

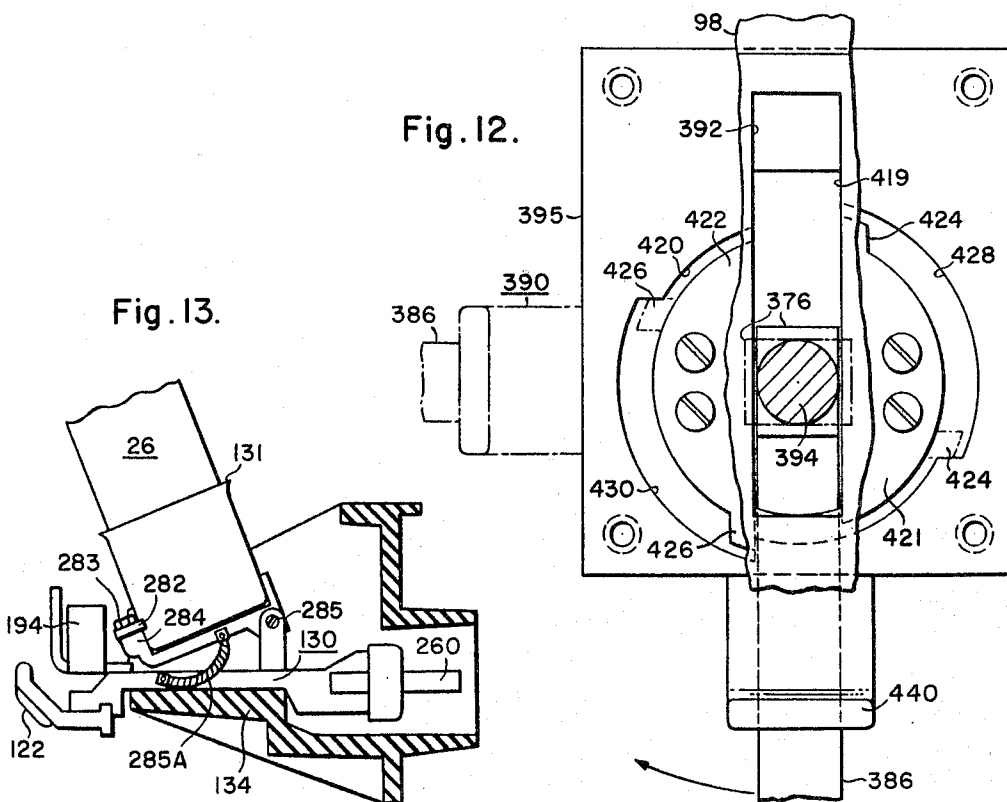
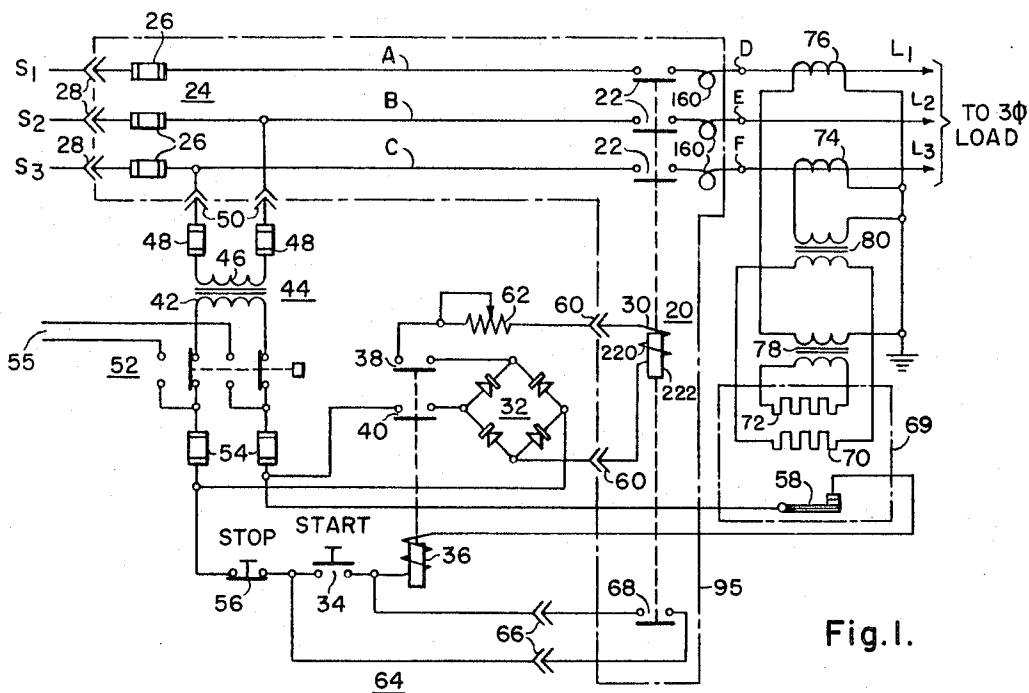
Aug. 2, 1966

R. D. CLARK, JR., ETAL  
SWITCHING APPARATUS EMPLOYING FUSE AS MOVABLE  
CONTACT AND HAVING SAFETY FEATURES

3,264,433

Filed Nov. 7, 1962

8 Sheets-Sheet 1



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8 Sheets-Sheet 2

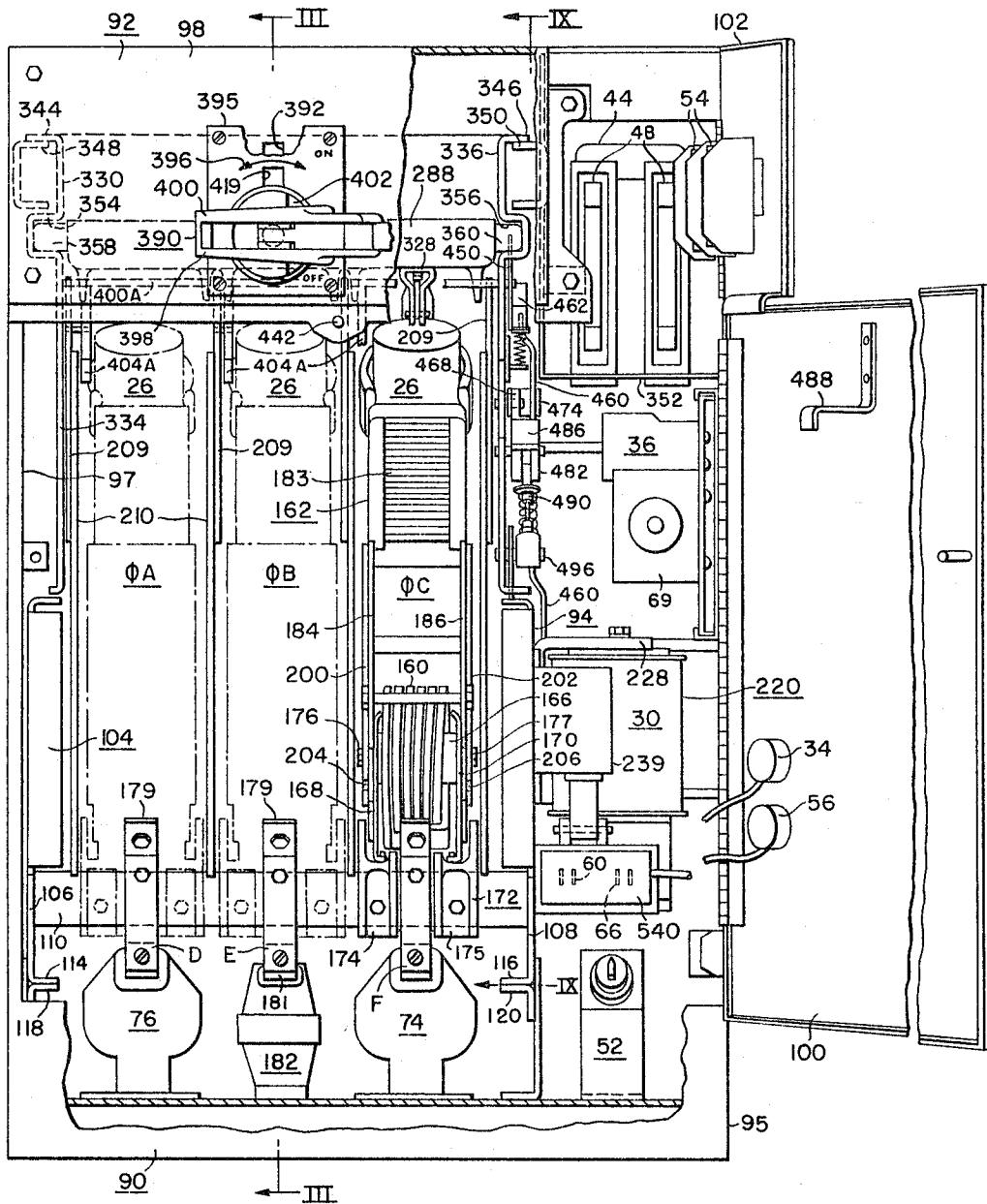


Fig. 2.

WITNESSES

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8 Sheets-Sheet 3

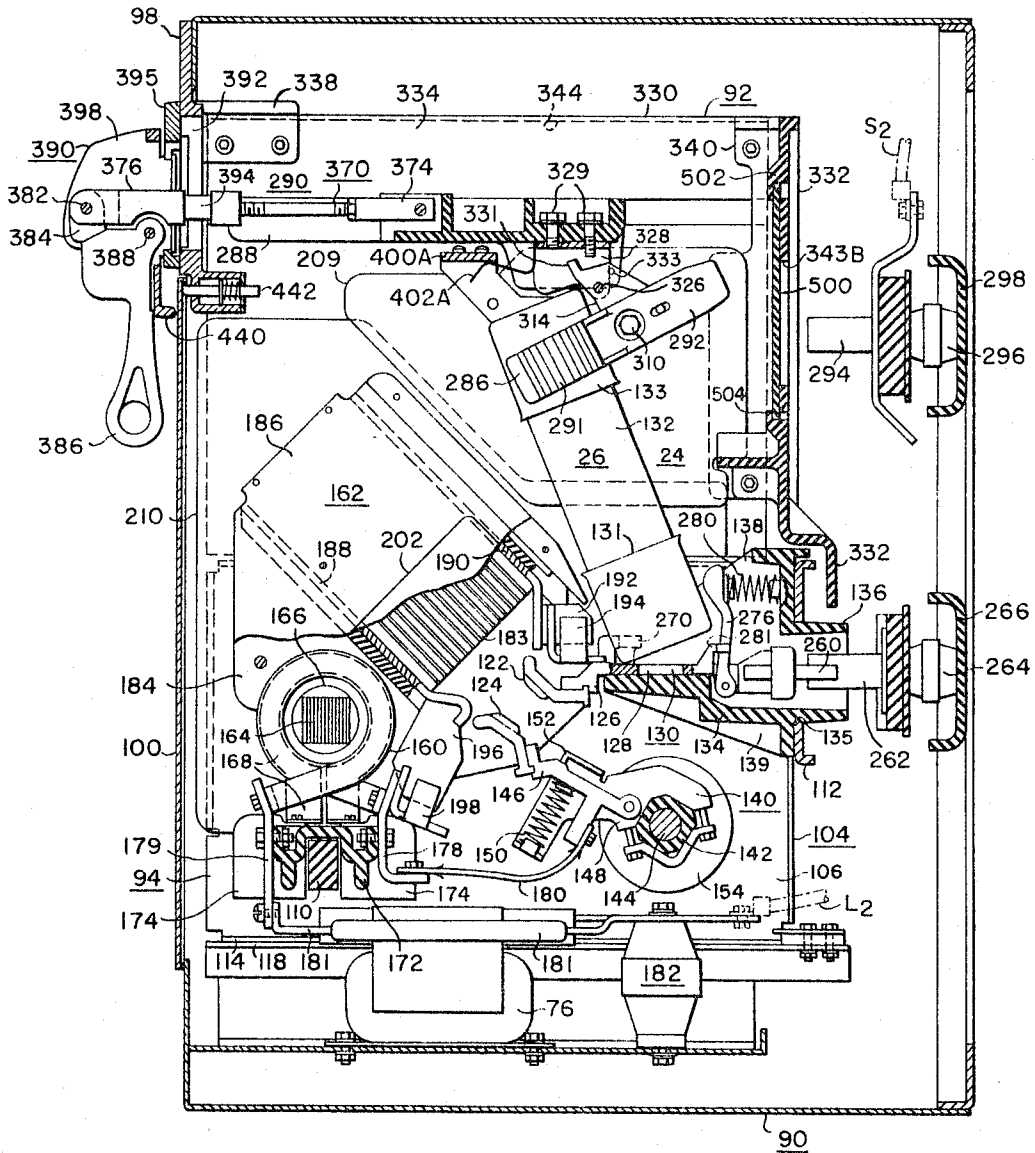


Fig. 3.

Aug. 2, 1966

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3,264,433

Filed Nov. 7, 1962

8 Sheets-Sheet 4

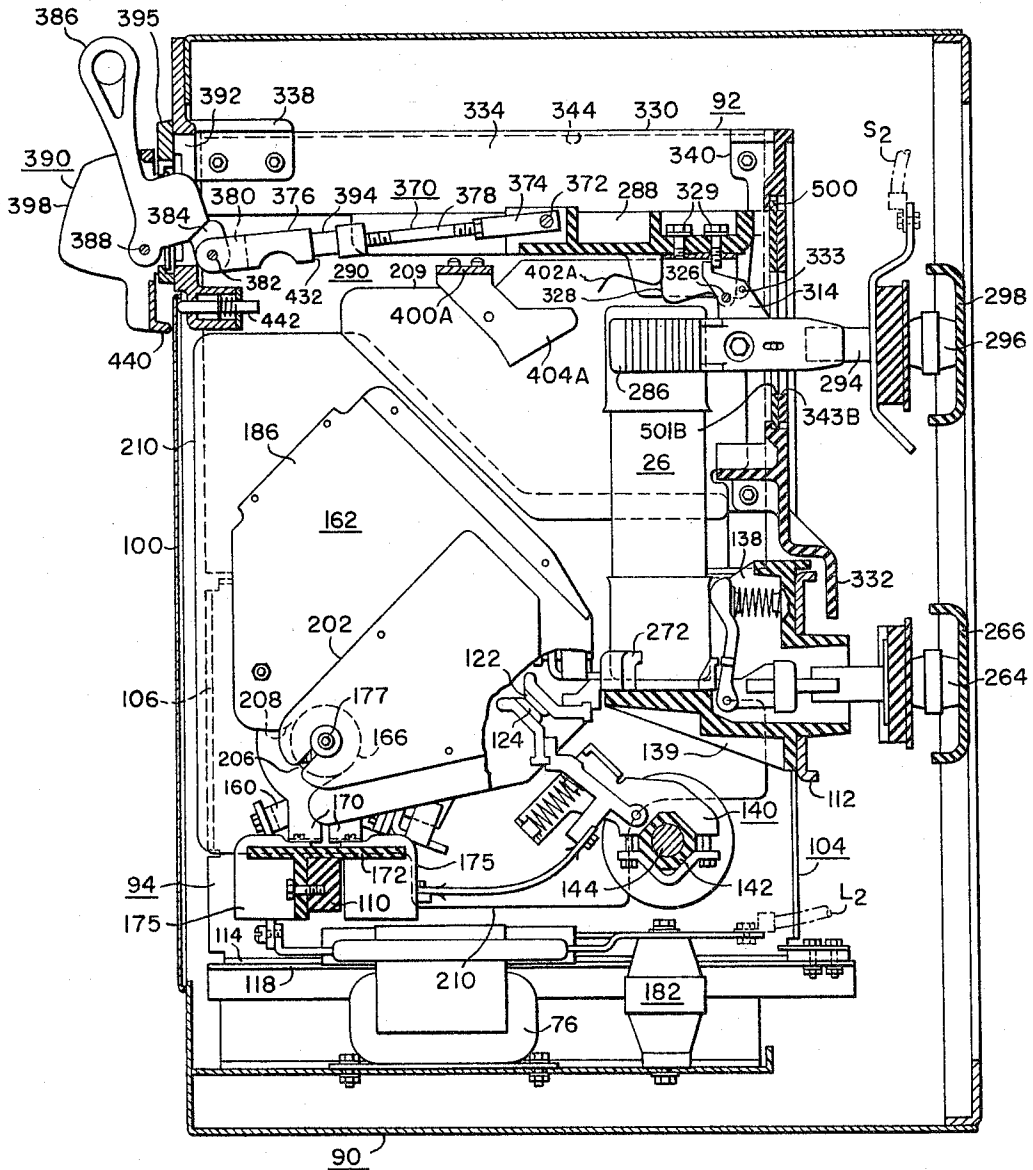


Fig. 4.

Aug. 2, 1966

R. D. CLARK, JR., ET AL  
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3,264,433

Filed Nov. 7, 1962

8 Sheets-Sheet 5

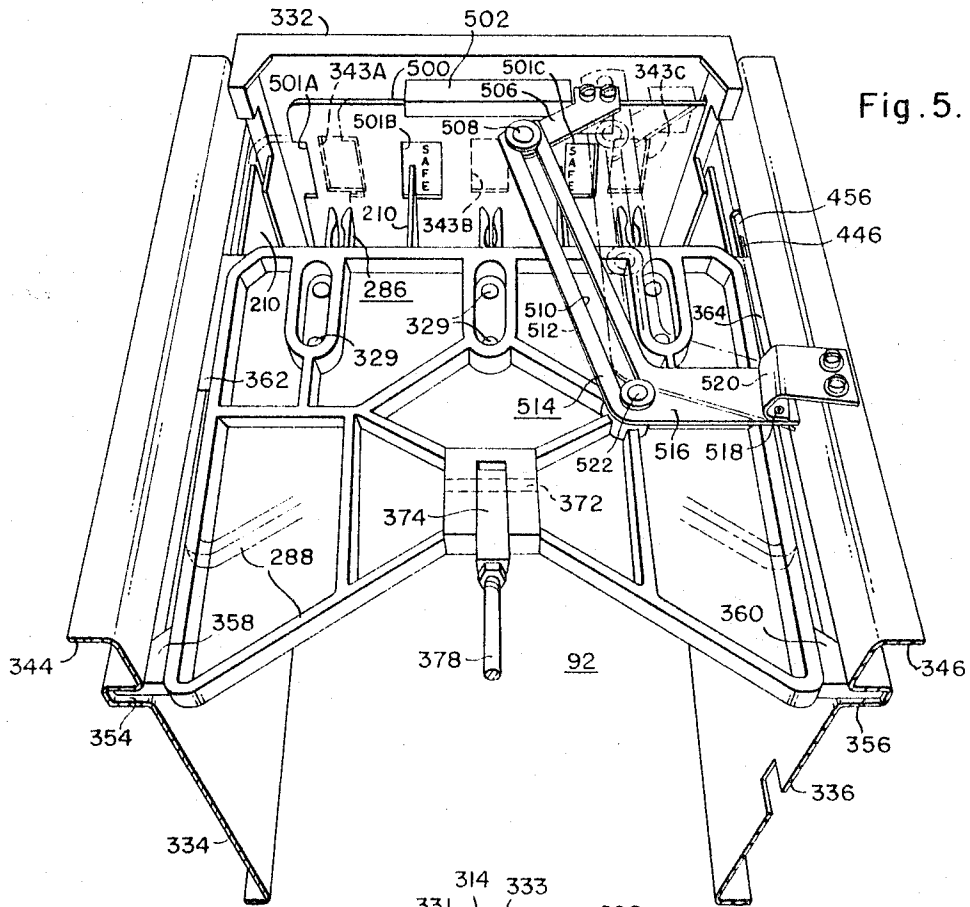


Fig. 5.

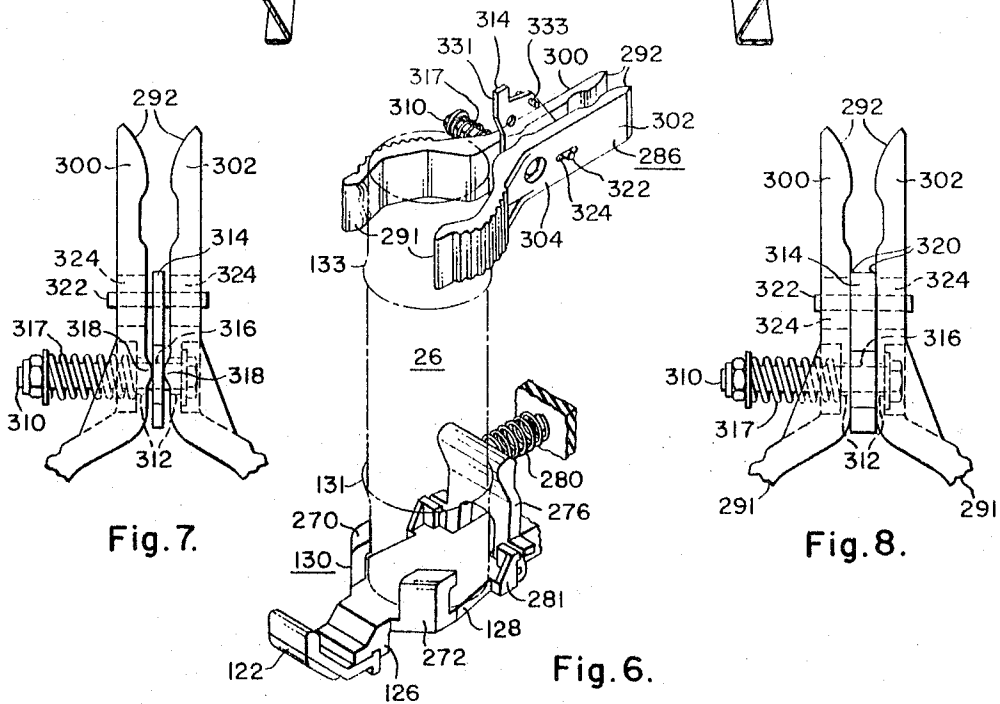


Fig. 7.

Fig. 8.

Fig. 6.

Aug. 2, 1966

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SWITCHING APPARATUS EMPLOYING FUSE AS MOVABLE  
CONTACT AND HAVING SAFETY FEATURES

3,264,433

Filed Nov. 7, 1962

8 Sheets-Sheet 6

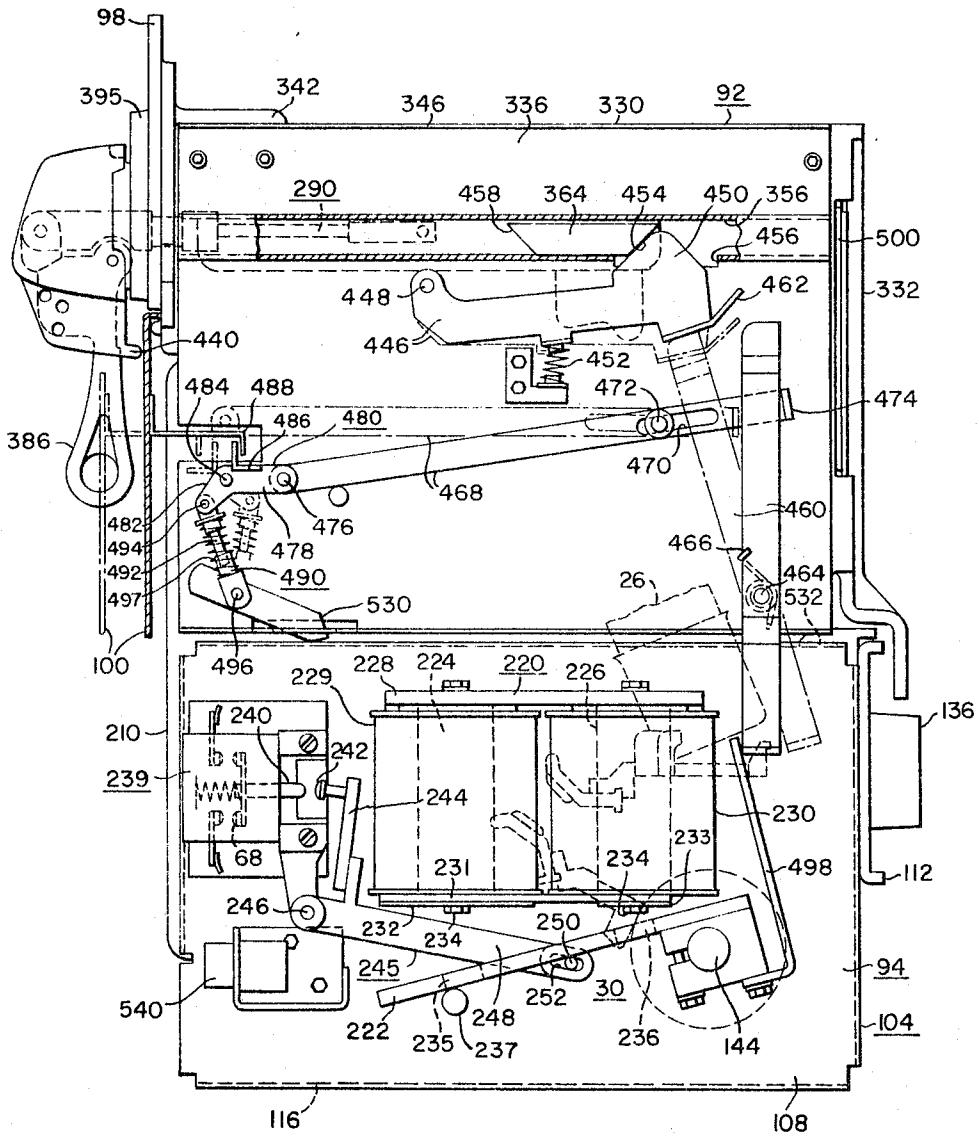


Fig. 9.

Aug. 2, 1966

R. D. CLARK, JR., ETAL  
SWITCHING APPARATUS EMPLOYING FUSE AS MOVABLE  
CONTACT AND HAVING SAFETY FEATURES

3,264,433

Filed Nov. 7, 1962

8 Sheets-Sheet 7

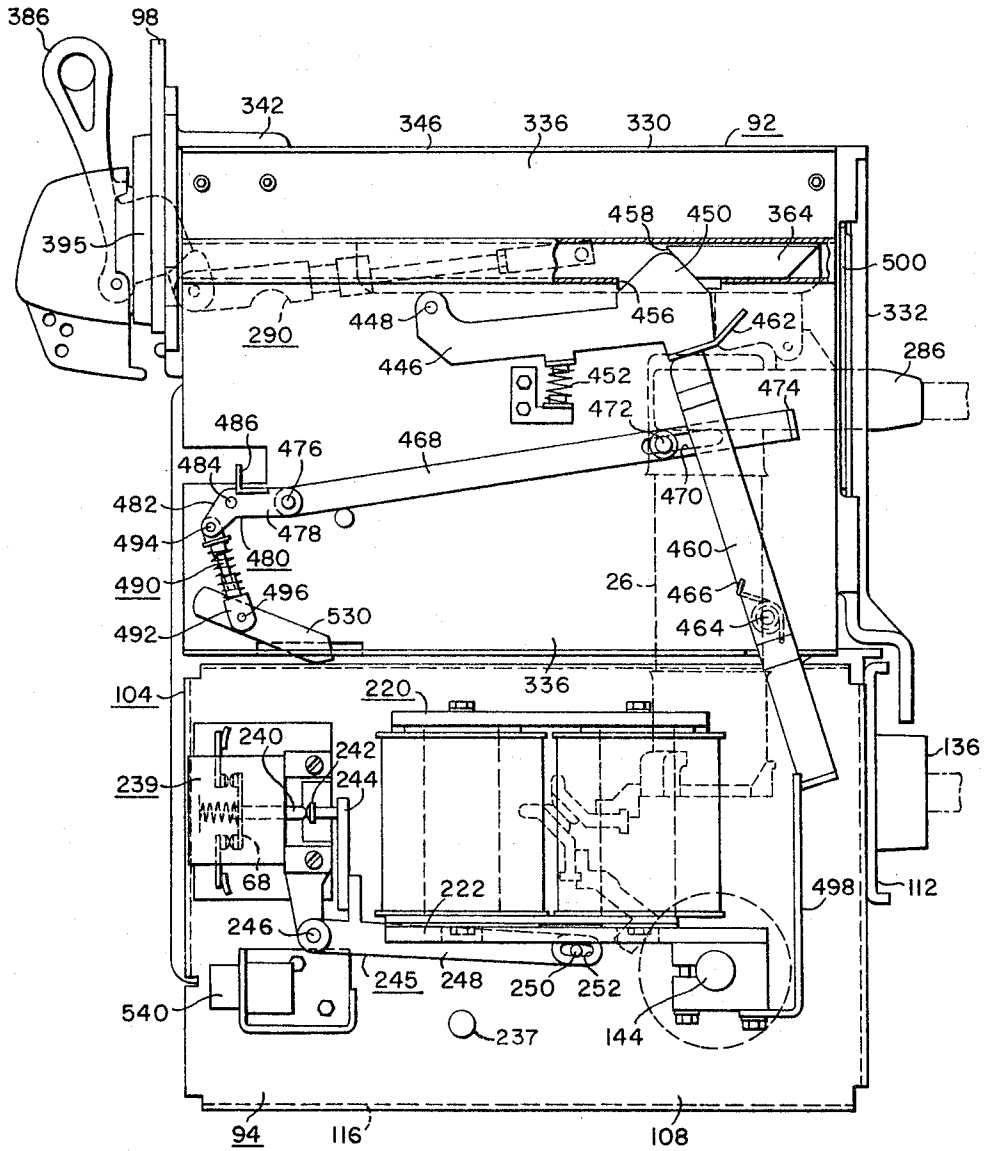


Fig. 10.

Aug. 2, 1966

R. D. CLARK, JR., ETAL  
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3,264,433

Filed Nov. 7, 1962

8 Sheets-Sheet 8

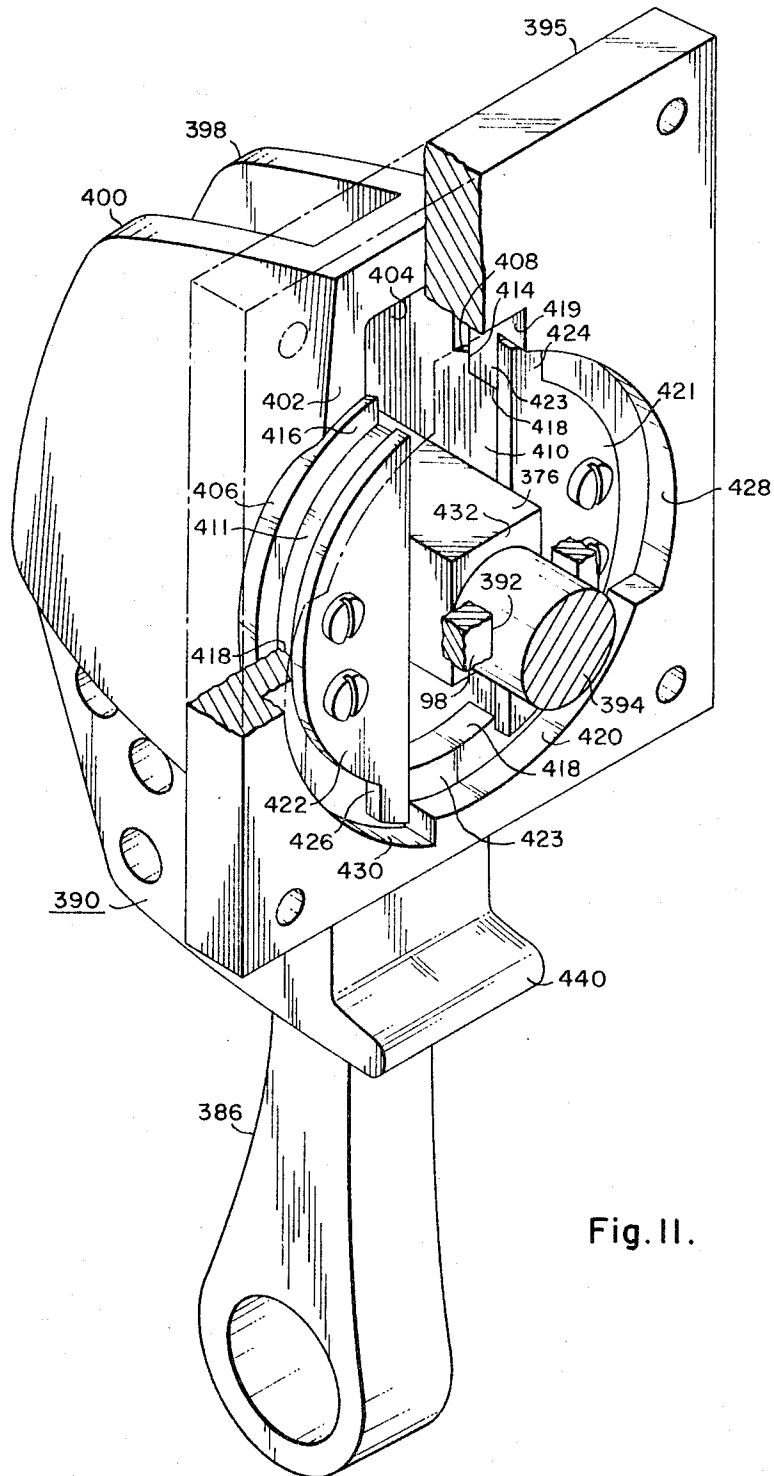


Fig. II.

3,264,433

**SWITCHING APPARATUS EMPLOYING FUSE AS MOVABLE CONTACT AND HAVING SAFETY FEATURES**

Russell D. Clark, Jr., East Aurora, and Charles J. Mahler, Fairport, N.Y., assignors to Westinghouse Electric Corporation, Pittsburgh, Pa., a corporation of Pennsylvania  
 Filed Nov. 7, 1962, Ser. No. 235,940  
 20 Claims. (Cl. 200—114)

This invention relates to switching apparatus and more particularly to line starters of the type having in series in the power circuit, a disconnect or isolating switch, a fuse, and main or power contacts of a contactor. Such a switching apparatus is generally disclosed herein and is also disclosed and claimed in the U.S. patent application, Serial No. 235,938, filed by Alfred W. Hodgson concurrently herewith, and assigned to the same assignee. Particular features of a fuse mount for pivotably supporting one end of a power fuse disclosed herein (FIG. 6) are claimed in U.S. patent application, Serial No. 235,939, filed concurrently herewith by Alfred W. Hodgson and Russell D. Clark, Jr., and assigned to the same assignee. Particular features of a fuse clip at the other end of the fuse (FIGS. 6, 7, and 8) are claimed in U.S. patent application, Serial No. 399,119 (a division hereof).

An important object of this invention is to achieve size reduction in switching apparatus. Aside from manufacturing and space economies, reduced mechanical size is conducive to longer life of operating parts such as the contactor. Safety of mechanical interlocks is improved with small levers and other movable lock elements having more positive action than larger parts. With smaller components and structure, maintenance is easier in spite of a smaller enclosure. Thus an over-all object of the invention is switching apparatus having for particular power capacity, minimum dimensions, weight, and manufacturing costs, but at the same time providing increased safety, reliability, and ease of maintenance.

In accordance with one embodiment of the invention, the above objects are achieved by a novel over-all and detailed structural arrangement wherein a contactor, power fuse, and disconnect, structurally "flow" into each other to provide a compact integral unit. In this embodiment, the apparatus is disposed in an enclosure with a door, and the power fuse is rockably mounted at one end, while the other end is coupled to a movable carrier which rocks the fuse into and out of contact with a line contact member, thus forming a disconnect or isolating switch. Also in this embodiment, an externally operable mechanism moves the carrier.

An important phase of the invention is directed to various mechanical interlocks which provide the following features: The carrier is lockable in position in response alternatively to operation of the contactor or to opening of the door; the isolating switch cannot be closed with the door open; and the door cannot be opened with the isolating switch closed. A shutter moves between the isolating switch contacts in response to movement of the carrier.

It is therefore an object of the present invention to provide switching apparatus with novel safety arrangements including mechanical interlocks and automatic shutter.

Another object of the invention is to provide switching apparatus in an enclosure with a door wherein novel safety interlocks prevent opening of the door when switch contacts are closed, and which prevent closure of the switch contacts when the door is open.

A further object is to provide novel mechanism for operating a movable fuse into and out of contact with a line contact.

Other and further objects and advantages will become apparent from the following description taken in conjunction with the drawings, wherein a preferred embodiment of the invention is illustrated.

In the drawings:

FIGURE 1 is a schematic diagram of an example of a circuit for switching apparatus built in accordance with one embodiment of the invention and described herein;

FIGURE 2 is a front view with parts broken away of switching apparatus incorporating features of the invention;

FIGS. 3 and 4 are sectional views taken generally along the line III—III of FIGURE 2, with some parts shown in full. FIG. 3 shows the apparatus in the OFF position while FIG. 4 shows the apparatus in the ON position;

FIG. 5 is a perspective view looking at the fuse clip carrier from the top and illustrating the slidably mounting of the carrier and the cooperative relation between the carrier and a shutter along the back wall which is interposed between the switching apparatus and active line elements in the off position of the apparatus;

FIG. 6 illustrates details of upper and lower fuse clips included in the apparatus of FIG. 3;

FIG. 7 shows a detail of the upper fuse clip in FIG. 6;

FIG. 8 illustrates an alternative form of the detail in FIG. 7;

FIGS. 9 and 10 are views taken generally along the line IX—IX of FIGURE 2 showing the right sides of the disconnect and contactor units, and illustrating details of safety interlocks in various positions. In FIG. 9 the apparatus is shown in the OFF position, while in FIG. 10 the apparatus is shown in the ON position. Although these views show the disconnect and contactor units as they are related in the cabinet, the cabinet itself is not shown in FIGS. 9 and 10, except for a fragment of the cabinet door seen in FIG. 9;

FIGS. 11 and 12 are views illustrating details of the operating handle, handle housing, and bearing plate arrangement, both views looking at the backside of the bearing plate; and

FIG. 13 is a view illustrating an alternative arrangement for pivotably mounting the lower end of the fuse.

*Circuit*

Included in the diagram of FIG. 1 is a power-operated main contactor 20 with power contacts 22 to connect three-phase load lines L1, L2 and L3 to conductors A, B and C, which are normally connected to main supply lines S1, S2 and S3, through a disconnect or isolating switch 24 formed in accordance with the invention by a unique arrangement of main fuses 26 and sets of complementary disconnect contacts 28.

Contact 20 includes an electromagnetic operator 30, which is energized by a rectifier 32 in response to the operation of a normally biased open push button start switch 34. Closure of the start switch energizes a relay 36 whose normally open contacts 38 and 40 respectively connect the output of rectifier 32 to the operator 30 and the input of the rectifier to the secondary 42 of a step-down transformer 44, whose primary 46 is connected across one phase of the main power lines. The input to primary 46 includes fuses 48 and stab type disconnects 50. The electromagnetic operator of relay 36 is energized from the transformer secondary 42 through a circuit which includes a double pole, double throw switch 52, normally in the position shown, fuses 54, a normally closed stop switch 56, and a normally closed thermostatic switch 58. Included in the output circuit of rectifier 32 are the normally open contacts 38, male-female type plug disconnects 60, and an adjustable resistor 62 which may be adjusted when needed to compensate for aging of the rectifier cells in rectifier 32. A hold or latch circuit 64

is shunted across the start button 34 and includes male-female plug type disconnects 66 and normally open contacts 68, which are operated to close the circuit across the start button when contactor 20 is operated, thereby holding relay 36 and consequently contactor 20 in the operated condition.

The thermostatic switch 58 is an overload switch and responds to overload of the load lines as manifested in the heating of resistors 70 and 72, energize respectively from current transformers 74 and 76 through intermediate transformers 78 and 80. Current transformers 74 and 76 are coupled to the load lines.

#### *Cabinet and general disposition of components therein*

The apparatus components of FIGURE 1 are distributed in various areas of an interior space defined by exterior structure for example a cabinet indicated generally at 90 in FIGURES 2, 3 and 4.

Located one above the other on the left side and central portions of the cabinet 90 (FIG. 2) are an isolating switch unit 92 and a main contactor unit 94, each being slidably removable from the cabinet. The isolating switch 24 and its operator are included in the unit 92 while the main contactor 20 is included in the unit 94. The power fuses 26 are supported by both units 92 and 94. Thus the main power components are located in units 92 and 94. Thus, the main power components lying within the dashed line enclosure 95 (FIG. 1) are located in units 92 and 94 (FIG. 2).

The apparatus within the dashed line enclosure comprising the contactor 20, the isolating switch 24, and the power fuses 26, may be designated the main power apparatus, while that outside the dashed line enclosure may be referred to as the auxiliary equipment.

Referring again to FIG. 2, it is seen that the current transformers 74 and 76 are located in the lower section of the cabinet 90 below the contactor unit 94, while most of the rest of the auxiliary equipment is located in the space on the right side of cabinet 90 formed between the right wall 95 of the cabinet 90 and units 92 and 94. Most of the wiring between the components is not shown in FIG. 2.

Although the back of cabinet 90 is shown generally open to provide convenient access for connections to main power and load lines, it will be appreciated that either the top or the bottom of the cabinet may be apertured instead of the back for the receipt of supply and load lines. Cabinet 90 is provided with a frontal opening 97 through which units 92 and 94 are accessible and removable. When the isolating switch unit 92 is properly located in the cabinet, a portion of opening 97 is covered by a front panel 98 attached to and forming a part of unit 92. The rest of the opening 97 is coverable by main door 100 and an auxiliary door 102, both hinged to the right wall 95 of cabinet 90.

#### *Main contactor unit*

The main contactor unit 94 is provided with a frame 104 formed from side walls 106 and 108 held in rigid spaced relation by cross pieces 110 and 112 whose ends are secured to the side walls of the frame. In a particular example, the cross piece 110 was made of strong insulating material to improve the voltage rating of the apparatus. While the side walls and the front cross piece 110 of this frame are visible in FIG. 2, the back cross piece 112 is visible only in FIGS. 3, 4, 9 and 10. The cross piece 110 is also visible in section in FIGS. 3 and 4. One or the other of the side walls may be seen in each of FIGS. 3, 4, 9 and 10.

At their lower edges, walls 106 and 108 are provided with inturned flanges 114 and 116 for seating on and slidably engaging a pair of rails 118 and 120 secured to the cabinet floor and extending from front to back.

Since a three-phase example is shown, contacts 22 comprise three sets of relatively movable, mutually en-

gageable, complementary main contacts, one set per phase line. Thus the contactor has three sets of main contacts and attendant blowout coils and arc chutes. In FIG. 2, details for only one set,  $\phi C$ , are shown, while in FIGS. 3 and 4, the set shown in detail is that of  $\phi B$ . However, all sets are the same, being duplicates of one another.

Each set of contacts 22 includes a fixed contact 122 (FIGS. 3 and 4) and a movable contact 124. Contact 122 is secured to a conductive bracket 126 which extends from and is an integral part of the conductive base 128 of a fuse mount 130 for rockably supporting the lower ferrule or contact end 131 of a main power fuse 26. By way of example, the fuse shown is an elongated tubular type having an insulating casing 132 and end contacts such as ferrule type terminals 131 and 133 coupled to the opposite ends of the fuse, the end contacts 131 and 133 being connected to an internal fusible element. The fuse mount 130 is carried by an insulating support 134 fixed to the back cross bar 112 which is provided with an aperture 135 for the passage therethrough of a bushing portion 136 of the insulating support 134. The insulating support 134 has upper and lower side walls 138 and 139 to provide insulative shielding between phases.

Movable contact 124 is carried by an assembly 140 clamped with an intervening insulating sleeve 142 to a contactor operating shaft 144 for rotation therewith. More specifically, contact 124 is secured to a spring-loaded arm 146 pivoted to a member 148 that is clamped to rotate with shaft 144. A bias spring 150 urges the arm 146 forward to seat the contacts when they are operated (closed). When the contacts are in an unoperated position (open) the arm 146 is stopped by an abutment 152 on member 148. The spring loading and pivoting of arm 146 provides a rolling contact force when the contactor shaft 144 is rotated to close the contacts. The insulation 142 is part of insulative molding around the shaft 144, which molded insulation includes annular flanges 154 on opposite sides of member 148 to provide insulation between phases.

Each phase section of the contactor is provided with a blowout coil 160 and associated arc chute 162. The blowout coil is located forward of both the fuse 26 and the set of main contacts 22, while the arc chute is located between the blowout coil and the fuse. This provides an extremely compact arrangement which permits convenient access and allows the arc chute "outlet" to be angled outward to steer the arc and gases away from sensitive areas. Compactness is served by the generally L-shaped pattern in which the fuse 26, the contactor contacts 122-124 and the blowout coil 160 are arranged. The fuse is along the leg of the L, the blowout coil at the toe of the L, and the set of contacts is along the foot of the L and back of the toe. In FIGS. 3 and 4, the L-pattern appears in reverse.

The blowout coil 160 encircles a laminated iron core 164 from which it is insulated by an insulating sleeve 166 which supports the core (FIG. 3). The sleeve 166 is supported at opposite ends by brackets 168 and 170 secured to an irregularly shaped insulating member 172 which is carried by and straddles the cross bar 110. The ends of the sleeve 166 are shouldered and snugly pass through apertures in the upper ends of brackets 168 and 170 so that the ends of the sleeve extend beyond the brackets to provide a bearing surface for side plates of the arc chute. Insulating member 172 has flanges 174 and 175 on opposite sides of the blowout coil mounting to provide insulation between phases. A pair of arc chute retaining bolts 176 and 177 are threaded into opposite ends of the core 164.

The ends of the blowout coil 160 are bolted to heavy conductive terminals 178 and 179 secured to opposite sides of the insulating member 172. A flexible conductive strap 180 connects the terminal 178 to the movable contact arm 146. Since it is phase B which is

shown in detail in FIGS. 3 and 4, terminal 179 is connected to load line L2 through a conductive strap 181 supported by an insulator 182 secured to the cabinet 90. It should be noted that in phases A and C, the respective terminals 179 are connected to the strap primaries of transformers 76 and 74, the other ends of these primary windings being connected to load lines L1 and L3, respectively. In FIGS. 1 and 2 the terminals 179 of the respective phases are represented by D, E and F. It should be noted that the connections at terminals D, E and F are made only after the contactor unit 94 has been inserted in the cabinet 90.

The arc chute 162 is of the spaced plate type having a group of parallel spaced insulator plates 183 bounded by insulating side walls 184 and 186. At opposite ends of the stack of plates 183 there are provided a pair of conductive arc horns 188 and 190. The lower end of arc horn 190 has attached thereto a conductive blade 192 which is received and frictionally gripped by a conductive spring clip 194 attached to bracket 126. Likewise, the lower end of arc horn 188 is provided with a conductive blade 196 which is received and frictionally gripped by a conductive spring clip 198 attached to terminal 178. Arc horns 188, 190, their respective blades 192 and 196, and clips 194 and 198, are made of conductive material for circuit continuity.

On opposite sides thereof, the arc chute 162 is provided with ferromagnetic pole pieces 200 and 202 secured to the side plates 184 and 186, respectively. The pole pieces 200 and 202 are provided with slots 204 and 206 in which bolts 176 and 177 are received to provide a pivotal mounting for the arc chute 162 and easy removal of the arc chute along the slot when the arc chute is tilted to the left, FIGS. 3 and 4, so that the arc chute may be removed through the frontal opening of the cabinet. The arc chute may be tilted to the left to permit inspection of the contacts or for removal of the arc chute as desired. When the arc chute is tilted to the left the arc horn stabs 192 and 196 disengage from clips 194 and 198. The side walls 184 and 186 of the arc chute 162 are cut out at 208 to fit around and "ride" on the insulating tube 166. Extra insulation around phases is provided by fixed insulating barrier plates 209 and readily removable insulating barrier plates 210 that are slidable in and out of place. Plates 209 are hung from members 404A attached to a cross bar 400A that is fixed within the isolating switch unit 92.

The arc chute is mounted at an angle of approximately 45° to provide space for the power fuse to pivot as required during operation of the isolating switch and also to direct hot exhaust gases from the arc chute up and forward toward the enclosure door away from energized components.

From the aforesaid description of the structural details and position of the arc chute it is seen that the arc chute is pivoted about the blowout core center line through the use of a floating blowout core mounting arrangement, to permit removal of power fuses and for inspection of contactor contacts and internal parts of the arc chute. The arc chute is proportioned and pivoted in a manner such that no additional clearance is required within the starter for swinging the arc chute open. Since the arc chute swings out of the open cabinet door, the necessity for additional clearance space within the cabinet for arc chute opening or removal is eliminated, the arc chute is more accessible for inspection, and the operator cannot close the enclosure door and energize the starter with the arc chute open. It is further apparent that the arc chute is supported by its blowout pole pieces which in turn are bolted to the blowout core by means of the open end slotted holes, as heretofore described, so that the arc chute may be removed simply by loosening the blowout core bolts rather than by removing these bolts completely.

It will be noted that the connector 178, the flexible

strap 180, and the movable contact and contactor arm 146 form a reverse current loop which in response to power current through the contacts provides magnetic forces that react to help hold the contacts closed.

Contact 124 is driven into engagement with contact 122 by rotation of shaft 144 which is journaled in the side walls 106 and 108 of the contactor assembly frame 104 and is driven by the electromagnetic actuator 30. The latter comprises an electromagnet 220 and an armature 222 clamped to contactor shaft 144 (FIGS. 9 and 10), and aligned to be attracted by the electromagnet 220 when the latter is energized by rectifier 32. The electromagnet 220 includes ferromagnetic cores 224 and 226 connected by a magnetic yoke 228, around which cores are wound coils 229 and 230. Yoke 228 is L-shaped and also functions as a bracket, being secured to the side wall 108 of the contactor frame 104 (FIG. 2). The ends of poles 224 and 226 are overlaid by a nonmagnetic shim 231 held in place by ferromagnetic pole faces 232 and 233 clamped by bolts 234 screwed into the cores. The shim 231 provides an effective air gap to reduce armature sticking. Clearance for the heads of bolts 234 is provided by apertures 235 and 236 formed in the armature 222. In FIG. 9, the electromagnetic actuator 30 is shown deenergized, in which position the contactor 20 is unoperated and its contacts are open. When the electromagnet 220 is energized, the armature 222 is drawn upward as in FIG. 10, thus rotating shaft 144 to force contact 124 into engagement with the fixed contact 122. This is the "operated" position of the contactor. When the electromagnet 220 is deenergized, the main contacts 22 are opened by the force of contact spring 150 and the force of gravity on the armature 222. In this position armature 222 rests against a stop 237 fixed to the wall 108.

In addition to operating the main contacts to a closed position, the electromagnetic actuator 30 also when energized, closes the normally open contacts 68. Normally open switch contacts 68 are shown in FIGS. 9 and 10 in the form of a plunger switch 239 having a spring-biased operating plunger 240. This plunger is driven from its open (FIG. 9) to its closed (FIG. 10) position by a boss 242 attached to one arm 244 of a bell-crank lever 245 movable around a pivot 246 fixed relative to the side plate 108, and having another arm 248 driven from open to closed positions by the armature 222 of the electromagnetic actuator 30. Coupling between armature 222 and the bell crank arm 248 is effected by a lateral pin 250 fixed to the armature and having one end disposed in and engaging the walls of a slot 252 formed in the end of the bell crank arm 248. Thus it is apparent that normally open contacts 68 are closed in response to the operation of contactor 20.

It will be seen in FIGS. 3 and 4 that the fuse mount 130, which pivotably supports the power fuse 26, has conductively attached thereto and integral therewith a contact clip 260 which extends through bushing 136 and engages a stab contact 262 when the contactor unit 94 is disposed in operative position in the cabinet. Stab 262 is mounted on an insulator 264 carried by an insulator cross bar 266 secured to opposite sides of the back end of cabinet 90. Clip 260 and stab 262 constitute the disconnect set 50 connected to phase B, stab 262 being connected through a fuse 48 to the primary 46 of transformer 44. It will be appreciated that a similar stab 262 associated with the fuse mount 130 in phase C is connected to the other end of the transformer primary 46 through a fuse 48.

Fuse receptacle 130 is provided with a pair of spaced front contact fingers 270 and 272 extending upwardly from the base 128 to frictionally and conductively engage the contact ferrule 131 of fuse 26 (FIGS. 3, 4 and 6). The fuse receptacle 130 is further provided with a rearward upstanding gripping finger 276 pivoted at its lower end to the base 128 and forwardly biased by a spring 280.

As seen in FIG. 4, when the power fuse 26 is in a vertical position, the lower contact ferrule 131 is engaged and forwardly urged by finger 276 into forced tight en-

gagement with contact fingers 270 and 272, thus holding the lower fuse ferrule in the grip of the three fingers. On the other hand, when the upper end of fuse 26 is forwardly tilted (leftward in FIG. 3), a stop 281 is engaged by finger 276, thereby limiting its forward movement and disengaging it from the lower ferrule 131 of the fuse. In this position, the lower end of fuse 26 is loosely "cupped" by the fuse receptacle 130, thus permitting easy removal and replacement.

#### *Isolating switch unit*

The upper ferrule 133 of fuse 26 is held in a conductive fuse clip 286 pivotally suspended from a carrier 288, made of insulating material, which is slidably mounted in the isolating switch unit 92 for backward and forward movement in response to an operating linkage 290 (FIGS. 3 and 4). In addition to fuse jaws 291, the clip 286 is provided with posterior stab jaws 292 for conductively engaging a fixed contact in the form of main line stab 294 mounted on an insulator arrangement 296 carried by cross member 298 secured between the side walls of cabinet 90. In the example shown, the clip 286 is a contact directly engaging the fixed contact 294. However, since the end contact 133 is coupled to the upper end of the fuse, and since the clip 286 is an extension of the end contact 133, the upper end of the fuse is in electrical contact with the line stab 294 when clip 286 is in contact with line stab 294. Being in phase B, the line stab 294 in FIG. 3 is connected to supply line S2.

As shown in FIGS. 6 and 7, clip 286 comprises two similarly shaped complementary members 300 and 302, each having an intermediate shank portion 304 and the fuse jaw and stab jaw end portions 291 and 292, respectively. At their shank portions 304, members 300 and 302 (FIGS. 7 and 6) are pivotally coupled together and to a pivot plate 314 by means of a spring loaded bolt 310 passing through oversize apertures 312 formed in members 300 and 302 and an aperture 316 formed in bracket 314. A spring 317 resiliently biases members 300 and 302 toward each other. At their inner faces, members 300 and 302 are provided with protuberances 318 about which members 300 and 302 can rock with the pivot plate 314 providing the fulcrum. A pin 322 affixed to and extending from opposite sides of bracket 314 extends through and engages the walls of slots 324 formed in the intermediate portions of members 300 and 302, thereby maintaining the members in alignment with each other and with the bracket 314.

In the position shown in FIG. 3, the stab jaws 292 are not in engagement with the stab 294 and the upper fuse ferrule 133 is held in the fuse jaws 291 under light pressure. However, in the position shown in FIG. 4, the stab jaws of the clip 286 are in engagement with the stab 294, which acts as a wedge to drive the stab jaws 292 apart and compress the spring 317, thereby increasing the compressive force of the fuse jaws 291 to tightly clamp the upper ferrule of the fuse. This compression of the spring increases the contact force on both the stab 294 and the upper ferrule of the fuse. When the clip is withdrawn from the stab 294 as in FIG. 3, the elements 300 and 302 are permitted to touch the pivot plate 314. In this position the spring force is much reduced, allowing easy removal of the fuse.

Pivot plate 314 is suspended on a pivot 326 (FIG. 3) carried by a bracket 328 attached with bolts 329 to the carrier 288, whereby the clip 286 is moved forward and backward together with the carrier 288. Plate 314 has a tab 331 and a pin 333 to provide opposite travel limits for clip 286 about pivot 326. From the above description it will be appreciated that the carrier 288 is flexibly coupled to the fuse 26 by means of the pivot plate 314, which with pivot 326 provides a flexible or articulate (movable) joint between the carrier 288 and the fuse 26.

Alternatively, as shown in FIG. 8, the protuberances 318 may be eliminated, and the pivot plate 314 thickened along its extent between the members 300 and 302 to

provide sufficient rocking clearance, thus to allow the elements 300 and 302 to be rocked around the pivot plate as a fulcrum. In this arrangement the pivot plate provides a fulcrum at its rearward edges 320 around which the members 300 and 302 rock when the fuse jaws are forced apart.

As seen in FIGS. 2, 3 and 9, the isolating unit 92 is provided with a frame 330 comprising the front panel 98, a back panel 332 made of insulating material, and side plates 334 and 336 rigidly secured together in the form of an open rectangle as viewed from the top. More specifically, the side plates are secured to angular extensions of the front and back panels extending from and normal to the front and back panels. For example, the side panel 334 is bolted to angular extensions 338 and 340 extending from the front and back panels respectively (FIG. 3). As seen in FIG. 9, the side plate 336 is secured to an extension 342 of the front panel 98. The extension from the back panel to which the side plate 336 is secured is not visible in the drawings. The back panel 332 is provided with three apertures 343A, 343B and 343C, through which the stab jaws 292 of the respective phases are projected and retracted.

Side plates 334 and 336 are provided at their upper edges with outwardly extending flanges 344 and 346 which slidably bear on rails 348 and 350, thereby supporting and allowing slidable movement of the isolating unit into and out of the cabinet. Rail 348 is secured to the left side wall of the cabinet (FIG. 2), while the rail 350 is supported by brackets 352 secured to the top and right sides of the cabinet. The side plates 334 and 336 are provided with inwardly facing channels 354 and 356 which provide guidance and support for the carrier 288 (FIGS. 2 and 5). More specifically, channels 354 and 356 are arranged to receive tabs 358, 360, and 362 and 364 which are integral with and laterally extend from the carrier 288. The lower surfaces of channels 354 and 356 act as rails which provide support and slidable movement for the carrier 288.

The operating linkage 290 for reciprocating the carrier 288 from one to the other of its ON and OFF positions, is provided with an adjustable connecting rod 370 having one end pivotally connected at 372 to the carrier 288. The connecting rod 370 includes an internally threaded pivot block 374 pivoted at 372 to the carrier 288, an internally threaded clevis block 376 and an intermediate shank 378 which is threaded at opposite ends and links the two end blocks 374 and 376. One end of the intermediate shank 378 is threaded into and locked with respect to the pivot block 374 while the other end of the shank 378 is threaded into but not locked with respect to the clevis block 376. Thus the clevis block 376 is rotatable around the longitudinal axis of the connecting rod 370 employing the threaded end of the shank portion 378 as a bearing. The clevis block 376 terminates in a clevis 380 pivotally coupled at 382 to an arm 384 of a bell-crank shaped switch handle 386. The latter is rotatable about a pivot 388 fixed relative to a handle housing 390 which is rotatable about an axis generally in line with the longitudinal axis of the connecting rod 370 when the linkage is aligned as in FIG. 3.

In order to allow coupling between the clevis 380 and the bell-crank 386, the front panel 98 is provided with a vertical slot 392 (FIGS. 3, 4, 12) through which the clevis block 376 and the crank arm 384 are passable when moved between the positions shown in FIGS. 3 and 4. Except for a reduced rounded portion 394 the clevis block 376 and the handle 386 each have opposite flat sides and a thickness therebetween which allows movement of these members between the positions shown in FIGS. 3 and 4. However, their rotational movement about the general axis of the connecting rod 370 is blocked by the vertical sides of slot 392 in all positions of the handle 386 around axis 388, except the position shown in FIG. 3 (also FIGS. 12 and 13), wherein the

reduced rounded portion 394 of the clevis block 376 is aligned within the slot 392. In the latter position, it is apparent that the clevis block 376 may be rotated and the handle 386 may be rotated around an axis generally parallel to the longitudinal axis of the connecting rod 370.

Since FIG. 3 shows the clip 286 disengaged from the line stab 294, the isolating switch and its operating elements are in the OFF position in this figure. Thus the particular position assumed in FIG. 3 by the fuse receptacle 130, fuse 26, clip 286, carrier 288, clevis block 376, and handle 386, shall be referred to as the OFF position of each of these elements. On the other hand, in FIG. 4 the clip 286 is fully engaged with line stab 294, and the isolating switch and all its operating elements are therefore in the ON position.

Referring now to the OFF position in FIG. 3, the operating handle 386 points downwardly and the reduced section 394 of the clevis block 376 is aligned with the slot 392. In order to operate the isolating unit from the OFF to the ON position, the handle 386 is moved upward and clockwise around the pivot 388 until it assumes the position shown in FIG. 4, that is, its ON position. As the handle 386 is rotated clockwise around pivot 388, its arm 384 moves the clevis block 376 and the carrier 288 from the positions of FIG. 3 to that of FIG. 4. During this movement, carrier 288 moves the clip 286 to the rear and into engagement with line stab 294. During the course of this movement, the upper end of fuse 26 is swung or rocked in a vertical arc around a pivot point approximately at the contact between the lower ferrule 131 and the fuse receptacle 130.

Attached to the isolating unit frame 330 is a "ground" bar 400A which is engaged by a flat contact spring 402A attached to the bracket 328 when the isolating switch is moved from the ON to the OFF position, thus grounding the upper end of fuse 26 for purposes of safety. Also during the movement from ON to OFF position, the upper edge of one fuse jaw engages a guide member 404A fixed relative to the frame 330, thereby to force the fuse jaws down and the stab jaws 292 upward relative to the fuse, thus changing the angle between the axes of the fuse 26 and the clip 286 from substantially 90° to an angle slightly greater than 90°. This action moves the stab jaws 292 to a sufficiently upward position where they may be easily viewed through the open door of the cabinet for visual indication of the open position. Guide 404A also positions clip 286 for fuse insertion.

Attached to the front face of the front panel 98, is a bearing plate 395 which supports the housing 390 for rotation in the directions of the double headed arrow 396 (FIG. 2) around an axis which is normal to panel 98 and generally parallel to the path of movement of the connecting rod 370. Housing 390 comprises a pair of spaced parallel guide walls 398 and 400 (FIGS. 2 and 11) integral with and extending forward from a back portion 402, which is provided with a slot 404 that is aligned with the space between the guide walls. This slot may also be aligned with the slot 392 in the front panel 98 by rotating the housing 390 to that position shown in FIGS. 3, 4, 9, 10, 11 and 12. The axis of the pivot 388 around which the handle 386 is rotatable is crosswise of the rotational axis of the housing 390. Thus the handle 386 is rotatable about two axes, that of pivot 388 and that of the housing 390.

Referring now to FIGS. 11 and 12, the back portion 402 of the housing 390 includes twin arcuate sections 406 and 408 disposed on opposite sides of the slot 404. Sections 406 and 408 have respective rearwardly extending arcuate sections 410 and 411 of lesser radius than the parent sections. Thus there are formed between the reduced sections and the parent sections annular shoulders having flat backwardly directed faces 414 and 416, respectively. The rearwardly extending arcuate sections 410 and 411 are so dimensioned that they are received with a snug but rotatable fit within a generally circular

aperture 418 in the bearing plate 395. The upper part of aperture 418 has a slot contour 419 which registers with slot 392 in the front panel 98.

The bearing plate 395 has a circular undercut "channel" 420 extending radially outward from the edge of aperture 418 and dimensioned to provide a snug but rotational fit to a pair of generally arcuate plates 421 and 422 secured respectively to the arcuate extensions 410 and 411 of the housing base 406, thus trapping the undercut lip 423 around the aperture 418. Thus the bearing plate 395 forms a bearing support carrying and permitting rotation of the housing 390. Arcuate plates 421 and 422 are provided with stop tabs 424 and 426 which freely travel the arcuate extent of radially enlarged segments 428 and 430 of the channel 420. The opposite ends of enlarged channel segment 430 and the lower end of enlarged channel segment 428 form abutments to engage the respective stop tabs thereby to limit the rotation of the housing 390 to 90° (FIG. 12). The position of the housing 390 in FIGS. 3, 4, and 9 to 12 is at one limit of the rotation, and the position in FIG. 2 and in dot-dash in FIG. 12 is at the other limit 90° away, counterclockwise.

As seen in FIGS. 11 and 12, the bell-crank arm 384 and the clevis block 376 can pass freely through slot 392, when the housing 390 is in the operative position, i.e., when the housing is aligned with slot 392. However, the dimensions of their rectangular cross sections relative to the slots are such that when the handle 386 is in the ON position (FIGS. 4 and 10), or any position between OFF and ON, the walls of slot 392 prevent the clevis block 376 and the bell crank arm 384 from rotating around an axis normal to the panel 98, and thereby prevent rotation of the housing 390. However, when the handle 386 is in the OFF position, FIGS. 3 and 9, the reduced section 394 of clevis block 376 is aligned with slot 392, thereby allowing the linkage and handle 386, together with housing 390 to freely rotate within its permissible 90° arc of travel, for example, to the SAFE position (FIG. 2 and in dot-dash FIG. 12). Another result which follows from this arrangement is that when the housing 390 is in any other position than the operative position (opening 404 of the housing aligned with slot 392 in panel 98), the shoulder 432 between the main body of the clevis block 376 and its reduced portion 394 overlies the edges of slot 392, thereby preventing rearward movement of the clevis block toward the back of the cabinet 90. As a consequence, in the SAFE position (FIG. 2 and dot-dash FIG. 12), or in any position between the OPERATIVE and SAFE positions of the housing 390, the handle 386 cannot be rotated around pivot 388 to move the carrier 288 to the ON position.

Housing 390 is provided with an extending portion 440 which blocks the closed door 100 when the housing 390 is in the OPERATIVE position (FIGS. 3, 4, 9 and 10). Thus the door cannot be opened unless the housing 390 is rotated to the SAFE position (FIG. 2 and dot-dash FIG. 12). It has already been established that the SAFE position can be approached by the housing only when the handle 386 is in the OFF position, in which position the carrier 288 is in the OFF position.

In order to prevent operation of the handle 386 from the OFF to the ON position when the door is open, rotation of the housing 390 from the SAFE to OPERATIVE positions is blocked by a spring loaded pin 442 based in the lower part of panel 98, and extending across the path of movement of the housing 390. When the door is closed, the pin 442 is depressed against its spring by engagement with the inner face of the door. With the door closed, the pin 442 does not impede movement of the housing 390.

From the foregoing description, it should be apparent that the door 100 cannot be opened unless the carrier 288 has been moved to the OFF position, and that the

carrier 288 cannot be moved to the ON position unless the door is closed.

The apparatus includes additional and concurrent safety features which lock the carrier 288 in the OFF position when the door 100 is opened, and in the ON position when the contactor armature 222 is attracted to the electromagnet 220 to operate the contactor 20 main contacts. The arrangement for providing these features includes a spring loaded latch 446 (FIGS. 9 and 10) rotatable about a pivot 448 fixed to the side plate 336 of the isolating switch frame 330. The latch 446 has a detent 450 which is continuously and resiliently urged upward toward engagement with the carrier 288 by a spring 452. In the OFF position of the carrier (FIG. 9), the detent 450 engages a rearwardly inclined face 454 on the carrier tab 364 through a slot 456 in the channel 356. In the ON position of carrier 288 (FIG. 10), the detent 450 engages a forwardly slanting face 458 of the tab 364 through the slot 456. When the carrier 288 is moved from the ON position to the OFF position, the slanting face 458 cams the detent 450 downward until the OFF position of the carrier is reached, at which time the detent 450 moves into engagement with the rearward face 454. In somewhat the same manner when the movement of the carrier 288 is reversed, the rearward slanting face 454 cams the detent 450 downward, and the detent is held down until the other position is reached.

The latch 446 can be locked in place with the carrier 288 in either the ON or the OFF position by moving the upper end of a pivoted lock bar 460 under a shoe 462 attached to the latch 446. This position of the lock bar 460 is shown in solid in FIG. 10 and in dot-dash in FIG. 9. In this position the latch 446 cannot be cammed downward by the faces 454 and 458, thus preventing movement of the carrier 288. The lock bar 460 is swingable about a pivot 464 fixed to the side wall 336 of the isolating switch frame 330. A spring 466 continuously urges the upper end of the lock bar 460 toward the rear of the cabinet.

The lock bar 460 is movable into the locking position either in response to the opening of door 100 or in response to operation of contactor 20. The arrangement for locking the latch 450 in response to opening of the door includes a draw bar 468 having a slot 470 which cooperates with a pin 472 fixed to the side plate 336 and extending through the slot to allow a combination of reciprocal and rotational movement of the bar 468. The back end of the bar 468 has a hook 474 which is hooked around the back edge of the lock bar 460, so that the lock bar is drawn forward into locking position in response to a forward pull on the draw bar 468.

The forward end of the draw bar 468 is coupled by a pivot 476 to one arm 478 of a bell-crank arrangement 480 which includes another arm 482 that is fixed to rotate with arm 478 around a pivot 484. Bell crank 480 is also provided with an L-shaped operator arm 486 fixed thereto which in one attitude, that shown in FIG. 9, is engageable by the hooked end of a bracket 488 attached to the door 100 (FIG. 9). In case the door is opened, the bracket 488 draws the forward leg of the L-shaped operator 486 forward to rock the bell-crank 480 counterclockwise, thereby to draw the bar 460 forward to lock the latch 446. In this mode, the positions of the bell-crank 480, draw bar 468, and lock bar 460 are as shown in dot-dash in FIG. 9. Since the door is being opened, the carrier 288, perforce, must be in the OFF position.

Stability in the forward and the relaxed positions of the draw bar 468 is provided by a spring biased toggle arrangement 490 which has two overcenter positions respectively coinciding with the forward and the relaxed positions of the lock bar 468. Included in the toggle arrangement 490, is a longitudinally resiliently compressible lever 492 having one end coupled to the free

end of bell-crank arm 482 at a pivot point 494. The other end of lever 492 is swingable about a pivot pin 496 fixed to the side wall 336 of frame 330. The opposite ends of lever 492 are slidably movable to and away from each other by means of an arrangement wherein one end includes a pin which is received slidably in a cylinder socket in the opposite end of the lever, both ends being resiliently urged apart by a spring 497.

As the door is closed, the end of the hook bracket 488 engages the other leg of the L-shaped operator 486 (dot-dash in FIG. 9) to rotate the bell crank 480 clockwise, thereby to relax the bar 468, and allow the lock bar 460 to move back to its non-locking position.

The lock bar 460 is moved to its locking position in response to operation of contactor 20 by means of an arm 498 fixed to the contactor shaft 144 for rotation therewith, and which arm 498 in response to such rotation engages the lower end of lock bar 460 thereby to rotate it counterclockwise into the locking position. The end position of this operation is shown in FIG. 10. This locks the carrier 288 in the ON position whenever the contactor 20 has been operated to close its main contacts.

A further safety feature is provided by a shutter 500 (FIG. 5) which covers the stab apertures 343A, 343B and 343C, in response to movement of the carrier 288 to its OFF position, and uncovers these apertures in response to movement of the carrier 288 to its ON position. These apertures are uncovered when corresponding cut out areas 501A, 501B and 501C of the shutter (FIG. 5) are brought into registry therewith in response to movement of the shutter. The back panel 332 is provided with upper and lower slide ways 502 and 504 (FIGS. 3 and 5) which support and guide the shutter 500 for slidable movement to the right or left as the case may be.

The mechanism for moving the shutter 500 is best seen in FIG. 5. Attached to the top of the shutter is a fixed arm 506 having at the free end thereof a pin 508 which passes through a slot 510 in one arm 512 of a generally L-shaped lever 514 having a second arm 516 at an obtuse angle with the other arm. The end of arm 516 is rotatable about a pivot 518 fixed to a bracket 520 attached to the side frame 336. An upstanding pin 522 fixed to the top of the carrier 288, extends through the slot 510 of lever arm 512. The sides of slot 510 are slidably engaged with pins 508 and 522. In FIG. 5, the carrier 288 is shown in the OFF position, and the stab apertures 343A, 343B and 343C in the back panel 332 are covered by the shutter 500. The word SAFE applied to the inner face of the back panel 332 is visible through the shutter apertures 501B and 501C, and may be seen by an operator looking through the door (when opened).

When the carrier 288 is moved from the OFF position to the ON position (shown in dot-dash in FIG. 5), the pin 522 moving rearwardly with the carrier, cams the lever arm 512 to the right to "open" the shutter 500, i.e., move the shutter to the right to bring the shutter apertures into registry with the stab apertures in the back panel 332. It should be noted that less than full movement from the OFF to the ON positions is required to open the shutter. The pin 522 moves the lever arm 512 to the dot-dash position shown in FIG. 5 during a fraction of the initial movement of the carrier 288 from the OFF to the ON position. During the rest of the rearward movement of carrier 288, the pin 522 "idles" through the slot. In response to movement of the carrier 288 from the ON to the OFF position, pin 522 during the first fraction of forward motion of the carrier idles through the slot 510, and during the rest of the forward movement of the carrier engages the forward end of the slot wall 510 and pushes the lever 514 counterclockwise, thereby moving lever arm 512 to the left and "closing" the shutter.

A spring latch 530 (FIG. 9) pivoted around pivot 496 drops into a slot 532, provided in the back end of the upper flanged edge of the contractor unit side plate 108, when the contactor unit 94 is drawn almost all the way out

of the cabinet. This feature holds the contactor unit locked in a partially withdrawn position to allow work and inspection therein if desired. To completely remove the contractor unit 94, the latch 530 is lifted manually out of the slot 532.

An alternative arrangement for rockably mounting the lower end of the fuse 26 on a support that also carries the fixed contact 122 of the contactor 20 is shown in FIG. 13. In this figure a conductive tab 282 fixed, for example by brazing, to the lower ferrule 131 of the fuse, is attached by a bolt 283 to a hinge member 284 which is rockable around a pivot 285 that is fixed to a variation of the fuse mount 130 which is supported by the insulating member 134. A flexible conductor 285A is provided for improved electrical connection between the fuse ferrule 131 and the fixed contact 122. For fuse removal, the single bolt 283 is pulled out to separate the fuse from the hinge member 284 on the fuse mount 130. The conductive clip 260 is attached to base 130. Thus, in each of the arrangements shown in FIGS. 3 and 13, the lower end of the fuse is pivotally carried on the fuse mount 130, whereby the upper end of the fuse is pivotable around the lower end of the fuse and is movable forward and backward in a generally arcuate path.

While any suitable insulating material may be employed to fabricate the various parts made of insulation, glass alkyl and glass polyester were found to be particularly advantageous for the dimensions involved. For example, glass polyester was employed for the member 172 and the phase barrier plates 209 and 210, while glass alkyl was used for the members 134, 142, carrier 288, and backwall 332.

For an independent check of the start-stop circuits, an alternative position of switch 52 will connect fuses 54 to lines 55 which may be connected to a test voltage source (FIG. 1).

In practice the major units of the apparatus may be assembled as follows: First, the isolating switch unit 92 is slipped into the cabinet 90 and secured in place by bolts screwed into metal tabs fixed to the cabinet 90. Then the contactor unit 94, sans fuses, is inserted into the cabinet, after which connections are made at points D, E and F. Next, the fuses 26 may be fitted into place. Then a plug 540 carrying the male elements of the connectors 60 and 66 is fitted into its receptacle to complete the connections at 60 and 66. Conversely, upon removal of the fuses 26, opening the connections at D, E and F, and pulling out the plug 540, the units 94 and 92 may be pulled out in that order for inspection or repair. The auxiliary equipment outside the dashed box 95 (FIG. 1) stays in the cabinet 90.

While not limited thereto, a practical operating example of the disclosed apparatus was constructed for 3-phase operation with a rating of 2500 volts, 180 amperes, 700 horsepower, interrupting capacity 150,000 kva., in a unit 22 inches wide, 33 inches high and 24 inches deep. An additional 6 inch depth was used as a cable pull box. Because of the compact and unique construction, two men were able to handle the subassemblies without need of hoists, cranes, dollies, etc.

From the foregoing description, it is seen that the disclosed apparatus provides novel switching structure including a main power contactor, power fuses, and an isolating switch, with the following features;

- (a) dramatic reduction in size;
- (b) front door cannot be opened when isolating switch is closed (ON);
- (c) isolating switch cannot be closed when front door is opened;
- (d) isolating switch cannot be opened when the contactor is operated to close main contacts;
- (e) "empty" stab jaws of isolating switch are tilted upward to be visible through door when isolating switch is opened; and

(f) when isolating switch is opened, shutter is interposed between stab jaws and stabs, and shutter uncovers indicia visible through door by operator.

It is to be understood that the herein described arrangements are simply illustrative of the principles of the invention, and that other embodiments and applications are within the spirit and scope of the invention.

We claim as our invention:

1. The combination comprising structure means defining interior space, said structural means having an opening and a door therefor movable between closed and open positions, first switch means including a set of contacts disposed within said space and operable between open and closed circuit positions and first operating means for operating said contacts, a fuse disposed within said space and having one end conductively coupled to one of said contacts, means for rockably supporting said one end of the fuse in such manner that the other end of the fuse is swingable in opposite directions around said one end, first contact means coupled to said other end of the fuse and movable therewith, second switch means including said first contact means and stationary second contact means in the path of movement of said first contact means, a member disposed in said space and movable to first and second positions, means for so coupling said member to said fuse that movement of the member to its first position swings said fuse in one direction and moves said first contact means into contact with said second contact means, and movement of the member to its second position swings said fuse in the opposite direction and moves said first contact means out of contact with said second contact means, second operating means coupled to said member and extending exteriorly of said structure means, said second operating means having respective ON and OFF positions for operating said member to its respective first and second positions, means for locking said member in its first position in response to said first operating means operating said set of contacts to its closed circuit position, means for locking said member in its second position in response to the opening of said door, a movable barrier, and means for moving said barrier between said first and second contact means in response to movement of said member to its second position and for retracting said barrier in response to movement of said member to its first position.

2. The combination comprising structure means defining interior space, said structure means having an opening and a door therefor movable to closed and open positions, first switch means including a set of contacts disposed within said space and operable between open and closed positions and operator means for operating said contacts, a fuse disposed within said space and having one end conductively coupled to one of said contacts, means for rockably supporting said one end of the fuse in such manner that the other end of the fuse is swingable back and forth about said one end, first contact means coupled to said other end of the fuse and movable therewith, second switch means including said first contact means and stationary second contact means in the path of movement of said first contact means, a first member disposed in said space and movable to first and second positions, means for so coupling said member to said fuse that movement of the member to said first position swings said fuse in one direction and moves said first contact means into contact with said second contact means, and movement of the member to said second position swings said fuse in the opposite direction and moves the first contact means out of contact with said second contact means, a mechanism coupled to said member and extending exteriorly of said structure means, said mechanism being movable to respective ON and OFF positions for operating said member to its respective first and second positions, said mechanism having interference means preventing the opening of said door when the mechanism is in its ON position, said mechanism hav-

ing a SAFE position approachable by the mechanism only when in its OFF position, in which SAFE position said member remains in its second position and the door is cleared of said interference means whereby the door may be opened, means responsive to the opening of said door for preventing movement of said mechanism from its SAFE position, a second member resiliently biased to a first position and movable to a second position in response to said operator means operating said contacts into their closed position and also in response to said door being moved from closed to open position, a latch having a lockable latching position in which the latch is locked in response to said second member being in its second position, said first member being locked in its current position in response to the latch being locked in the latching position, a barrier, and means for interposing the barrier between said first and second contact means in response to movement of the first member to its second position and for retracting said barrier in response to the first member moving to its first position.

3. Switching apparatus comprising a first set of switch contacts operable between closed and open positions, operating means for operating said contacts, a fuse having one end conductively coupled to one of said contacts, means for rockably supporting said one end of the fuse in such manner that the other end of the fuse is swingable about said one end, first contact means coupled to said other end of the fuse and movable therewith, a second set of complementary switch contacts including said first contact means and stationary second contact means in the path of movement of said first contact means, a member which is movable between first and second positions, means coupling said member to said fuse for swinging said other end of the fuse in one direction and moving said first contact means into contact with the second contact means in response to movement of the member to its first position and for swinging said other end of the fuse in the opposite direction and moving said first contact means out of contact with the second contact means in response to movement of the member to its second position, and means for locking said member in said first position in response to said operating means operating said first set of contacts into closed position.

4. In combination, structure means defining a space, said structure means having an opening and a door therefor operable between open and closed positions, first switch means including a set of contacts disposed in said space and operable between closed and open positions and operating means for operating said set of contacts, a fuse disposed in said space and having one end conductively coupled to one of said contacts, means for rockably supporting said one end of the fuse in such manner that the other end of the fuse is swingable about said one end, first contact means coupled to said other end of the fuse and movable therewith, second switch means having a second set of contacts including said first contact means and stationary second contact means in the path of movement of said first contact means, a member which is movable between first and second positions, means coupling said member to said fuse in such manner that movement of said member to said first position swings said fuse in one direction and moves said first contact means into contact with said second contact means, and movement of said member to said second position swings said fuse in opposite direction and moves the first contact means out of contact with the second contact means, and means for locking said member in said second position in response to opening of said door.

5. In combination, structure means defining a space, said structure means having an opening and a door therefor operable between open and closed positions, first switch means having a set of contacts disposed in said space and operable between closed and open positions, operating means for operating said contacts, a fuse disposed in said space and having one end conductively cou-

pled to one of said contacts, means for rockably supporting said fuse in such manner that the other end of the fuse is swingable forward and backward about said one end, first contact means coupled to said other end of the fuse and movable therewith, second switch means including said first contact means and stationary second contact means in the path of movement of said first contact means, a member which is movable between first and second positions, means for so coupling said member to said fuse that movement of said member to said first position swings said fuse and moves said first contact means into contact with said second contact means, and movement of said member to said second position swings said fuse and moves the first contact means out of contact with the second contact means, first locking means for locking said member in said second position in response to opening of said door, and second locking means for locking said member in said first position in response to said operating means operating said set of contacts to their closed position, said first and second locking means including a common locking element.

6. The combination of an enclosure and switching apparatus mounted therein, said enclosure having an opening and a door therefore with open and closed positions, said switching apparatus comprising a set of contacts operable between open and closed positions, first operating means for operating said contacts, a fuse having one end conductively coupled to one of said contacts, means mounting said fuse for pivotable movement of the other end of the fuse about said one end, first contact means coupled to said other end of the fuse and movable therewith, disconnect switch means including said first contact means and stationary second contact means in the path of movement of said first contact means, a first member movable to respective ON and OFF positions and coupled to said fuse for swinging said other end of the fuse in one direction about said one end and moving said first contact means into contact with said second contact means in response to movement of said member to its ON position and for swinging said other end of the fuse in the opposite direction about said one end and moving said first contact means out of contact with said second contact means in response to movement of said member to its OFF position, said member being disposed in said enclosure, second operating means for moving said member from one to the other of its ON and OFF positions, a second member movable between first and second positions, means for moving said second member to its second position in response to said first operating means operating said set of contacts to their closed position, means responsive to said door being moved from its closed to its open position for moving said second member to its second position, a latch having a lockable latching position which locks said first member when the latch is locked in the latching position, said latch being locked in the latching position in response to said second member being in its second position, said latch being free of said second member when that member is in its first position.

7. The combination comprising structure means defining interior space, said structure means having an opening and a door therefor movable to closed and open positions, first switch means having a set of contacts disposed in said space and operable between open and closed positions, means for operating said contacts, a fuse disposed in said space and having one end conductively coupled to one of said contacts, means for rockably supporting said one end of the fuse whereby the other end of the fuse is swingable in opposite directions around said one end, first contact means coupled to said other end of the fuse and movable therewith, second switch means having a second set of contacts including said first contact means and stationary second contact means in the path of movement of said first contact means, a member movable to first and second positions, means

for so coupling said member to said fuse that movement of the member to said first position swings said fuse in one direction and moves said first contact means into contact with said second contact means, and movement of the member to said second position swings said fuse in the opposite direction and moves the first contact means out of contact with the second contact means, a mechanism coupled to said member and having respective ON and OFF positions for operating said member to its respective first and second positions, and locking means comprising a locking element movable to a locking position in response to which said member is locked, said element being resiliently biased away from its locking position, a linkage including a toggle, means coupled to said door for moving the linkage from a first to a second position in response to opening of the door and from the second to the first position in response to closing of the door, and means responsive to movement of said linkage to its second position for moving said locking element to its locking position.

8. The combination comprising structure means defining interior space, said structure means having an opening and a door movable to closed and open positions which respectively cover and uncover said opening, first switch means including a set of contacts disposed in said space and operable between open and closed positions and means for operating said contacts, a fuse disposed in said space and having one end conductively coupled to one of said contacts, means for rockably supporting said one end of the fuse in such manner that the other end of the fuse is swingable in opposite directions about said one end, first contact means coupled to said other end of the fuse and movable therewith, second switch means having a second set of contacts including said first contact means and stationary second contact means in the path of movement of said first contact means, a member movable to first and second positions and coupled to said fuse for swinging said other end of the fuse in one direction and moving said first contact means into contact with the second contact means in response to movement of the member to its first position and for swinging said other end of the fuse in the opposite direction and moving said first contact means out of contact with the second contact means in response to movement of the member to its second position, said member being disposed in said space, a mechanism coupled to said member and extending exteriorly of said structure means, said mechanism having ON and OFF positions for operating said member to its respective first and second positions, said mechanism including a frame and an operator, said frame being rotatable about a first axis from one to the other of first and second angles, said frame at said first angle barring said door to prevent opening thereof, said operator being connected to said member and being supported by said frame for rotation about a second axis from one to the other of ON and OFF positions corresponding to the ON and OFF positions of said mechanism, the second axis being transverse to the first axis, said operator being operable to either ON or OFF positions when the frame is at said first angle, means for preventing operation of said operator to its ON position when the frame is at the second angle, and means for preventing rotation of the frame to the second angle when the operator is in its ON position.

9. The combination comprising structure means defining interior space, said structure means having an opening and a door movable to closed and open positions which respectively cover and uncover said opening, first switch means including a set of contacts disposed in said space and operable between open and closed positions and means for operating said contacts, a fuse disposed in said space and having one end conductively coupled to one of said contacts, means for rockably supporting said one end of the fuse whereby the other end of the fuse is swingable backward and forward about said one end, first contact means coupled to said other end of the fuse and movable

therewith, second switch means including said first contact means and stationary second contact means in the path of movement of said first contact means, a member movable to first and second positions, means for coupling said member to said fuse in such manner that movement of said member to said first position swings said fuse in one direction and moves said first contact means into contact with said second contact means, and movement of said member to said second position swings said fuse in the opposite direction and moves the first contact means out of contact with the second contact means, a mechanism coupled to said member and extending exteriorly of said structure means, said mechanism having ON and OFF positions for operating the member to its respective first and second positions, said mechanism including rotatable support means and an operator, said rotatable support means being rotatable about a first axis from one to the other of first and second angles, said rotatable support means at said first angle barring said door to prevent opening thereof, said operator being connected to said member and being supported by said rotatable support means for rotation about a second axis from one to the other of ON and OFF positions corresponding to the ON and OFF positions of said mechanism, the second axis being transverse to the first axis, said operator being operable to either ON or OFF positions when the rotatable support means is at said first angle, means for preventing operation of the operator to its ON position when the rotatable support means is at the second angle, means for preventing rotation of the rotatable support means to the angle when the second operator is in its ON position, and means responsive to opening of said door for preventing rotation of the rotatable support means from said second to said first angle.

10. The combination comprising structure means defining interior space, said structure means having an opening and a door therefor movable to closed and open positions, first switch means including a set of contacts disposed in said space and operable between open and closed positions and means for operating said contacts, a fuse disposed in said space and having one end conductively coupled to one of said contacts, means for rockably supporting said one end of the fuse so that the other end of the fuse is swingable in opposite directions around said one end, first contact means coupled to said other end of the fuse and movable therewith, second switch means including said first contact means and stationary second contact means in the path of movement of said first contact means, a member movable to first and second positions, means for so coupling said member to said fuse that movement of the member to said first position swings said fuse in one direction and moves said first contact means into contact with said second contact means, and movement of the member to said second position swings said fuse in the opposite direction and moves the first contact means out of contact with the second contact means, said structure means having a wall with a slot, and a mechanism coupled to said member and extending through said slot, said mechanism having respective ON and OFF positions for operating said member to its respective first and second positions, said mechanism being rotatable to first and second angles about an axis, said mechanism being reciprocable along said axis between its ON and OFF positions, said mechanism having a portion which moves through said slot when the mechanism is operated between its ON and OFF positions, said portion having a reduced section which is aligned with said slot when the mechanism is in its OFF position, said portion being so dimensioned that the walls of the slot interfere with said portion except said reduced section to prevent rotation of the mechanism around said axis when the mechanism is in its ON position, said mechanism having interference means barring said door when the mechanism is at said first angle to prevent opening of the door, said interference means being ineffective to bar the door when the mechanism is at said second angle.

11. The combination comprising structure means defining an interior space, said structure means having an opening and a door therefor movable to closed and open positions, switching means including a set of contacts disposed in said space and operable between open and closed positions and means for operating said contacts, a fuse disposed in said space and having one end conductively coupled to one of said contacts, means so rockably supporting said one end of the fuse that the other end of the fuse is swingable in opposite directions about said one end, first contact means coupled to said other end of the fuse and movable therewith, second switch means including said first contact means and stationary second contact means in the path of movement of said first contact means, a member movable to first and second positions, means for coupling said member to said fuse in such manner that movement of said member to said first position moves said first contact means into contact with said second contact means, and movement of said member to said second position swings said fuse in the opposite direction and moves the first contact means out of contact with the second contact means, said structure means having a wall with a slot, a mechanism coupled to said member and extending through said slot, said mechanism having respective ON and OFF positions for operating said member to its respective first and second positions, said mechanism being rotatable to first and second angles about an axis, said mechanism being reciprocable along said axis between its ON and OFF positions, said mechanism having a portion which moves through said slot when the mechanism is operated between its ON and OFF position, said portion having a reduced section which is aligned with said slot when the mechanism is in its OFF position, said portion being so dimensioned that the walls of the slot interfere with said portion except said reduced section to prevent rotation of the mechanism around said axis when the mechanism is in its ON position, said mechanism having interference means barring said door when the mechanism is at said first angle to prevent opening of the door, said interference means being ineffective to bar the door when the mechanism is at said second angle, and means responsive to opening of said door for preventing rotation of said mechanism from said second to said first angle.

12. The combination comprising an enclosure, said enclosure having an opening and a door therefor with open and closed positions, switch means including a set of contacts disposed in said enclosure and operable between open and closed position and first operating means for operating said contacts, a fuse disposed in said enclosure and having one end conductively coupled to one of said contacts, means rockably mounting said one end of the fuse to make the other end of the fuse swingable in opposite directions around said one end, first contact means coupled to said other end of the fuse and movable therewith, second switch means including said first contact means and stationary second contact means in the path of movement of said first contact means, a member movable between respective OFF and ON positions and coupled to said fuse for swinging said other end of the fuse in one direction about said one end and moving said first contact means into contact with said second contact means in response to movement of said member to its ON position and for swinging said other end of the fuse in the opposite direction about said one end and moving said first contact means out of contact with said second contact means in response to movement of said member to its OFF position, said member being disposed in said enclosure, second operating means including linkage coupled to said member, said linkage being rotatable around and reciprocable along an axis, said second operating means further comprising means for rotating said linkage around said axis from one to the other of first and second angular positions, means for reciprocating said linkage along said axis from one to the other of ON and OFF positions when

the linkage is at said first angular position to move said member from one to the other of its ON and OFF positions, means for preventing reciprocation of the linkage when said linkage is at said second angular position, said second operating means having interference means preventing the opening of said door when the linkage is in the first angular position, and means for preventing rotation of said linkage from its first angular position when the linkage is in its ON position.

13. The combination comprising an enclosure, said enclosure having an opening and a door therefor with open and closed positions, first switch means including a set of contacts disposed in said enclosure and operable between open and closed position and first operating means coupled to said set of contacts for operating said contacts, a fuse disposed in said enclosure and having one end conductively coupled to one of said contacts, means rockably mounting said one end of the fuse whereby in such manner that the other end of the fuse is swingable in opposite directions about said one end, first contact means coupled to said other end of the fuse and movable therewith, second switch means including said first contact means and stationary second contact means in the path of movement of said first contact means, a member movable between respective OFF and ON positions, means for so coupling said fuse to said member that movement of the member to its ON position swings said fuse in one direction and moves said first contact means into contact with said second contact means, and movement of the member to its OFF position swings said fuse in the opposite direction and moves said first contact means out of contact with said second contact means, second operating means including linkage coupled to said member, said linkage being rotatable around and reciprocable along an axis, said second operating means further comprising means for rotating said linkage around said axis from one to the other of first and second angular positions, means for reciprocating said linkage along said axis from one to the other of ON and OFF positions when the linkage is at said first angular position to move said member from one to the other of its ON and OFF positions, means for preventing reciprocation of the linkage when said linkage is at said second angular position, said second operating means having interference means preventing the opening of said door when the linkage is in the first angular position, means for preventing rotation of said linkage from its first angular position when the linkage is in its ON position, and means responsive to opening of said door for preventing rotation of said linkage from its second angular position.

14. Switching apparatus comprising a first frame, a second frame slidably mounted in said first frame, a third frame slidably mounted in said first frame above the second frame, the second and third frames being separately slidably removable from the first frame, a set of contacts mounted on the second frame and operable between open and closed position, first operating means mounted on said second frame for operating said set of contacts, a fuse having one end conductively coupled to one of said contacts, said one end of the fuse being rockably mounted on said second frame in such manner that the other end of the fuse is swingable in opposite directions around said one end, first contact means coupled to said other end of the fuse and movable therewith, stationary second contact means in the path of movement of said first contact means, a carrier movable between respective ON and OFF positions and operatively connected to said fuse for swinging said other end of the fuse in one direction around said one end and moving said first contact means into contact with said second contact means in response to movement of the carrier to its ON position and for swinging said other end of the fuse in the opposite direction about said one end and moving said first contact means out of contact with said second contact means in response to movement of the carrier to its OFF position, said third frame

having means supporting said carrier, second operating means coupled to said carrier and extending outside said third frame for moving said carrier from one to the other of its ON and OFF positions, and means for locking said carrier in the ON position in response to said first operating means operating said set of contacts to their closed position.

15. Switching apparatus comprising an enclosure having an opening and a door therefor with open and closed positions, the door in the closed position covering a part of said opening, a first frame slidably mounted in said enclosure, said frame being removable through said opening when the door is opened, a second frame slidably mounted in said enclosure above the first frame, the second frame being slidably removable from the enclosure through said opening, the second frame having a plate which is disposed in a portion of the opening not covered by said door in its closed position, a set of contacts mounted on the first frame and operable between open and closed position, first operating means mounted on said first frame for operating said contacts, a fuse having one end conductively coupled to one of said contacts, means for pivotally mounting said one end of the fuse on said first frame in such manner that the other end of the fuse is swingable about said one end first contact means coupled to said other end of the fuse and movable therewith, disconnect switch means including said first contact means and stationary second contact means in the path of movement of said first contact means, a carrier mounted on said second frame and movable between respective OFF and ON positions, means for so coupling said fuse to said carrier that movement of the carrier to its ON position swings said fuse in one direction and moves said first contact means into contact with said second contact means, and movement of the carrier to its OFF position swings said fuse in the opposite direction and moves said first contact means out of contact with said second contact means, second operating means extending through said plate and including linkage coupled to said carrier, said linkage being rotatable around and reciprocable along an axis, said second operating means including means for rotating said linkage around said axis from one to the other of first and second angular positions and means for reciprocating said linkage along said axis from one to the other of ON and OFF positions when said linkage is at said first angular position to move said carrier from one to the other of its ON and OFF positions, means associated with said second operating means and said plate for preventing reciprocation of the linkage when said linkage is in said second angular position, said second operating means having interference means preventing the opening of said door when the linkage is in the first angular position, means associated with said second operating means and said plate for preventing rotation of said linkage from its first angular position when the linkage is in its ON position, means responsive to opening of said door for preventing rotation of said linkage from its second angular position, a member mounted on said second frame and movable between first and second positions, means for moving said member to its second position in response to said first operating means operating said set of contacts to their closed position, means responsive to said door being moved from its closed to its open position for moving said member to its second position, latch means carried by said second frame having a lockable latching position which locks the carrier when the latch means is locked in the latching position, said latch means being locked in the latching position in response to said member being in its second position, said latch means being free of said member when the latter is in its first position.

16. The combination of claim 4 wherein said fuse is generally vertically disposed with said one end of the fuse below said other end of the fuse, and wherein there is means for supporting said member for generally horizontal movement along a line adjacent said other end of

the fuse, and said means coupling said member to said fuse includes an articulated joint between said member and said first contact means.

17. The combination of claim 5 wherein said fuse is generally vertically disposed with said one end of the fuse below said other end of the fuse, and wherein there is means for supporting said member for generally horizontal movement along a line adjacent said other end of the fuse, and said means for coupling includes a movable joint between said member and said first contact means.

18. The combination of structure means defining interior space and switching apparatus mounted in said space, said switching apparatus comprising a fuse disposed in said space, means for supporting said fuse for substantially pivotable movement of one end of the fuse about the other end of the fuse, first contact means coupled to said one end of the fuse and movable therewith, stationary second contact means in the path of movement of said first contact means, a member coupled to said fuse and movable to first and second positions to swing said one end of the fuse about said other end and move said first contact means, whereby movement of the member to its first position moves said first contact means into contact with said second contact means, and movement of the member to its second position moves said first contact means out of contact with said second contact means, said members being disposed in said space, operating means coupled to said member and extending exteriorly of said structure means for operating the member to its respective first and second positions, a movable barrier, and barrier moving means including coupling means connecting said barrier to said member for transmitting force from said member to said barrier to interpose the barrier between said first and second contact means in response to movement of said member to its second position and to retract said barrier in response to movement of the member to its first position.

19. The combination comprising structure means defining interior space, said structure means having an opening and a door therefor movable between closed and open positions, first switch means including a set of contacts disposed within said space and operable between open and closed positions and first operating means for operating said contacts, a fuse disposed within said space and having one end conductively coupled to one of said contacts, means rockably supporting said fuse in such manner that the other end of the fuse is swingable in opposite directions about said one end, first contact means coupled to said other end of the fuse and movable therewith, second switch means including said first contact means and stationary second contact means in the path of movement of said first contact means, a member movable to first and second positions and operatively connected to said fuse for swinging said other end of the fuse about said one end and moving said first contact means into contact with the second contact means in response to movement of the member to its first position and out of contact with the second contact means in response to movement of the member to its second position, said member being disposed in said space, second operating means coupled to said member and extending exteriorly of said structure means, said second operating means having respective ON and OFF positions for operating said member to its respective first and second positions, means for locking said member in its first position in response to said first operating means operating said set of contacts to its closed position, and means for locking said member in its second position in response to opening of said door.

20. The combination comprising structure means defining interior space, said structure means having an opening and a door therefor movable to closed and open positions, first switch means including a set of contacts disposed within said space and operable between open and closed positions and operator means for operating said

contacts, a fuse disposed within said space and having one end conductively coupled to one of said contacts, means rockably supporting said one end of the fuse to make the other end of the fuse swingable back and forth about said one end, first contact means coupled to said other end of the fuse and movable therewith, second switch means including said first contact means and stationary second contact means in the path of movement of said first contact means, a member movable to first and second positions and operatively connected to said fuse for swinging said other end of the fuse in one direction and moving said first contact means into contact with the second contact means in response to movement of the member to its first position and for swinging said other end of the fuse in the opposite direction and moving said first contact out of contact with the second contact means in response to movement of the member to its second position, said member being disposed in said space, a mechanism coupled to said member and extending exteriorly of said structure means, said mechanism being movable to respective ON and OFF positions for operating said member to its respective first and second positions, said mechanism having interference means preventing the opening of said door when the mechanism is in its ON position, said mechanism having a SAFE position approachable by the mechanism only when in its OFF position, in which SAFE position said member remains in its second

position and the door is cleared of said interference means whereby the door may be opened, means responsive to the opening of said door for preventing movement of said mechanism from its SAFE position, a second member resiliently biased to a first position and movable to a second position in response to said operator means operating said set of contacts to their closed position and also in response to said door being moved from closed to open position, a latch having a lockable latching position in which the latch is locked in response to said second member being in its second position, said first member being locked in its current position in response to the latch being locked in the latching position.

## References Cited by the Examiner

## UNITED STATES PATENTS

2,629,795	2/1953	Hanks	200—114
2,636,954	4/1953	Hellstern	200—114
2,792,472	5/1957	Koch	200—133
2,894,085	7/1959	Wilson	200—50.15
2,938,093	5/1960	McCloud	200—133

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