotating relative to the steel panel.

Accordingly, it may be seen that this has all the advantages described in connection with the modifications illustrated in Figures 1, 2 and 3 and has the additional advantage that a steel panel may be employed. Also as in the previous modification, axial movement may (as seen at the right hand stud 85a of Figure 4) be permitted in certain of these studs by omitting the washer 97 and using a shorter bushing 112 and permitting the washer 113 to be pulled tightly against the shoulder 93 of the insulation 96. This will provide an axial freedom of movement while precluding any rotational movement of the stud. Also, the tightening of nuts 71, 72 cannot place a strain upon the circuit breaker base or the supporting steel panel 105.

The insulation around the stud 85 precludes possible short circuits between poles of the circuit interrupter. Thus it may be seen that in either of the modifications described, the circuit interrupters are readily removed by loosening the nuts 51 and 52 which operation does not disturb the electrical connections at the rear of the stud and behind the panel.

Similarly the insertion of a circuit breaker may be accomplished without impairing the electrical connections and without requiring that a service man go behind the panel. If an insulated socket wrench is employed, the circuit breakers may be removed when the main conductors are energized since the circuit breaker may be handled at its outermost portions during removal.

In Figure 6, I have shown a construction which corresponds somewhat to that of Figures 1 and 2 wherein the stud members which in turn support the circuit breaker are mounted on the plurality of switch board panels 121.

The stud itself is shown in an exploded view in Figure 7. The essential difference between the mounting arrangement of Figure 7 and that of Figure 3 lies in the additional non-rotatable

washer 164a which registers with the washer 164b. Otherwise the manner of arranging and mounting of the stud is essentially the same as was previously described.

Thus the stud itself comprises a cylindrical metallic member 135 having an area milled thereon to form flats 136 on either side which terminate in the shoulders 137. The front end of the stud has extending therefrom the threaded member 143 which in cooperation with the cylindrical member 135 forms the shoulder 144.

Shoulder 144 bears against the inner end of the metallic insert 146 and the line terminal 126 is mounted over the threaded end 143 by passing the perforation 127 thereof over the said threaded end. The line terminal is forced against the outer end of the metallic insert 146 by the nut 151 which in turn is held securely in place by the lock nut 152.

At the opposite end, a threaded element 141 extends inwardly towards the rear from the cylindrical portion 135 of the stud. The opening 174 in the bus bar terminal 131 is placed over the threaded end 141 against the nut 173 which is threaded onto the end 141 and the terminal is locked in place by the lock nut 175.

A washer 162 surrounds the back end of the stud and has an opening 163 therein which is so shaped as to closely coincide with the flats 136 of the milled section of the stud. This washer is drawn against the shoulders 137 at the forward end of the flats 136.

The second washer 164a also has a central opening 165a which is similarly formed so as to closely coincide with the periphery of the milled end of the stud. This washer is drawn back tightly against the washer 162 in the operative position of the mounting so that it also embraces the flats 136.

The washer 164a is provided with a pair of horizontal extensions 166a which enter into and cooperate with the slots 168 in the third washer 164b. The extensions 166a are of a length slightly less than the thickness of the washer 164b so that they do not pass through the opposite side of the washer.

The third washer 164b also has a central opening 165b which is also so shaped as to closely coincide with the flats 136 of the stud. In operative position, this washer is drawn back tightly against the washer 164a upon the milled portion of the stud.

It will be clearly seen in Figure 7 that the slots 168 are adapted to receive the extensions 166a on washer 164a. This is only for simplicity in manufacture, the only function of the slots 168 being to receive the extensions 166a. The third washer 164b is also provided with a pair of horizontal extensions 166b. The two extensions 166b on opposite sides of the washer 164b are arranged in a plane which is normal to the plane of the two extensions 156a of washer 164a.

The extensions 166b will enter into and cooperate with the slots 161 and 157 in the inner flange 156 formed by the counterbore 154 in the opening 153 of the frame member 121. The formation of the opening 153 and the counterbore 154 in the plate 121 of Figure 7 is substantially similar to the formation of the opening 53 and the counterbore 54 in the plate 21 of Figure 3. The essential difference between these two openings is that while the openings 57 and 61 in the plate 21 of Figure 3 are designed to closely fit around the extensions 66 of the washer 64 therein, the slots 161 and 157 are arranged to provide

a loose fit for the extensions 166b of the washer 164b of Figure 7.

Thus the arrangement of the washer 164b on the milled flats 136 of the stud and the engagement of its extensions 166b in the slots 157 and 161 of the frame member 121 will prevent rotation of the stud. The essential purpose of the modified construction of the stud of Figure 7 over that of Figure 3 is to provide not only a free floating condition at the center poles of the circuit breaker, but also to permit some freedom of movement of the studs in two perpendicular planes, thus assuring adequate adjustment of any misalignment of poles in the panel on which the circuit breaker is to be mounted.

Thus, by making the slots 157 and 161 oversize so that they are much larger than the extensions 166b, the washer 164b may have some freedom of movement within the counterbore 154. For this purpose, it is, of course, essential that the diameter of the washer 164b be somewhat less than that of the counterbore 154.

Likewise, by making the slots 168 in washer 164b somewhat over-size so that they are larger than the cross-section of extensions 166a of washer 164a, this washer may have some freedom of movement with respect to the washer 164b.

Since both washers 164a and 164b closely engage the flats 136 of the stud, any movement of the stud which is necessary to compensate for misalignment of the mounting holes will be permitted by the slight enlargement of the slots 157, 161 and 168.

The washer 169 is positioned on the threaded end 141 of the stud in back of the washer 164b. This washer has an inner bore 170 adapted to fit over the said threaded extension. The outside diameter of the washer 169 is greater than the diameter of the central bore 153 in the plate 121. However, it is of such diameter that it will fit easily between the extensions 166b of the washer 164b.

The length of the flats 136 is slightly less than the total thickness of the washers 162, 164a and 164b. The washer 169 will therefore provide a suitable bearing between the back face of washer 164b and the surface of the flange 156 in the counterbore 154. It will also provide a suitable bearing for the end of the bushing hereinafter described when washer 162 is removed.

The relationship of all of the elements thus far described to the circuit breaker and its panel is clearly shown in the left hand stud of Figure 6. In order to secure the stud assembly in the position hereinbefore described, the washer 167 having an inner bore adapting it to fit over the threaded end 141 of the stud is slipped over the end of the stud and is placed against the back surface of the plate 121.

Obviously, the washer 167 has a diameter substantially equal to that of the washer 169 and thus is of a greater diameter than the bore 153 so that it will furnish an appropriate bearing surface against the back of the plate 121.

Nut 171 is then threaded over the end of the stud 141 against the washer 167 to lock the same in place and this securement is further locked by the lock nut 172. The nuts 173 and 175 which secure the bus bar terminal 131 in place have already been described.

When the stud is in place, it will be seen that a clamping action against the plate 121 is provided by the washers 167 and 169. Washer 167 bears against the back surface of the plate 121; washer 169 bears against the front surface of the flange

156 formed by the counterbore 154. The locking pressure is then transmitted through the washer 164b, 164a and 162 to the shoulders 137 formed in the stud by the milling of the flats 136.

The circuit breaker may thus readily be secured in position. It is also clear that in order to remove the circuit breaker from the panel, it is only necessary to loosen the nuts 152 and 151 with respect to each of the mounting studs; and likewise to replace the circuit breaker, it is necessary only to mount the openings therein over the threaded ends 143 of the respective studs and place the locking nuts 151 and 152 thereon. Since, as before pointed out, the circuit breaker casings of phenolic material or similar commercial material do not in most cases have their surfaces particularly true, it is necessary, particularly in three pole circuit breakers, rigidly to hold the base in position at certain stud locations and to prevent a clamping action at other stud locations. This type of free floating condition has already been described in connection with Figures 1 and 4 for the particular studs therein illustrated.

Similarly, provision may be made for a floating mounting of the stud in connection with the studs herein set forth in Figures 6 and 7. It should be noted that while it is important to prevent clamping action at certain stud locations to prevent breakage or distortion of the circuit breaker casing, nevertheless even the floating studs which are used for this purpose must be in position to furnish some support for the circuit breaker casing at that particular location.

In Figure 6, on the right hand side, I have shown the arrangement of the stud of Figure 7 to provide for the free floating condition which at times becomes necessary. Here it will be seen that the washer 162 has been removed and a bushing 182 having an inner bore free to pass over the threaded section 141 of the stud and an outside diameter which is less than that of the bore 153 has been placed over the end 141 between the washers 167 and 169. The length of the bushing 182 is such that when the nuts 171 and 172 are tightened, the washer 167 will not bear against the back of the plate 121 and the force will be directed to the shoulder 137 of the stud through the washer 169, thus preventing any clamping action. In this way, a stud is provided which is free to move axially while at the same time the extensions 166b and 166a of the washers 164a and 164b prevent rotation of the stud.

The degree of axial movement which may be permitted for the stud when the bushing 182 is in place is determined primarily by the length of the bushing. However, the limiting factor is that the degree of axial movement should not be so great as to cause a disengagement of the extensions 166b from the slots 157 and 161. By this means, a construction is provided wherein not only axial movement of a stud can be permitted by utilization of the bushing 182, but also it is possible whether or not the axial movement is to be permitted, nevertheless to obtain a slight movement in perpendicular planes which are normal to the axis of the stud so that the stud may readily adjust itself should the mounting holes in the switch board panel and the circuit breaker be to some slight degree misaligned.

Again, the convenience in use and operation of the stud is preserved since the circuit breaker may be removed from or placed on the panel without requiring access to the rear circuit connections.

In Figures 8 and 9, I have shown a modifica-

tion of my stud wherein the supporting panels or bars 221 may be of conducting material which thus permits the utilization of structurally strong members such as steel. Here again, the circuit breaker casing has exactly the same form as the circuit breaker casings of Figures 1, 2, 4 and 6, so that the arrangement of these members need not be further described. Similarly, the circuit connections and the securing connections obtained by the nuts at each of the outer ends of the stud are attained in the same manner as was described in connection with the studs of the prior figures so that these require no further elaboration.

Where a steel mounting panel is used for a load bearing and current carrying stud, it becomes essential, of course, that a safe creepage distance be maintained. This is accomplished by use of an insulated stud and bushing. Referring first to Figure 9, there is here shown a metallic stud 200 having a cylindrical flange 235. The front end of the stud 200 has a threaded extension 243 which, with the cylindrical flange 235, forms the shoulder 244. The shoulder 244 when the stud is in place, bears against the inner surface of the metallic insert 246 in the manner already described while the threaded end 243 passes through this metallic insert and through the opening 227 in the terminal 226. The circuit breaker is then securely held in place on the stud by the nut 251 and the lock nut 252. This has already been described in connection with similar reference numbers in the prior figures.

The rear end of the stud 200 likewise has an extension 241 which is threaded at its outer end but which, however, is knurled as seen particularly in the left hand stud of Figure 8 adjacent the cylindrical flange 235. This knurling is provided in order to maintain a secure bond between the metallic portion of the stud 200 and the insulating sleeve 283 which is molded thereon.

The insulating sleeve 283 includes a cylindrical flange 210 having on the front surface the face or shoulder 211. The insulating sleeve also includes on the rear side of the flange 210 a section 213 having a diameter equal to the diameter of the metallic flange 235. The sleeve itself, between the flange 210 and the flange 235, is of the same diameter as flange 235. Between the section 213 of the sleeve 283 and the flange 210 thereof, I provide a squared section 215 which is thus on the rearward side of the flange 210. As may readily be seen from an inspection of Figures 8 and 9, the section 213 of the insulating sleeve 283 terminates substantially short of the end of the threaded extension 241 to form the shoulder 217.

The insulating sleeve 283 which is integrated with stud 200 by reason of its being molded around the knurled portion thereof, may be made of a diameter which is determined by the amount of voltage used. More specifically, the positioning and diameter of the insulating flange 210 will govern the creepage distance.

A washer 264 having the square central opening 265 surrounds the insulated stud, the said squared opening being made to fit closely on the squared section 215. In operative position, this washer will press against the back face of the flange 210. Washer 264 is provided with a pair of horizontal extensions 266 which normally will enter into and engage the holes 257 and 261 in the supporting plate 221 when the parts are assembled for operation and the stud has entered into the opening 253 of the panel 221.

An additional washer 269 having the square central opening 270 corresponding in size to the opening 265 in washer 264 also is fitted over the stud with the opening 270 closely fitting over the squared section 215 and the face of the washer 269 bearing against the back face of the washer 264. As may readily be seen from Figure 8, when the parts are assembled for operation, an insulating sleeve 282 surrounds that portion of the insulated section 213 of the stud which projects through the rear side of the metal panel 221.

A washer 267 and a pair of nuts 271 and 272 press this sleeve against the back of the panel 221 and pull the flange 210 of the insulating sleeve of the stud tightly against the washers 264 and 269 and hence pull these members tightly against the front of the panel 221 to hold the unit securely in the said panel. The cooperation of the squared opening of washer 264 with the squared portion 215 of the stud and the engagement of the extensions 266 of the washer 264 in the openings 257 and 261 of the panel prevent the stud from rotating relative to the panel.

The length of squared section 215 is such that it does not abut against panel 221. The length of section 215 is less than the summation of washers 264 and 269.

As previously pointed out, the opening 274 of bus bar terminal 231 is fitted over the threaded end 241 of the stud 200 and is securely held in place by the nuts 273 and 275. The position of the stud 200 for a tight clamping action is shown on the left hand side of Figure 8. Where it is necessary to permit axial movement of the stud owing to distortion or lack of trueness of the casing of the circuit breaker, then the modification shown on the right hand side of Figure 8 may be made in the mounting of the stud.

For this purpose, the washer 269 is omitted and a shorter insulating sleeve 282*a* is used instead of the bushing 282. This permits the washer 267 to be pulled tightly against the shoulder 217 on the back surface of the insulation. Since the insulating sleeve 282*a* is sufficiently short so that when the washer 267 is pulled tightly against the shoulder 217 it does not press the sleeve 282*a* against the panel 221, the right hand stud of Figure 8 is permitted to have axial movement. The length of sleeve 282*a* is such, however, as not to permit sufficient axial movement of the right hand stud of Figure 8 to cause the extensions 266 to be entirely withdrawn from the openings 257 and 261.

Thus, while the stud is permitted some axial movement, the axial movement is not sufficient to permit a disengagement of the members which prevent it from rotating. In this modification, as well, it will be clear that the circuit breaker may readily be mounted on or removed from the panel simply by manipulation of the nuts 251 and 252 of each of the studs.

Referring now to Figures 10 and 11, I have here shown a slightly modified form of stud which, however, does not depend upon utilization of horizontal extensions to prevent rotation, but utilizes a formation of the opening in the insulating supporting panel to obtain the same.

Here referring particularly to Figure 11, the stud 300 has a cylindrical section 335 which is straddle-milled to form the flats 336. The juncture of the flats 336 with the main body of the

cylindrical section 335 forms the shoulders 337. The rearward end of the stud at the ends of the flats 336 has extending therefrom a threaded extension 341. The junction between the threaded extension and the milled end of the cylindrical extension 335 forms the shoulder 317. The front end of the cylindrical section 335 has extending therefrom a threaded end 343 forming at its junction with the cylindrical section the shoulders 344.

The circuit breaker shown in Figure 10 has exactly the same construction as that shown in the prior figures. Thus the shoulder 344 of the stud bears against the inner surface of the metallic insert 346 while the threaded end 343 passes therethrough and also passes through the opening 327 in the line terminal 326 and is securely held in place by the nuts 351 and 352. The opening 353 in the insulating supporting panel 321 has a shape corresponding exactly with the milled portion of the stud 300 so that the flats 336 thereof enter thereinto and are closely engaged by the inner surfaces thereof to prevent rotation of the stud 300.

The spacing washers 369 and 367 here have central openings 370 adapting them to fit over the milled portion of the stud. This is necessary since they are intended to pass over that portion of the stud which is milled. They do not, however, cooperate in any special way in preventing rotation of the stud, the prevention of rotation being obtained by the shaping of the opening 353 to closely engage the milled portion of the stud.

The stud is tightly positioned in place by the nuts 371 and 372 in the manner previously described and the bus bar terminal 331 is held in place over the threaded end 341 of the stud by the nuts 373 and 375. Here it will readily be seen that when the stud is held in place in the manner shown at the left hand side of Figure 10, it can have no axial movement and at the same time it is prevented from rotational movement by engagement of the milled portion thereof in the squared hole 353 of the insulating supporting panel 321.

Should it, however, become necessary to provide for axial movement of the stud for purposes hereinbefore pointed out, then removal of the spacing washers 367 and 369 accomplish this result. When, as shown at the right hand side of Figure 10, the washers 367 and 369 are removed, then the washer 371 may be tightened directly against the shoulder 317 on the stud so that clamping action of the stud members against the panel 321 is prevented and the stud is permitted to have an axial movement to a degree which is determined by the amount by which the shoulder 317 of the stud normally extends beyond the back face of the panel 321.

Here again it will be seen that while axial movement is thus permitted, the engagement of the milled portion of the stud in the opening 353 of similar cross section in the panel 321 prevents rotation thereof. Thus once more even though the circuit breaker casing may be disaligned or distorted, it may nevertheless be mounted in place and certain of the studs may be given some axial movement to permit the utilization thereof at least for positioning the slightly distorted portion of the circuit breaker casing on the panel.

Again it should be pointed out that since in a three-pole circuit breaker six such mounting studs are used, the fact that one or two or even three of the studs at various locations cannot exert a tight clamping action, but are permitted

to have axial movement does not prevent the secure mounting of the circuit breaker upon the panel.

The tight clamping action which is obtained by the three or four studs which can be tightened ensures absolute securement of the circuit breaker on the panel. The one, two or three remaining studs which must of necessity be permitted axial movement nevertheless serve to position the circuit breaker with respect to the particular openings through which they pass.

Again it will be obvious that the circuit breaker may be removed from or placed on the panel simply by manipulation of the nuts 351 and 352.

In Figures 12 and 13, I have shown a slight modification of the construction of Figures 10 and 11 where again a supporting panel 421 of insulating material is used. Here instead of the broached opening 353 of Figure 11, an opening 453 is provided in the panel. This opening is backed up by a plate 480 preferably of insulating material which is secured against the back surface of the panel 421 in any suitable manner, as, for instance, by the self-tapping screws 481, 481. The insulating plate 480 has an opening 482 therein which registers exactly with the opening 453. The opening 482 is substantially equal in its vertical diameter to the diameter of the opening 453 but the sides of the opening 482 are flat and extend substantially over the opening 453 in order to provide a suitable rotation preventing opening to engage the milled portion of the stud.

The stud 400 consists of a cylindrical member 435 which is turned and threaded at the front end 443, thus forming the shoulder 444. The cylindrical member 435 is also turned and threaded at the rear end 441 to form the shoulder 417 and is also straddle milled to form the flats 436 communicating with the shoulders 437. Here again the shoulder 444 bears against the inner end of the metallic insert 446 in the circuit breaker and the threaded end 443 passes therethrough and also through the opening 427 in the line terminal 426 where it is secured by the nuts 451 and 452.

The cylindrical portion 435 of the stud 400 is of a diameter which permits it to pass through the opening 453 in the panel 421. The milled portion thereof passes through the opening 482 in the plate 480 so that the flats 436 thereof are engaged by the sides of the opening 482, thus preventing rotation of the stud.

A spacing washer 467 having an opening 470 permitting it to pass over the milled portion of the stud is then placed over the portion of the stud projecting beyond the plate 480 and the entire assembly is locked in place by the nut 471. An additional locking washer may be used if desired.

The bus bar terminal 431 is then placed over the end 441 of the stud and held in place by the nuts 473 and 475. When all of the elements are appropriately tightened, it will be seen from an inspection of the left hand side of Figure 12 that the operation of the stud assembly is sufficiently like those already described as not to require further description.

In order to provide for axial adjustment of the stud for the purposes already fully described, it is necessary only to remove the washer 467 which may, of course, be of any appropriate thickness to accomplish this purpose. When the washer 467 is removed, it will be seen that the nut 471 may then bear tightly against the shoulder 417 of the stud without producing any clamping action against the panel 421. Thus when the stud of

Figure 13 is arranged in the manner shown at the right hand side of Figure 12, it may have axial movement without however being permitted to rotate. All of the advantages of this type of construction have already been previously described and need not be further set forth.

In Figures 14 and 15 I have shown a further slight modification of my stud and particularly a further modified means for preventing rotation thereof while nevertheless permitting axial movement for alignment purposes.

The stud 500 has a metallic flange 535. A threaded extension 543 is connected to the forward end of metallic member 535. This extension is of less diameter than the portion 535, thus producing the shoulder 544. As is seen more particularly at the left hand side of Figure 14, the rear end of stud 500 is turned down to produce the extension 515 of limited diameter which at its outer end is threaded at 541 for purposes which will now readily be understood.

The section 515 of the metallic portion of the stud is knurled so as to receive and securely retain a molded sleeve of insulation 583. The sleeve 583 as will readily be seen from an inspection of the cross sectional view of Figure 14 is a member which is T-shaped in cross section, having the principal flange 510 and a section 513 of reduced diameter, a shoulder 537 being formed by reason of this change in diameter of the sleeve.

The stud is adapted to pass through and engage in the opening 553 in the panel 521. The opening 553 is counter-bored at 554 to produce the inner flange 556. An opening 557 is also formed near the periphery of the opening 553. The side opening 557 extends into the flange 556 and is a completely enclosed opening adjacent the periphery of the opening 553 but the section thereof which extends through the counter-bore 554 is semi-circular. This may best be accomplished by first drilling the small hole 557 in the panel 521 and then drilling the bore 553 adjacent the hole 557 without breaking the periphery of this hole.

Thereafter, the counter-bore 554 is drilled so that the periphery thereof passes substantially through the axis of the hole 557, thus producing a hole outside of the periphery of the opening 553 and a slot in the counter-bore 554.

A bronze pin 566 is force-fitted into the hole 557 and extends up into the counter-bore 554 and projects thereinto, particularly as shown in Figure 14. Also as seen in Figure 14, the neck 513 of the insulated member 583 is slotted at 561 to register with the pin 566. The pin 566 does not extend beyond the forward face of the panel 521 so that it does not interfere in any way with the clamping action of the stud hereinafter described.

It will now be obvious that the engagement of a portion of the periphery of the pin 566 in the slot 561 of the insulated portion of the stud will now prevent rotation of the stud while at the same time the pin does not prevent longitudinal movement thereof. The clamping action of the panel 521 is obtained by inserting the stud so that the shoulder 537 thereof bears against the outer face of panel 521.

It will here be seen that the inner end of the neck 513 will not then bear against the flange 556, thus ensuring that the clamping action will be obtained at the surface 537. A washer 567 is then placed over the threaded end 541 of the stud on the rear side of the panel.

This washer is of greater diameter than the bore 553 and thus provides a bearing surface

against the back of the panel 521. The tightening of nuts 571 and 572 against the washer 567 will now secure this clamping action so that the panel is securely clamped between washer 567 and the shoulder 537.

Here again it should be noted that the line terminal 526 of the circuit breaker is secured in position over the forward end of the stud by the nuts 551 and 552 so that the circuit breaker may be placed in position or removed from the switch board simply by manipulation of these nuts. The bus bar terminal 531 is held on the threaded end 541 of the stud by the nuts 573 and 575.

As may readily be seen in Figure 14, the opening 553 is over-size, it being much larger in diameter than the portion 541 of the stud which extends therethrough. This is to permit the mounting of the bushing 582 as seen in the right hand side of Figure 14 within the opening 553 when it is desired to permit the stud to have axial movement in order to avoid a clamping action on the panel 521 for reasons already fully set forth.

When it is necessary to permit the stud to slide axially then a bushing 582 is slipped over the stud between the washer 567 and the rear face of the neck portion 513 of the insulating member on the stud. The bushing 582 is of a length which is greater than the distance between the face of the neck portion 513 and the upper face of panel 521 when the stud is clamped tightly in position.

Owing to this increased length, when the washer 567 is tightened against the bushing 582 by the nuts 571 and 572, then the bushing is forced against the face of the neck member 513 while the washer 567 nevertheless remains clear of the rear surface of the panel 521. Accordingly, clamping action against the panel is prevented by the interposition of the bushing 582 so that the stud on the right hand side of Figure 14 may have axial movement for all of the purposes previously set forth.

In Figures 16 and 17 I have shown a construction which is exactly similar to that of Figures 14 and 15 and which accordingly requires no further description except with respect to the slight modification of the stud to prevent rotation thereof. In this modification, the counter-bore 554 is provided with two semi-circular receses 580, 580 on opposite sides thereof, 180° apart. The neck portion 513 of the stud is provided with lateral extensions 590, 590 which are adapted to enter into and register with the extensions 580 in the counter-bore 554 thus preventing rotation of the stud while the nuts 551 and 552 are manipulated. With this single exception, the construction of Figures 16 and 17 is exactly like that of Figures 14 and 15.

Of course, it should be remembered that the essential reason for preventing rotation of the stud while it is in position in the panel is to permit the tightening of the nuts carried by the stud. Obviously if the stud were able to rotate, then no amount of rotative motion of the nuts would be effective actually to tighten the members.

In Figure 18 I have shown a slight modification of the metal insert 646 in each of the circuit breaker structures which may, if desired, be substituted for the metal insert 46 of Figures 1, 2 and 4 or for the similar inserts in the other preceding figures. Obviously, the metallic insert 646 is mounted on and made a part of the circuit breaker itself, but must be so arranged as to cooperate with the stud construction.

In this construction, I have shown a panel 621 of a switchboard or other structural member for

supporting the circuit breaker, the said panel having an opening 653 through which a stud 600 passes. The stud 600 is here schematically shown, it being understood that it may have any of the forms of the various studs already described.

Metallic insert 646 is mounted in an opening 650 in the circuit breaker housing. Contrary to the inserts 45 of the prior figures, the insert 646 of Figure 18 does not have any formation which adapts it to be secured into the molding of the circuit breaker housing. With respect to the molding, it actually is free floating in that the cross section of the opening 650 is substantially the same in area and shape as the cross section of the insert 646. The insert 646 is, however, non-circular in cross section so as to prevent rotation thereof and obviously the opening 650 is of similar non-circular cross section.

The forward or outer end of the insert is turned down to a cylindrical cross section at 603 thus forming the shoulder 604. The shoulder 604 bears against the inner surface of the line terminal 626. The cylindrical section 603 passes through the opening 627 in the line terminal 626 and is riveted at 605 to form an electrical current carrying engagement with the circuit breaker terminal 626.

The metallic insert 646 also has a bore 610 to permit the passage therethrough of the threaded end 643 of the circuit breaker stud 600.

In operation the shoulder 644 of the circuit breaker stud will bear against the inner face of the metallic insert. By the utilization of this type of insert, the necessity for the formation of a special ribbed metallic insert and the necessity for molding the metallic insert in the circuit breaker housing is dispensed with.

As will be seen, any strain that may occur will take place between the shoulders 637 of the stud 600 bearing against the panel 621 and the said shoulder 637 will act as a spacer in the mounting of the circuit breaker away from the panel. The special importance of this modification is that the strain of the clamping forces in the circuit breaker itself will not be on the molded housing of the circuit breaker but upon the flexible terminal member 626.

This is so particularly because the metallic insert 646 can slide readily with respect to the molded housing of the circuit breaker. It may well be, in fact, that by the utilization of this kind of metallic insert which is actually floatingly mounted in the circuit breaker housing itself, the necessity for the floating arrangement of the stud may be dispensed with. However, this requires a modification of the circuit breaker construction.

Assuming the rigid arrangement of the circuit breaker terminal member which occurs in most circuit breakers which are now manufactured commercially, the necessity for forming a stud which can be arranged to float axially for all of the reasons above pointed out still remains.

It might also be noted here that with the arrangement set forth in Figure 18, if the section 635 of the stud 600 which enters into the opening 650 of the circuit breaker is of the same non-circular cross-section as the opening 650 of the circuit breaker then that in itself will be enough to prevent rotation of the stud, thus dispensing with the necessity of any cooperating elements on the panel itself. This again presupposes either the existence or the manufacture of circuit breaker housings which are peculiarly suited to this type of operation.

The arrangement of the studs of Figures 1–17 so that they float axially is still necessary in connection with existing types of commercial circuit breaker housings and is of course necessary wherever the floating or resilient arrangement cannot for structural or other commercial reasons be incorporated in the circuit breaker housing itself.

It should be noted for instance that where reliance is placed on the flexibility or elasticity of the current carrying terminal 626 in the circuit breaker to provide for the floating condition that nevertheless when the nuts 651 and 652 are tightened against the terminal 626 and hence against the outer shoulder 604 of the metal insert no further axial movement of the stud is possible. This kind of automatic adjustment owing to the yieldability of the terminal itself within the housing and hence to the yieldability of the metallic insert 646 permits the circuit breaker housing automatically to adjust itself to irregularities without any residual floating condition in any of the studs when they are all tightened in place.

This arrangement will absorb all shocks. The circuit breaker housing may be spaced at a distance from the panel by making section 635 of the stud of a sufficient length to compensate for any irregularities in the surface of the housing.

Again it is pointed out, however, that where existing circuit breaker structures are to be mounted on a panel the floating arrangement possible by the use of the studs of Figures 1–17 becomes essential.

In the foregoing I have described a mounting stud for a circuit breaker which enables the circuit breaker readily to be removed from the front of a switchboard and readily to be remounted on the front of the switchboard without the necessity for obtaining access to the rear of the switchboard. The arrangement of the mounting studs which I have herein described also makes it possible by the addition or removal of certain members thereof, to make the stud a free floating mounting element. This is particularly useful at points where tight clamping of the circuit breaker casing to the panel would be injurious to its molded construction.

In the foregoing I have also set forth means whereby automatic adjustment of the mounting structure may be obtained by a modification in the construction of the circuit breaker housing itself.

In all of the foregoing I have described my invention only in connection with preferred embodiments which have actually been tested in practical use and found effective to perform the functions required of them. It will be obvious that many further modifications and adaptations of my invention both with respect to the structures of the various elements thereof and also with respect to the various uses thereof and also with respect to the various adaptations in which these mounting elements may be used should now be obvious.

Accordingly, I prefer to be bound not by the specific disclosures herein but only by the appended claim.

I claim:

In electrical switchgear, a stationary panel having a principal opening, a round conducting stud extending through said principal opening in said panel, a locking member slidable along

said stud to a non-rotatable position thereon; said panel having additional openings therein; said locking member having fingers engageable in said additional openings to prevent relative rotation therebetween; said stud comprising a cylindrical portion and threaded portions at each end, shoulders at the junctions of said cylindrical and said threaded portions, a pair of parallel opposed flats on one end of said cylindrical portion; shoulders normal to the axis of

the stud at the ends of said flats remote from said adjacent threaded portion; said locking member having an opening embracing the flats on said stud to prevent relative rotation; the body of said locking member abutting one side of said panel; and means engageable with said stud on the opposite side of said panel for clamping said locking member to said panel.

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