May 1, 1945. F. W. REILLY 2,374,702

ELECTRIC SWITCHGEAR

Filed Nov. 4, 1940 4 Sheets-Sheet 1

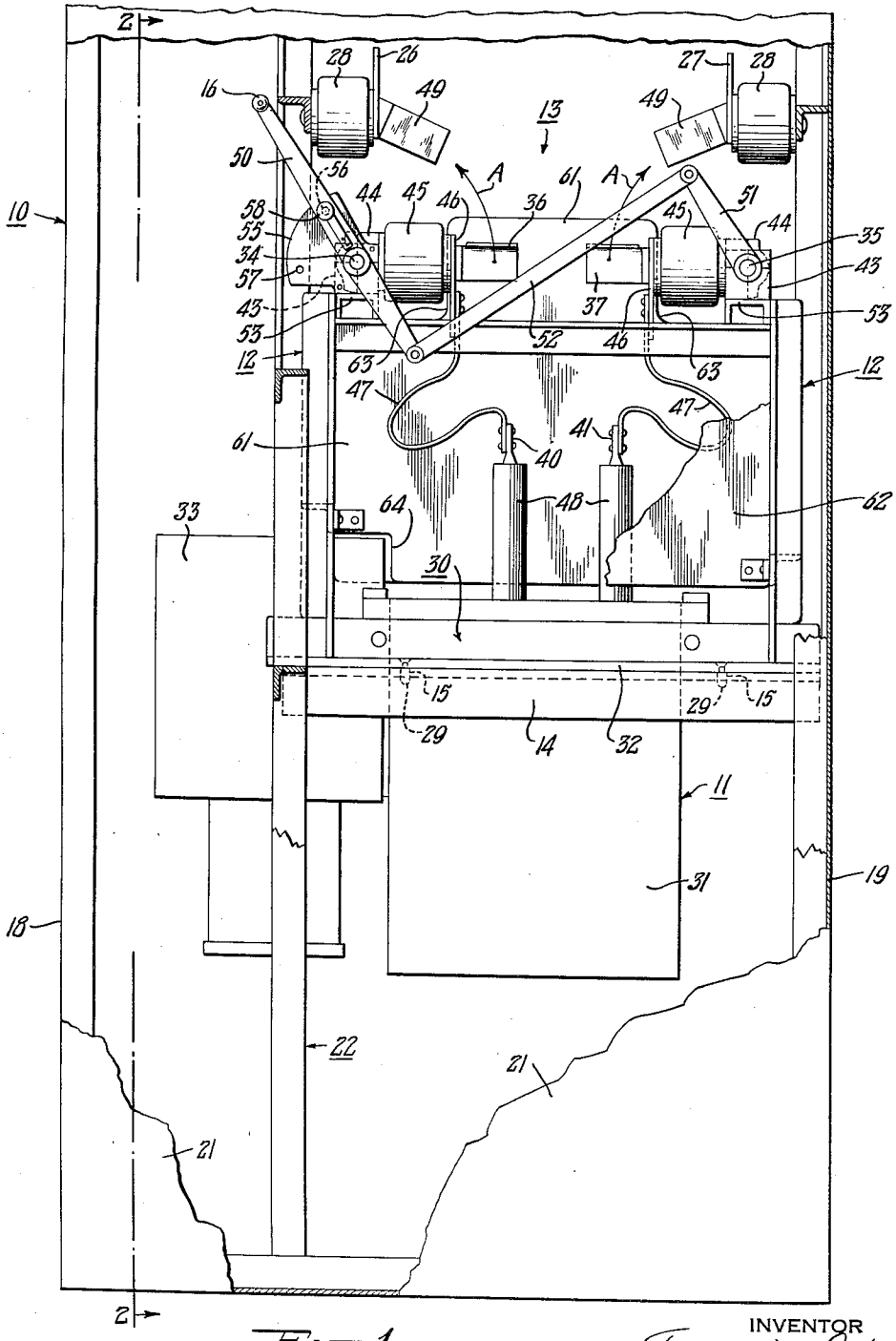


FIG 1

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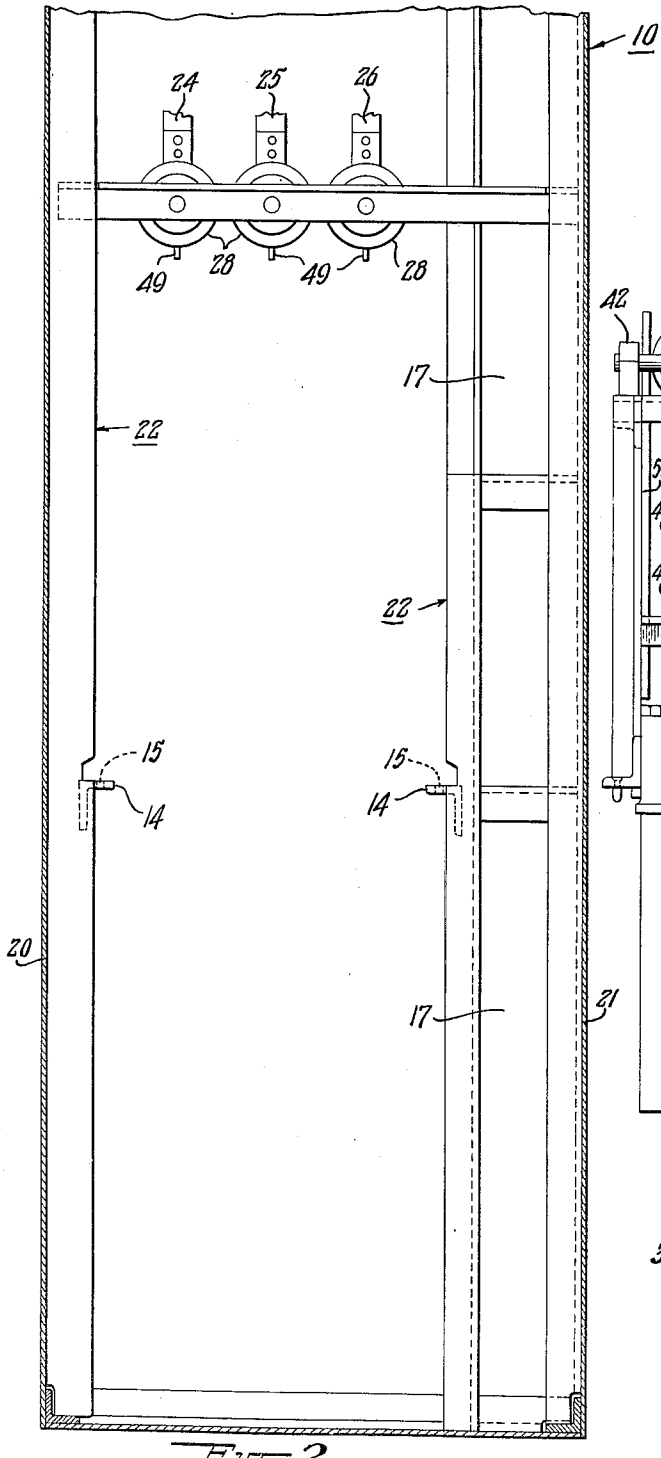
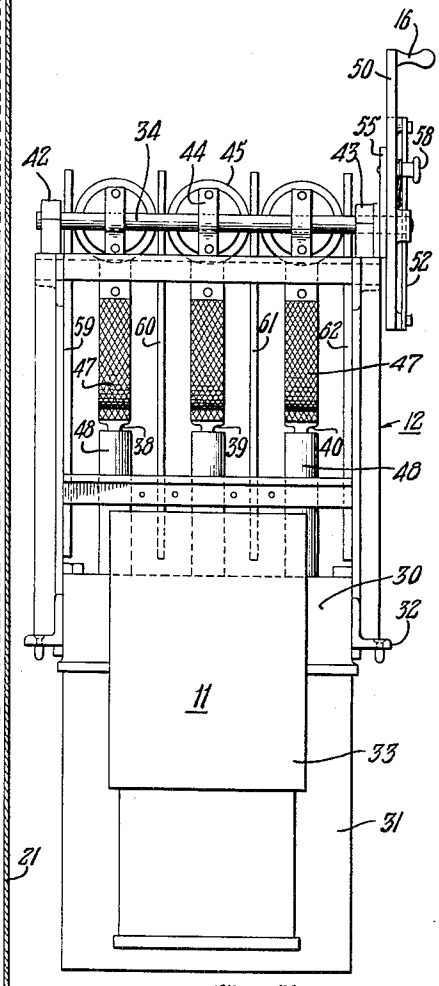


Fig 2

Fig 3



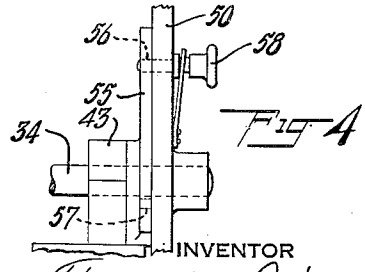


Fig 4

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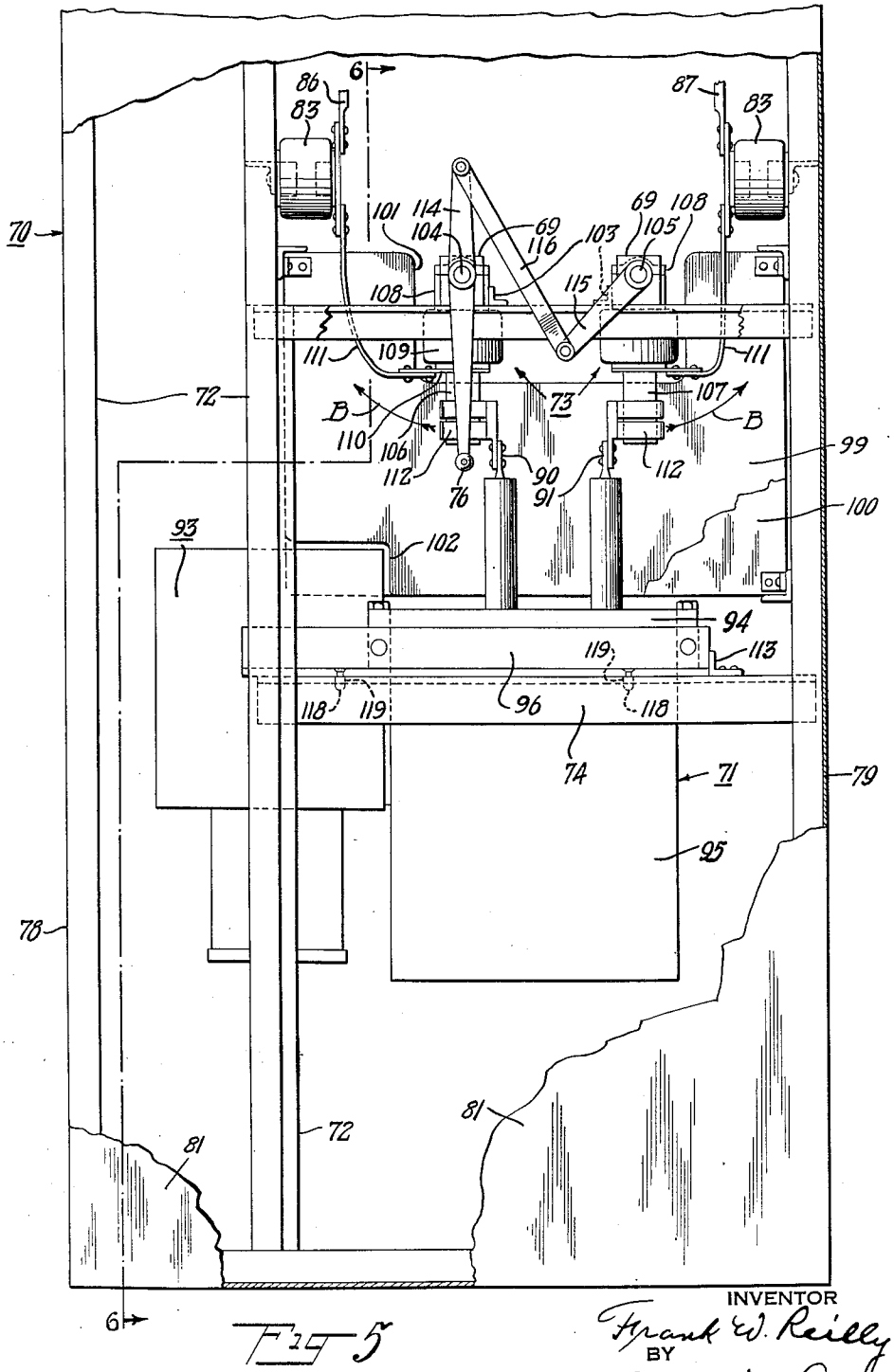


Fig 5

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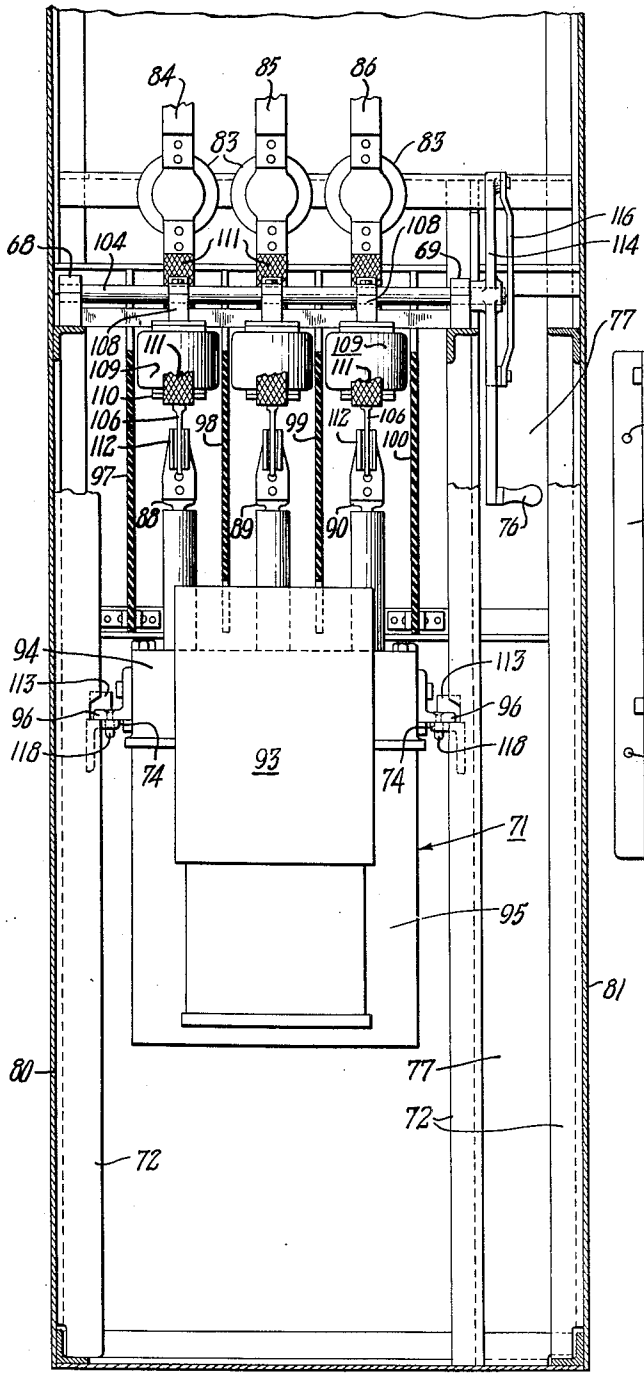


Fig 6

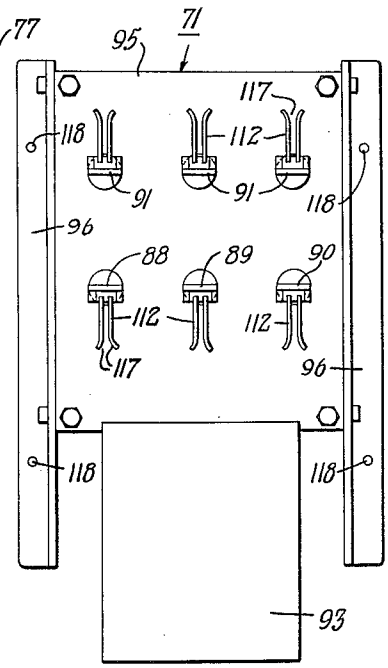


Fig 7

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UNITED STATES PATENT OFFICE

2,374,702

ELECTRIC SWITCHGEAR

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Application November 4, 1940, Serial No. 364,149

4 Claims. (Cl. 175—298)

The invention relates to electric switching and, more particularly, to disconnect switches adapted to be contained in an enclosing compartment or cubicle.

According to a preferred form of the invention, a disconnect switch is provided which comprises a grounded support journalling a switch shaft. Rigidly mounted on this shaft is a post type insulator which supports a movable switch contact. A stationary insulated contact is provided with which said movable contact may engage and disengage and a stationary insulated terminal is provided which is connected to the movable contact by a flexible conductor, such as a pigtail. A plurality of such switches may be mounted on the same shaft to form a gang switch and, if desired, two or more gangs may be provided having suitable connections whereby all switches may be operated together or interlocked for independent operation.

Although this type of switch is capable of a wide range of uses in connection with switchboards and other places where it is desired to connect and disconnect electric conductors, it has an important use with switching apparatus which is enclosed in a compartment or cubicle.

This type of switching apparatus commonly includes a removable interrupting switch which may be of the oil or air immersed type and the disconnect switch. In one preferred form of the invention the disconnect switch arm may be journalled directly upon the circuit breaker frame and coact with stationary switch contacts mounted upon the cubicle frame. In another preferred form of the invention, the disconnect switch arm may be journalled upon the cubicle frame and may cooperate with stationary switch contacts mounted upon the terminals of the circuit breaker casing.

The invention also consists in certain new and original features of construction and combination of parts hereinafter set forth and claimed.

Although the novel features which are believed to be characteristic of this invention will be particularly pointed out in the claims appended hereto, the invention itself, as to its objects and advantages, and the manner in which it may be carried out, may be better understood by referring to the following description taken in connection with the accompanying drawings forming a part thereof, in which

Fig. 1 is a side elevation, partly in section, illustrating the new switching apparatus;

Fig. 2 is a front sectional elevation taken on the line 2—2 of Fig. 1, with the removable switching unit removed;

Fig. 3 is a front elevation of the removable switching unit after removal from the cubicle;

Fig. 4 is a detail showing the device for locking the disconnect switch in open and closed positions;

Fig. 5 is a side elevation, partly in section, of a modified switching apparatus;

Fig. 6 is a front elevational view taken on the line 6—6 of Fig. 5; and

Fig. 7 is a top plan view of the removable unit of Figs. 5 and 6.

In the following description and in the claims, various details will be identified by specific names for convenience, but they are intended to be as generic in their application as the art will permit.

Like reference characters denote like parts in the several figures of the drawings.

In the drawings accompanying and forming part of this specification, certain specific disclosure of the invention is made for purposes of explanation, but it will be understood that the details may be modified in various respects without departure from the broad aspect of the invention.

Referring now to the drawings, and more particularly to Figs. 1, 2 and 3, the switching apparatus comprises as its main parts, a cubicle indicated in general by 10, made up of a suitable structural steel framework with steel panels, a removable unit made up of a circuit breaker, denoted generally by 11, carrying a framework 12 which in turn carries the movable contacts of a disconnect switch, indicated generally by 13. The cubicle has horizontal ways 14 on which the removable unit 11, 12, shown in Fig. 3, normally rests and from which it may be moved outwardly out of the front of the cubicle by a suitable truck (not shown). The framework 12 of the removable unit carries individual insulating panels or barriers 59, 60, 61, 62 and a handle 16 for operating the disconnect switch 13. The cubicle 10 is provided with a vertical space, indicated by 17, to accommodate the handle 16. It will be understood that, if desired, a series of such cubicles may be placed side by side in a manner known to those skilled in the art, with their fronts in line, available for operation, inspection, and repairs. These cubicles may be used for general switching purposes, for connecting and disconnecting any suitable electrical apparatus and a source of electricity.

The cubicle 10 comprises a suitable steel framework denoted in general by 22, covered by suitable steel panelling, the front being indicated by 18, the back by 19, and the sides by 20 and 21. The steel framework is arranged to provide the operating space 17. Secured to the framework are the pair of ways 14 extending from the front to the back of the cubicle. These ways support the removable unit 11, 12, as described hereinafter more in detail. The front 18 may be provided with a removable closure such as a door (not shown).

Mounted within the upper part of the cubicle 10 are three conductors 24, 25 and 26, forming part of a three-phase line. This line may be the incoming line supplying the electricity to the load through the switching apparatus forming part of this invention. Similarly, three outgoing conductors, all indicated by 27, are provided for supplying electricity to the load. All of the conductors 24, 25, 26 and 27 are mounted upon suitable post insulators, indicated in general by 28, these insulators being mounted upon the framework of the cubicle. These several conductors may lead to suitable busses or to feeders, or, in fact, the conductors 24 to 27 may be busses in themselves.

Circuit breaker 11 may be of any well known type, as for an example, an oil or air circuit breaker of high interrupting capacity, i. e., adapted to break the circuit under load. In the form shown, oil circuit breaker 11 is of the three-phase type having six terminals, three incoming terminals and three outgoing terminals. The incoming terminals are denoted by 38, 39 and 40 and the outgoing terminals are all indicated by 41.

The circuit breaker 11 comprises a switch frame 30 from which is detachably suspended the oil tank 31. The switch frame 30 has secured thereto a pair of cross heads 32 adapted to rest on the ways 14 when the removable unit 11, 12 is in place within the cubicle. The ways 14 have a series of holes 15, two on each side, in which are seated dowel pins 29 depending from cross heads 32. The operating mechanism for operating the circuit breaker 11 is denoted diagrammatically by 33. Supported on top of the switch frame 30 are bushings 48 supporting the terminals 38, 39, 40 and 41.

Forming part of the removable unit and supported by the circuit breaker 11 is the framework 12. The framework 12 carries bearings 42 and 43 for disconnect switch shafts 34 and 35, which carry insulators for the various movable forked prongs indicated by 36 and 37. There are three prong contacts, all indicated by 36, corresponding to the three conductors of the three-phase system forming part of the incoming line, and three prongs, all indicated by 37 for the corresponding outgoing line. All of these forked prongs form part of a multiple gang, multiple pole switch. The poles are all identical so that it is only necessary to describe the one in detail.

The shaft 34 carries a support 44 which in turn carries a post type insulator 45 which carries the prongs 36. Secured to the prongs 36 is a plate 46 which has a pigtail 47 secured thereto extending to the terminal 40 of the circuit breaker 11. Secured to the insulator 28 and in electric contact with the conductor 26 is a contact blade 49 adapted to enter between the prongs 36 when the disconnect switch is closed. The constructional details of the blades and forked prongs are discussed more in detail hereinafter.

For operating the gang switch, the handle 16 is secured to the end of an arm 50 secured to shaft 34. An arm 51 is secured to shaft 35 and the two arms 50 and 51 are connected by a connecting rod 52. Thus by pulling down on the handle 16 in Fig. 1, the both gangs of prongs 36 and 37 are raised upwardly in the direction of the arrows A, contacting their respective blades 49 to close both gangs of the disconnect switch. It will be noted that the supports 44 swing into engagement with the adjacent structural members 53 in Fig. 1 to provide a positive stop to limit the downward movement of the disconnect switch.

For locking the disconnect switch in both open and closed positions, a suitable locking device may be provided. This may take the form of a plate 55 suitably secured to the framework and having holes 56 and 57. A spring-pressed plunger 58 is secured to arm 50 which is adapted to engage in the hole 56 and 57. Thus a single locking device locks both gangs of switches in both open and closed positions.

For thoroughly insulating the several phases from each other and from the grounded cubicle, a series of insulating barriers 59, 60, 61 and 62 may be provided. These barriers may be of any well known dielectric material, such as transite, asbestos ebony, slate, Bakelite, etc., and are suitably secured as by angle irons, angles, or the like, to the framework 12, as shown. These barriers all have clearance spaces 63 in their upper front and rear corners to clear the insulators 45. In addition, the two middle barriers 60 and 61 have clearance spaces 64 in their lower corners to clear the operating mechanism 33 of the oil circuit breaker 11. The barriers eliminate all possibility of flash-over and also prevent the possibility of the flexible pigtail conductors 47 from swinging against each other or against the grounded cubicle frame.

In the ordinary use of the switching device, assuming that it is desired to withdraw the circuit breaker 11 out of the cubicle for inspection or repairs, the circuit breaker 11 will first be opened to open the circuit. Locking member 58 will then be removed from hole 57. The disconnect switch will then be opened by operating the handle 16 to open position, after which the locking device 58 is engaged in hole 56 to hold the switch in open position. A truck (not shown) will be wheeled into the cubicle and the entire removable unit 11, 12 raised slightly to raise the cross heads 32 off the ways 14 to remove the dowel pins 29 from their holes 15. The removable unit will then be withdrawn on the truck out of the front of the cubicle where the circuit breaker will be inspected or repaired. To put the cubicle back into use, the removable unit 11, 12 is then replaced by wheeling it in on the truck to position the cross heads 32 on top of the ways 14 and against the back of the cubicle. This aligns the dowels 29 with holes 15. The truck is then lowered and removed and the dowels 29 seat in the holes 15. This insures that the prongs 36, 37 will be in proper position to engage their blades 49 when the switch is closed. The disconnect switch is then closed by lowering handle 16 in Fig. 1 and engaging the locking device 58 with hole 57 to hold the disconnect switch in closed position. The circuit breaker 11 is then also closed and the cubicle is back in service.

Referring now to Figs. 5, 6 and 7, a somewhat different type of switching apparatus is shown. Here, as in the first form, a cubicle 70 is provided,

made up of suitable structural steel work with steel panels and having a removable unit. The removable unit here is made up merely of the circuit breaker 71. The swinging arms carrying the movable contacts of the disconnect switch 73 are carried by the cubicle frame instead of by the circuit breaker frame. In the present case the barriers are also carried by the cubicle frame instead of by the circuit breaker frame.

The cubicle 70 comprises a suitable steel framework 72 covered by suitable steel panelling, the front being indicated by 78, the back by 79, and the sides by 80 and 81. The steel framework is made to provide a clearance space 77 to accommodate the handle 76 of the disconnect switch. The cubicle framework is also provided with ways 74 on which the removable unit 71 rests.

Mounted within the upper part of the cubicle 70 are the three conductors, indicated by 84, 85 and 86, forming part of a three-phase line. These conductors may be the incoming line which supplies electricity to the load through the switching apparatus forming part of this invention. The three corresponding outgoing conductors are all indicated by 87. All of these conductors 84, 85, 86 and 87 are mounted upon suitable post type insulators indicated by 83 mounted upon the framework of the cubicle. These conductors may form part of suitable busses or may be connected to busses.

The circuit breaker 71 may be of any well known type as in the case of circuit breaker 11 in the first form, having three incoming terminals, indicated by 88, 89 and 90, and three outgoing terminals, indicated by 91. The circuit breaker operating mechanism is indicated diagrammatically by 93, the switch frame by 94, and the detachable oil tank by 95. Secured to the switch frame are cross heads 96 adapted to rest upon the ways 74. Cross heads 96 carry dowel pins 118 disposed in holes 119 in ways 74 to insure holding the circuit breaker 71 in correct position. Circuit breaker 71 is removable by means of a truck (not shown) in a manner similar to the removable unit in the first form.

The cubicle frame 72 carries bearings 68 and 69 for the disconnect switch shafts 104 and 105 which carry insulators for the various movable blades, indicated by 106 and 107. There are three blades, indicated by 106, corresponding to the three conductors of the incoming line. There are three blades, indicated by 107, for the corresponding outgoing line. All of these blades form part of the multiple gang, multiple pole disconnect switch 73. The poles are all identical so it is only necessary to describe one set in detail.

Suitably secured to the shaft 104 is a support 108 which has anchored thereto a post type insulator 109 which in turn carries a blade 106. The insulator 109 also supports a plate 110 in electric contact with blade 106. Plate 110 is secured to a pigtail conductor 111 which in turn is secured to the conductor 86. Blade 106 is adapted to engage with forked prongs 112 secured to the terminal 90 of circuit breaker 71.

The handle 76 for operating the disconnect switch is connected to arm 114 affixed to the shaft 104. A similar arm 115 is secured to a shaft 105 and connecting rod 116 connects the arms 114 and 115. Thus it will be seen that by moving the handle 76 to the left in Fig. 5, both gang switches will move in the direction of the arrows B to open the disconnect switch. It will be noted that the supports 108 swing into engagement with the adjacent structural members 103 to provide a positive stop to limit the downward movement of the disconnect switch. A suitable locking device may be provided for holding the disconnect switch in either open or closed position, similarly to that described in the first form.

A series of barriers of suitable insulating materials such as used in the first form are provided, these barriers being mounted by suitable angle irons or angles directly on the framework 72 of the cubicle. Four barriers are provided, the two middle barriers 98 and 99 being disposed between the blades of the disconnect switch and preventing arcing over between the several phases, and the two end barriers 97 and 100 providing protection against ground. Comparatively large recesses 101 are provided in the upper edges of all barriers to provide clearance for the disconnect shafts 104 and 105 and for the insulators 109, and the lower front edges of the intermediate barriers 98 and 99 are provided with notches 102 to clear the operating mechanism 93. These barriers provide protection against flash-over either between phases or between the several phases and ground, and also prevent any possible accidental swinging together of the several flexible pigtail conductors 111.

It is thought that the use of this switching apparatus will be obvious to those skilled in the art from the explanation given above in connection with the first form. To remove the circuit breaker 71 it is first opened by operation of mechanism 93, as will be understood by those skilled in the art. The disconnect switch is then opened by swinging the handle 76 to the left in Fig. 5, the disconnect switch being locked open for safety by engaging the spring-pressed member in the locking hole. The circuit breaker 71 is then removed by placing a truck (not shown) in the cubicle under the circuit breaker and raising the cross heads slightly off the ways to disengage dowels 118 from holes 119 so that the circuit breaker can be easily withdrawn from the cubicle. After the circuit breaker is withdrawn, it may be inspected and repaired, if necessary, and then replaced. Stops 113 are provided on the ways 74 to assist in aligning the dowel pins 118 and holes 119. This insures locating the circuit breaker in the proper position so that the prongs of the disconnect switch will be properly aligned with its blades. Before the circuit breaker 71 is closed, the disconnect switch must be closed by swinging the handle 76 to the right into the position shown in Fig. 5.

The pigtail conductors 47 and 111 may be of flexible flat ribbon stock and so connected at their ends that when the disconnect switches 13 or 73 are open, they will bend only in a plane parallel to the plane of movement of the switch arms and will not bend laterally out of these planes. Ample clearance is provided for the bending of these pigtails when the disconnect switches are open (see Fig. 1). These pigtails assume a moderately taut condition when the disconnect switches are closed (see Fig. 5). Other flexible connections, such as sector plates, pistons and plungers, and jack-knife levers, may be used instead of the pigtails.

The forked prongs 36, 37 and 112, it will be understood by those skilled in the art, will be of suitable construction to yieldably grip the blades disposed between the prongs and may have suitable flaring outer ends 117 (see Fig. 7) to guide the blades to closed position irrespective of any slight misalignment between the blades and the

forked prongs. The blades 49 and 106, 107 will be of suitable construction to cooperate with the forked prongs to make good electrical connections.

It will be understood that, if desired, various safety interlocks may be provided between the disconnect switches and the circuit breakers in both the above forms.

There are many advantages in the present invention, both from a structural standpoint and from the standpoint of safety and operation. Although the disconnect switch is shown used in a cubicle with a circuit breaker, it is obvious that it may be used alone to connect and disconnect any two terminals or conductors in any circuit. For general application, the disconnect switch may be arranged so that its rotating contacts may swing in a vertical plane either up or down, as shown in the drawings, or it may be arranged to swing in a horizontal plane or at an angle, as for example 45° with the horizontal.

The disconnect switch may be adapted to existing apparatus with a minimum of change. For example, the stationary switch contacts may be located on existing bus bars, as shown in Fig. 1, or on existing stationary terminals, as shown in Fig. 5. The contact arms may be adjusted along their shaft to correspond to the spacing of the stationary contacts.

All of the several poles are separated by insulating barriers which may be mounted upon a stationary part of the frame as shown, or the barriers may be mounted upon the disconnect switch shaft so as to rotate with the switch, thus protecting the poles and eliminating arc-over.

The operating shafts may be of metal and may be thoroughly grounded, entirely eliminating the necessity for insulated operating linkage. The operating shafts may be grounded through their bearings as shown or by any other suitable means. Since there are no insulators directly surrounding the switch contacts, full visibility of the contacts is enjoyed at all times. The switch is especially strong since both the stationary and movable contacts are directly mounted upon post type insulators and, when the switch is closed, increased cantilever strength is obtained.

The disconnect switch lends itself admirably to use with metal enclosed switch gear. The stationary contacts of the switch may be mounted upon the existing terminals of the oil circuit breaker, as in Fig. 5, or they may be mounted upon the existing bus bars, as in Fig. 1. The rotating contact arms may be carried by the stationary cubicle frame or they may be carried by the removable unit. In both cases they may be adequately grounded.

The use of this disconnect switch in a metal cell or cubicle has many advantages. It permits the withdrawal of the breaker without breaking any cable connections. The breaker can also be electrically opened without withdrawal. The breaker tank may be removed without withdrawal of the breaker. In case the swinging arm of the disconnect switch is mounted on the breaker frame, as in Fig. 1, it becomes removable with the circuit breaker for inspection and maintenance. In addition, the prongs 36, 37, which require attention from time to time, are exposed for convenient adjustment and repair. Also, in Fig. 1, the movable blades fall away from the upper contacts, which makes the disconnect switch doubly safe. Furthermore, the fixed contacts may be mounted directly upon the bus or upon the insulator supporting bus, as shown in Fig. 1.

When the swinging arm of the disconnect switch is mounted upon the stationary cubicle frame, when the switch is thrown to open position, the breaker is freed for removal. This construction also facilitates the use of a horizontal barrier between the bus and the disconnect switch.

While certain novel features of the invention have been disclosed and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. In enclosed electric switching apparatus, a cubicle, a circuit breaker in said cubicle and bodily removable horizontally therefrom, said circuit breaker and said cubicle each having thereon a set of fixed disconnect switch terminals, said cubicle terminals being mounted above said circuit breaker terminals to provide generally vertical air gaps, disconnect switch contacts movable in paths generally lengthwise of said air gaps to engage and disengage one set of terminals, said movable switch contacts including conductors extendible to the other set of terminals, a grounded metal operating shaft extending horizontally across the cubicle, post insulators rigidly attached to said shaft and to their respective movable contacts forming cantilever switch arms, operating devices secured to said shaft, said shaft being offset from points intermediate the length of said air gaps at such distance that, upon force being applied to said operating devices, said cantilever arms carry their movable contacts in the paths aforesaid.

2. In enclosed electric switching apparatus, a cubicle, a circuit breaker in said cubicle and bodily removable therefrom, said circuit breaker and said cubicle each having mounted thereon a set of stationary disconnect switch terminals, disconnect switch contacts movable to engage and disengage one set of terminals constituting stationary contacts, said movable switch contacts having flexible linear conductors secured thereto and to the other set of terminals, an operating shaft extending across the cubicle, insulators rigidly attached to said shaft and to their respective movable contacts to form cantilever switch arms, operating devices secured to said shaft to rotate said shaft to cause said cantilever arms to carry their movable contacts to open or close the disconnect switch, said cantilever arms being individually bodily adjustable lengthwise of said shaft during assembly to align said movable and stationary contacts, said flexible linear conductors yielding to permit such adjustment.

3. In enclosed electric switching apparatus, a cubicle, a multi-phase circuit breaker mounted in said cubicle and removable horizontally therefrom, said circuit breaker having mounted thereon incoming and outgoing switch contacts corresponding to the phases, said cubicle having corresponding terminals mounted above said circuit breaker switch contacts to provide generally vertical air gaps, movable switch contacts movable upwardly lengthwise of said air gaps to disengage said circuit breaker contacts, flexible linear conductors depending from said cubicle terminals and secured to said movable contacts, an incoming metal operating shaft and an outgoing metal operating shaft both journaled in, and extending horizontally across, the cubicle above said circuit breaker contacts, post insulators rigidly attached to their respective shafts and to their

respective movable contacts to form cantilever switch arms, operating devices secured to said shafts, said shafts being offset from points intermediate the length of their respective air gaps at such distance that, when force is applied to said operating devices, said cantilever arms carry their movable contacts in the paths aforesaid, and plate-like insulating barriers adjacent said movable contacts and located between the phases and between the end phases and the adjacent wall of the cubicle to prevent said flexible conductors swinging together or against the cubicle.

4. In enclosed electric switching apparatus, a cubicle, a multi-phase circuit breaker mounted in said cubicle and removable horizontally through the front thereof, said circuit breaker having mounted thereon three forward and three rearward switch contacts corresponding to the phases, said cubicle having corresponding forward and rearward terminals mounted above said circuit breaker switch contacts to provide generally vertical air gaps, forward and rearward movable switch contacts movable upwardly lengthwise of said air gaps to disengage said circuit breaker contacts, flexible linear conductors depending from said cubicle terminals and secured to said movable contacts, a forward metal operating shaft and a rearward metal operating shaft both journaled in, and extending horizontally across, the cubicle from left to right, post insulators rigidly attached to their respective shafts and to their respective movable contacts to form cantilever switch arms, operating devices secured to said shafts, said shafts being offset from points intermediate the length of their respective air gaps at such distance that, when force is applied to said operating devices, said cantilever arms carry their movable contacts in the paths aforesaid, and plate-like insulating barriers adjacent said movable contacts and located between the phases and between the end phases and the adjacent wall of the cubicle, said barriers being secured to said cubicle and extending from front to rear.

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