

H. W. CHENEY.
CIRCUIT CONTROLLING APPARATUS.
APPLICATION FILED MAR. 27, 1909.

1,176,202.

Patented Mar. 21, 1916.

5 SHEETS—SHEET 1.

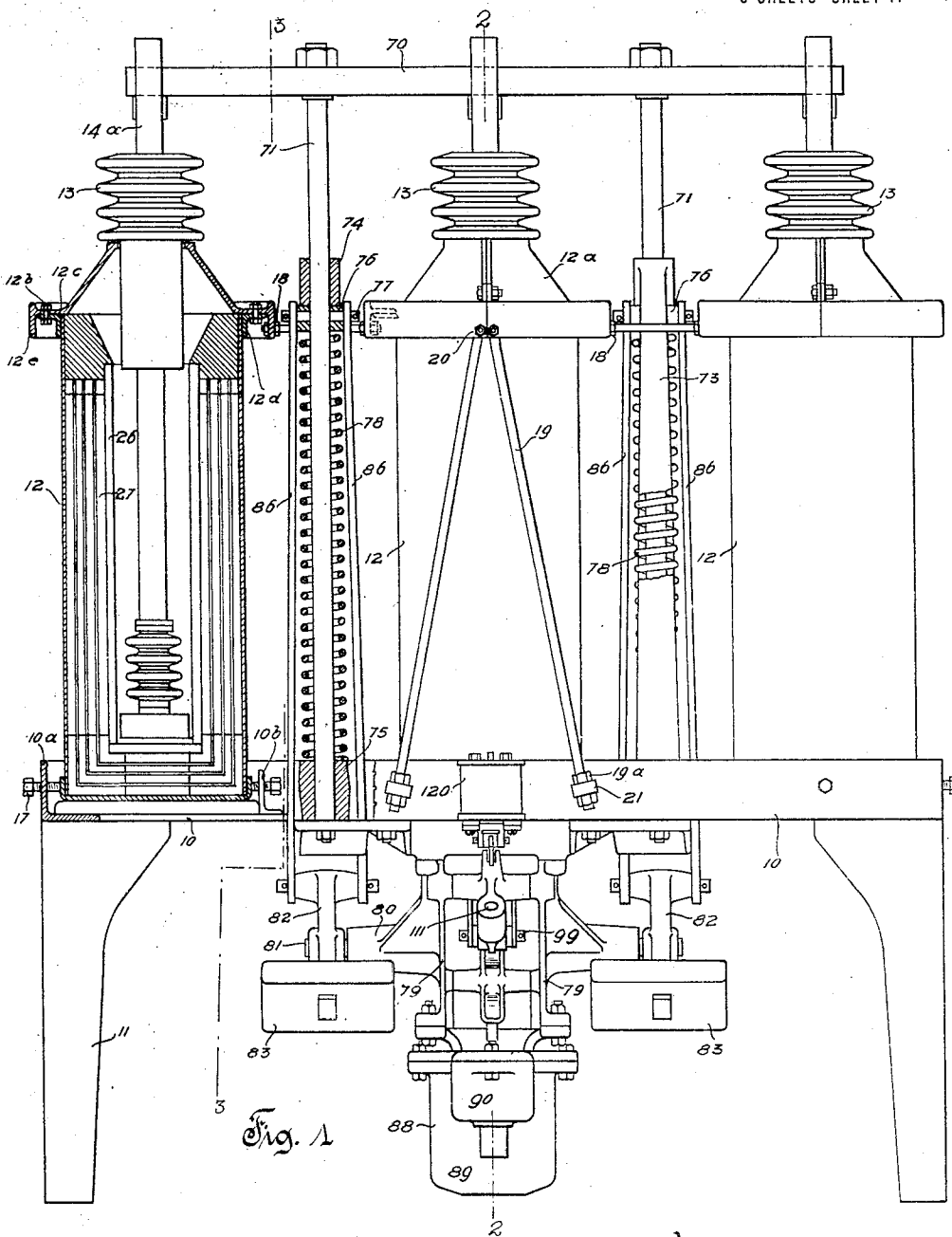


Fig. 1

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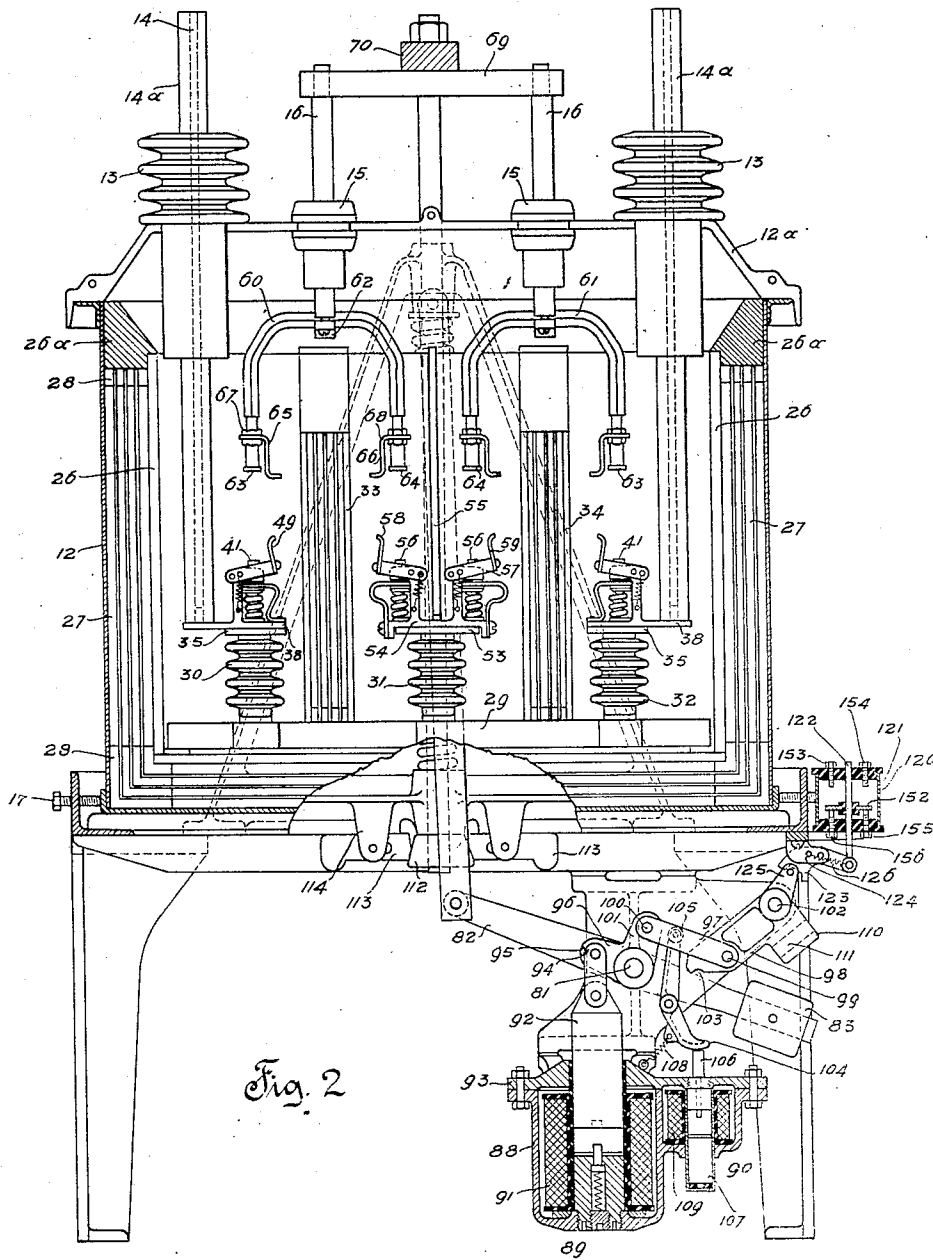


Fig. 2

Witnesses

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5 SHEETS—SHEET 3.

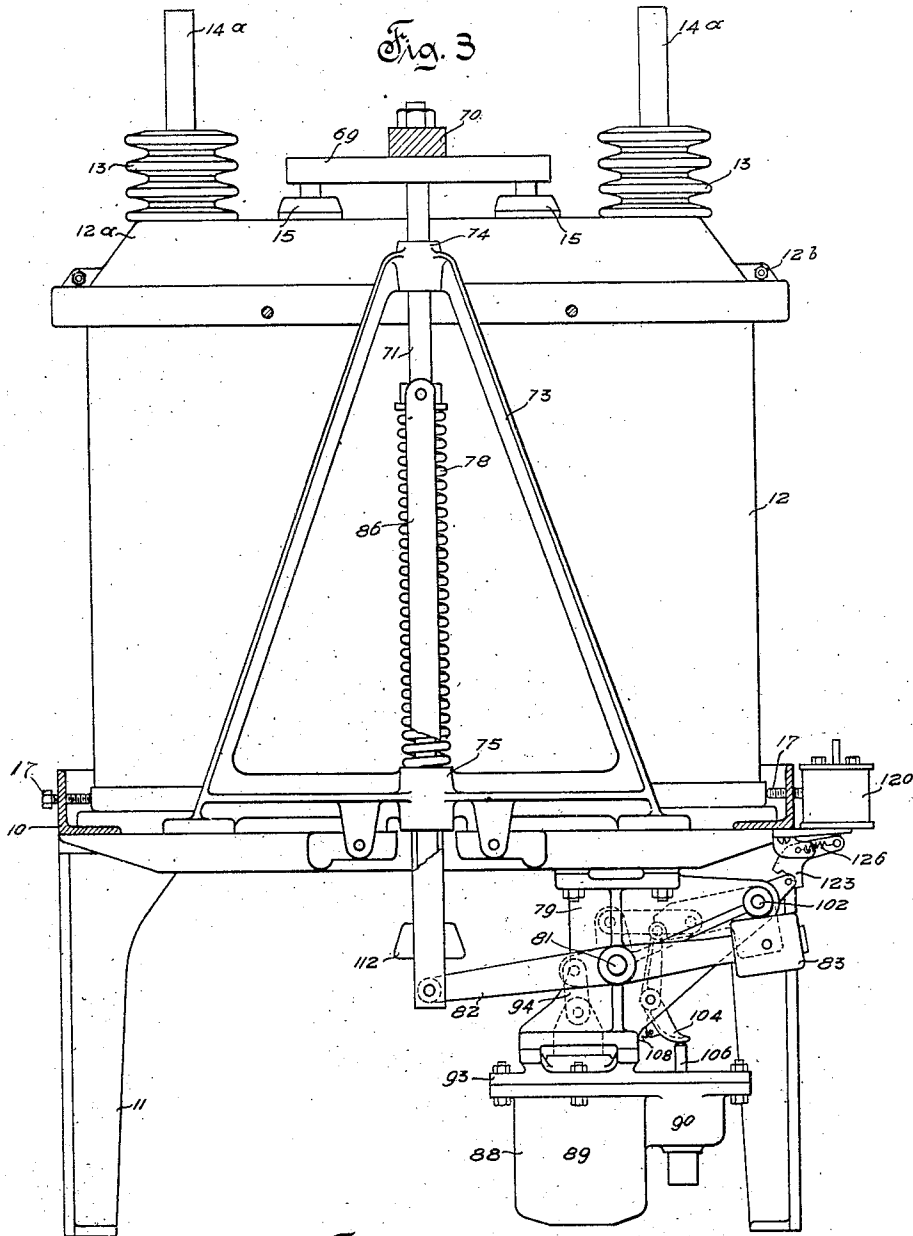
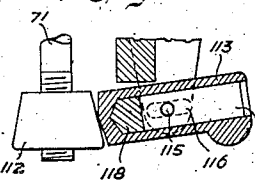


Fig. 8



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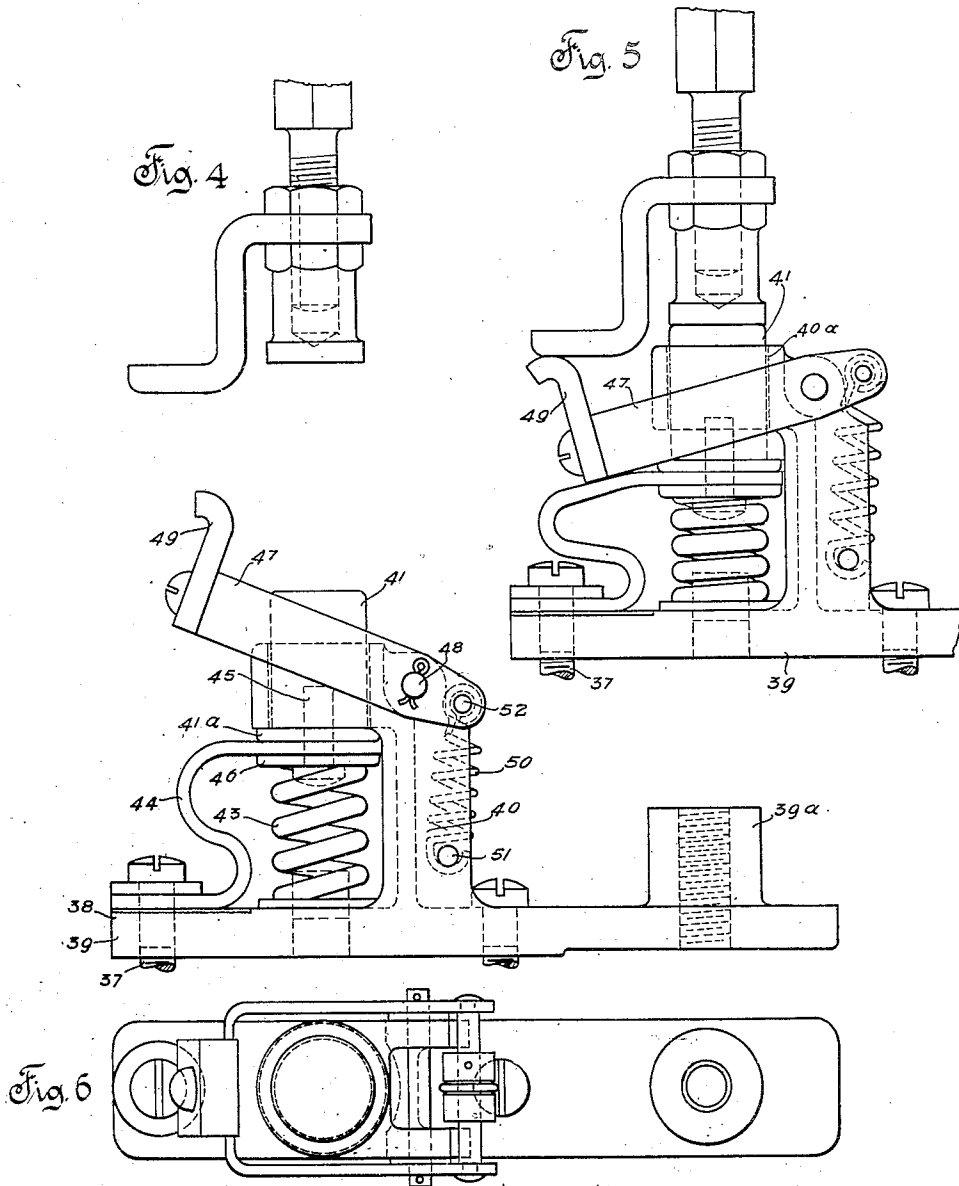
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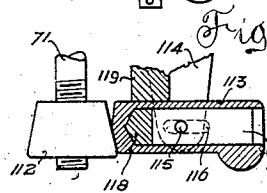
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5 SHEETS—SHEET 4.



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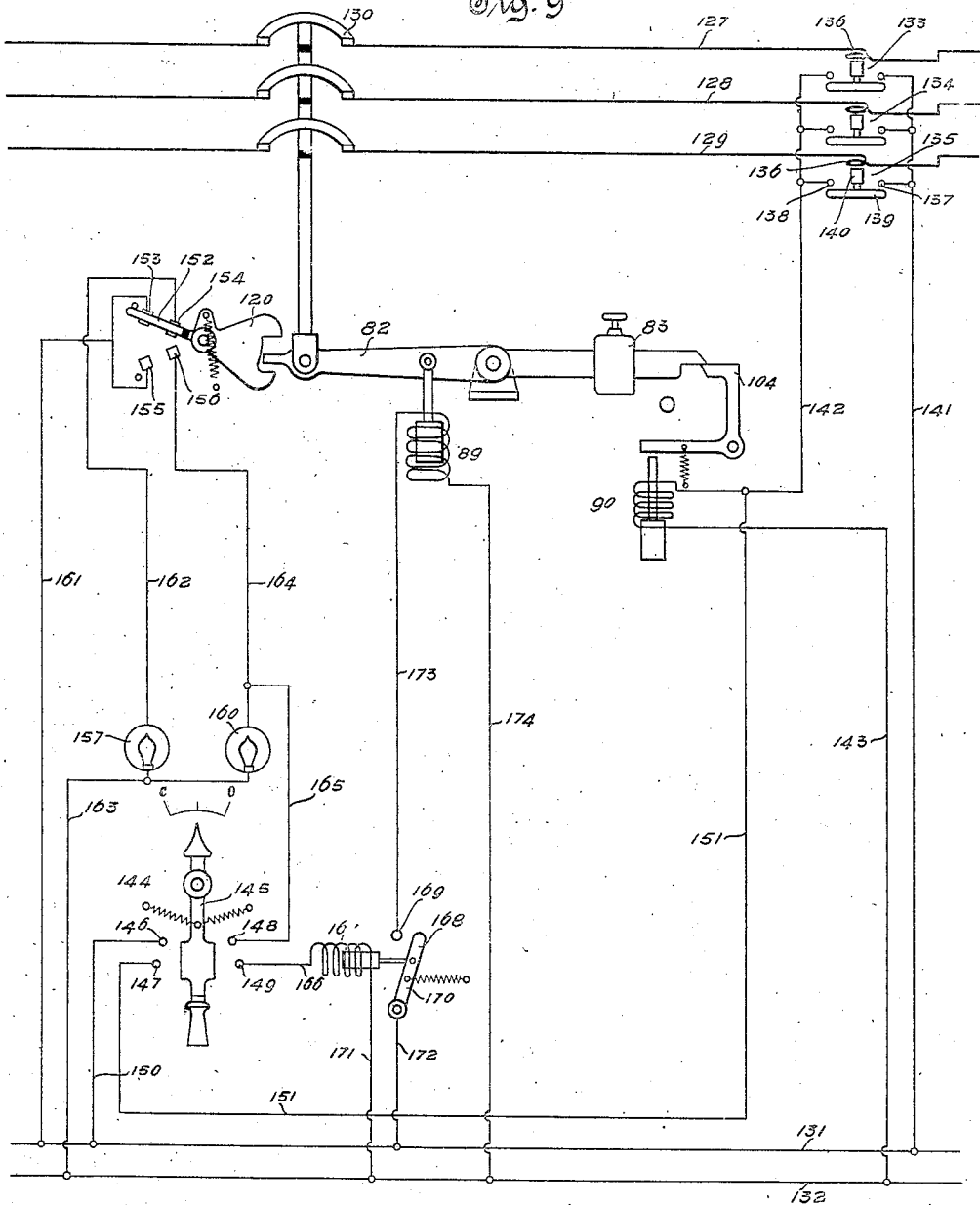
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5 SHEETS—SHEET 5.

Fig. 9



Witnesses
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UNITED STATES PATENT OFFICE.

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CIRCUIT-CONTROLLING APPARATUS.

1,176,202.

Specification of Letters Patent. Patented Mar. 21, 1916.

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To all whom it may concern:

Be it known that I, HERBERT W. CHENEY, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented certain new and useful Improvements in Circuit-Controlling Apparatus, of which the following is a full, clear, and exact specification.

This invention relates to circuit controlling apparatus and particularly to switches of large capacity and of the motor operated remote controlled type.

One of the objects of the invention is the provision of a switch which can be safely employed in circuits of exceedingly high voltages and large amperages without any danger of the arcs causing injury to the operator or to any of the apparatus.

A further object is to provide for a switch of high capacity switch mechanism which is strong, durable and effective in operation, which is well insulated from the oil tank and other surrounding parts and which is so constructed that access may be readily had to all parts.

A still further object is a provision of switch controlling and operating mechanism by means of which the switch can be readily controlled from a distance by the manual or automatic manipulation of switches which are so arranged and constructed that no arcing of any consequence will occur at the switch board when the operating circuit is broken.

A still further object is a provision of a simple and effective form of indicating mechanism which will indicate at all times whether the switch is open or closed.

My invention consists in certain novel details of construction and combination and arrangements of parts which will be described in the specification and set forth in the appended claims.

I have in the present case shown my invention as applied to a three pole switch such as are employed in three phase circuits, and have shown the contact mechanism of each pole inclosed within a separate oil compartment and receptacle. It is understood, however, that my invention is not limited in its scope to a switch of any particular number of poles and in many of its aspects is not limited to a switch having the mechanism of its poles arranged, constructed or inclosed as here shown.

For a better understanding of my invention, reference is had to the accompanying sheets of drawings, in which—

Figure 1 is a side elevation of a switch constructed in accordance with my invention, parts being broken away and other parts being in section; Fig. 2 is a sectional view, taken through one of the tanks and poles of the switch substantially on the line 2—2 of Fig. 1, the switch being here shown in its open position; Fig. 3 is a sectional view, the section being taken between two of the poles and between the adjacent tanks or compartments, substantially along the line 3—3 of Fig. 1, the different parts of the operating mechanism being shown in the position which they occupy when the switch is closed; Fig. 4 is an enlarged elevation of part of the stationary and movable contact members employed in each pole of the switch, the contacts being separated or out of engagement; Fig. 5 is a similar view showing the contacts in engagement and showing the relative positions of the parts when the switch is closed; Fig. 6 is a top plan view of one of the lower or stationary contact members; Fig. 7 is a detail of the buffer employed in connection with the operating mechanism; Fig. 8 is a similar view showing the manner in which the buffers are rocked when the switch closing movement starts. Fig. 9 is a diagrammatical view showing conventionally the switch and the circuits and switch of the operating and indicating mechanism.

Referring now to the figures of the drawing wherein I have shown the preferred embodiment of my invention, 10 represents a suitable switch supporting frame which is provided with legs 11, and on which rest a number of oil tanks 12, in this case three in number, said tanks being preferably formed of sheet metal and each being provided with a cover 12^a which is preferably divided along the longitudinal center or into two halves each of which is separately secured to the tank preferably by screws or bolts 12^b which pass through horizontal flanges 12^c on the cover and through horizontal flanges of angles 12^d secured to the tank and extending about the upper edge of the same. Supported by the cover of each tank between the two parts of the same and near the ends thereof are insulators or insulating bushings 13 having vertical pas-

sageways which receive respectively conductors 14 which are surrounded by insulating sleeves 14^a, and each cover also supports between the parts or halves thereof and between the insulators 14, a pair of bushings 15 through which are adapted to reciprocate in a vertical direction, a pair of plungers 16, which are preferably made of wood and which form part of the operating mechanism to be explained later.

The different tanks 12 may be adjusted or held in fixed positions relative to the frame and to one another, and the passageways in the different bushings may be brought in absolute vertical alinement by several tank adjusting and holding devices including set screws 17 which extend through vertical flanges 10^a of the frame, or through short angles 10^b extending transversely across the frame between the tanks. These set screws 17 engage the lower parts of the tanks on all four sides, and provide means whereby the tanks may be bodily shifted, or whereby the lower portion only may be shifted while the upper parts are held stationary. The upper ends of the tanks are mutually braced and spaced apart by means of transverse threaded bolts or rods 18 passing through the vertical flanges 12^e extending downward from the covers, said bolts being provided at their threaded ends with nuts which permit the upper ends of the tanks to be adjusted relative to one another. The tanks are also held down to the frame by pairs of the rods 19 which are attached by means of bolts or screws 20 to opposite sides of the cover 12^a of at least the middle tank 12, and are adjustably connected at their lower ends by means of nuts 19^a to lugs 21 on the sides of the frame. By means of these various holding and adjusting devices the tanks can be held in proper position relative to one another and to the frame so as to permit the different parts of the operating mechanism to work freely.

In order that there may be between the contact mechanism or other live parts of the switch and the tank, a better insulation than that which is obtained by the oil alone, I provide within each tank, and a short distance from the walls thereof, a casing or receptacle 26 which is made of insulating material such as wood and is provided with an open top, and between the bottom and sides of this receptacle and the bottom and sides of the tank, I provide a number of separated or spaced layers 27 of insulating material such as fuller board, insulating supporting members 28 being provided at intervals between these different layers, so as to hold them predetermined distances apart. Between the top of the inner casing 26 and the top of the tank is a separating collar 26^a of wood or other insulating material. This inner casing 26 and the

insulating walls or layers 27 are not oil tight, but the oil is permitted to enter between the different layers so that between the contacts and the metal walls of the tank there are alternate layers of oil and of solid insulating material. This arrangement provides a better insulation than the oil alone would provide, for the reason that when the oil is relied upon, the oil between a certain portion of the tank and a live part of the switch may be blown away or blown aside by the arc which will then remain established, causing immediate burning of the parts and destruction of the switch. Suitably supported by the bottom of the inner box or receptacle is a frame 29 of insulating material such as wood, and secured to this frame are three insulators 30, 31, and 32, which, as will be explained, support part of the contact mechanism. Between these insulators are arranged dividing partitions 33 and 34 preferably formed of separate spaced layers of insulating material, such as are provided along the bottom and sides of the tank.

The contact mechanism of each pole of the switch, which will now be explained, includes four yieldingly mounted main stationary contacts which are adapted to be bridged in a manner to be explained so as to provide a quadruple break or four point break switch, the movable contacts being carried by vertically movable plungers and being given an upward movement away from the stationary contacts, when the switch is opened, so as to draw the arcs upwardly. Secured to the upper ends of the insulators 30 and 32 in each tank are metal caps 35 to the upper surfaces of which are secured, preferably by screws 37 (see Figs. 5 and 6) two similar cast metal contact holders or supporting castings 38 formed of good conducting material, such as brass. Each of these holders 38 is provided with a horizontal base 39 which engages the corresponding cap 35 and which extends laterally beyond the corresponding insulator and is mechanically and electrically connected to one of the terminal rods 14, which, as stated before, extend down into the tank through the insulators 13, the lower ends of the terminal rods being screwed into threaded sockets in bosses 39^a of the holders. Each of these holders is provided also with an arm or bracket 40 which extends upwardly from the base and is provided with a vertical socket or guide 40^a (see Fig. 5) which receives one of the main contacts 41 having at its lower end a shoulder 41^a, which limits the upward movement of the contact and which is yieldingly supported and is pressed upwardly by means of a rather heavy coil spring 43 located between the shoulder 41^a of the contact and the base of the holder. This contact 41 is con-

5 nected to the base of the corresponding
holder by means of a flexible shunt or con-
ductor 44 which is secured to the base by
one of the screws 37 and to the lower end
of the contact by means of a screw 45 and a
washer 46, the latter being located inter-
mediate the head of the screw 45 and the
end of the shunt. The arm of bracket 40 of
the holder also supports a pivoted U-shaped
10 arm or member 47, which is pivoted to the
upper end of the bracket by means of a pin
48 passing through the bracket and through
the free ends of the U-shaped member 47,
and has at its forward end an auxiliary con-
15 tact or arcing tip 49. The forward end of
the pivoted member 47 and the contact 49
are yieldingly held upward so as to extend
above the end of the contact 41, as shown
clearly in the drawings, by means of a coil
20 spring 50, one end of which engages a trans-
verse pin 51 mounted in the bracket 40 a
short distance above the base and the other
end of which engages a pin 52 extending
transversely between the ends of the pivoted
25 member 47.

The insulator 31, which is located mid-
way between the insulators 30 and 32, has
secured to its upper end a cap 53 on the top
of which is secured a casting or holder 54
30 which has two sets of main and auxiliary
contact members such as are carried by each
of the holders 38, the two sets being located
near the opposite ends of the holder and be-
ing separated by a vertical barrier 55 which
35 extends downward from the top of the
wooden inner receptacle or casing 26 to the
base of the casting 54. As will be apparent
from Fig. 2 of the drawings, this contact
holder or casting 54 has two main contacts
40 56, similar in all respects to the contacts
41 and yieldingly supported as the latter
contacts are supported, and is provided also
with two pivoted or swinging arms 57,
which carry respectively auxiliary contacts
45 or arcing tips 58 which are, as in the first
instance, yieldingly held upward above the
contacts 56, by springs. Thus it will be seen
that each holder or contact supporting cast-
ing 38 and the corresponding main contact
50 41 constitute a single-break stationary con-
tact member, while the contact supporting
casting 54 and the two main contacts 56
carried thereby constitute a stationary
bridging contact member having two main
55 breaking points.

The movable contact members for each
pole are carried by the plungers 16 which,
as stated before, extend down through the
bushings 15 which are mounted in the cover
60 12^a intermediate the insulators 13. Clamped
to the lower ends of the plungers 16 are
two U-shaped bridging conductors 60 and
61 each of which is secured to the cor-
responding plunger by a clamp 62. These
65 conductors, which are formed of good con-

ducting material, have downwardly project-
ing free end portions, and are so arranged
that the free ends of one of the conductors
are vertically above the contact 41 of one
of the holders 38, and one of the contacts 70
56 of the middle holder, and the free ends
of the other conductor are vertically above
the contact 41 of the other contact holder
38 and the other contact 56 of the middle
holder. Secured to the lower ends of each 75
of these conductors, are main movable con-
tacts 63 and 64 which have threaded sock-
ets and are screwed onto threaded lower
ends of the conductors, as is shown clearly
in Fig. 4. The lower face of these contacts 80
are adapted to engage the upper faces of
the contacts 41 and 56 when the switch is
closed. The bridging conductors 60 and 61
are also provided with auxiliary or arcing
contacts 65 and 66 which are clamped be- 85
tween the upper ends of the main movable
contacts 63 and 64 and lock nuts 67 and 68,
the lower ends of the auxiliary contacts
65 and 66 extending downward below the
lower ends of the main contacts 63 and 64 90
and being so located and so shaped that
their lower ends will engage the upper ends
of the auxiliary contacts carried by the
stationary holders, when the switch is
closed. When the plungers 16 are lowered, 95
the auxiliary contacts 65 and 66 engage the
auxiliary contacts 49 and 58, pressing the
latter downward to the position shown in
Fig. 5, and the contacts 63 and 64 engage
the contacts 41 and 56 respectively with 100
sufficient force to press the latter contacts
downward a short distance against the ten-
sion of the springs 43, so that the latter
will cause the main contacts to be held to-
gether under a considerable degree of pres- 105
sure. The contacts 41 and 56 have, as
shown clearly in Figs. 5 and 6, a limited
play in the sockets 40^a which receive the
contacts so that the latter may adjust
themselves in the socket to accommodate any 110
unevenness or irregularity of the adjacent
engaging contact faces.

The upper ends of the two plungers 16
of each pole of the switch are connected
together by a cross-bar 69, which, together 115
with the plungers 16, constitute the yoke.
All the cross-bars are connected together
by a bar or beam 70 which extends hori-
zontally above all the tanks. Secured to
the upper beam 70 are two vertically mov- 120
able operating plungers or rods 71, which
extend downward between the tanks and
are supported and guided for vertical move-
ment by two frames 73, supported on the
frame 10 between the tanks, each frame being 125
somewhat triangular in shape and being
provided at the top with a boss or hub 74
and at the bottom with a boss or hub 75
having vertical bores or passageways
through which the corresponding plunger 130

or rod 71 is adapted to slide. The switch is adapted to be closed by an electro-magnetic motive device, preferably in the form of a solenoid, and is adapted to be opened with an exceedingly quick movement by means of weights and springs which act upon the plungers 71. For this purpose the plungers 71 are provided below the upper bosses 74 with collars 76, which are secured to the rods by transverse pins 77, and between the collars 76 and the lower bosses of the frames and surrounding the plungers 71 are rather heavy coil springs 78 which will be compressed when the plungers are drawn downward.

Secured to the lower side of the frame 10 and below the middle tank 16 are two cast metal plates 79 which form a supporting frame for part of the switch operating mechanism. These plates 79 are provided with bosses or bearings 80 in which is supported a shaft 81 which extends outwardly beyond the bearings of each of the plates 79 as shown clearly in Fig. 1. Secured or fixed to the outer ends of this shaft 81 are two levers 82, to the outwardly projecting ends of which are secured weights 83, and the forwardly or inwardly projecting ends of which are operatively connected to the collars 76 which are secured to the movable plungers 71. In this case the inner end of each lever 82 is connected to the corresponding collar 76 by a pair of links or straps 86.

Secured to the lower sides of the plates 79 is a casing 88 for a switch closing solenoid 89 and for a tripping solenoid 90. The closing solenoid includes a coil 91 and a core 92 which extends upwardly through the cover 93 of the casing, and this core is connected by a link 94 to one arm 95 of a bell-crank lever 96 which is secured to the shaft 81 between the two plates 79, so that when the core is drawn into the coil 91, the bell-crank 96, shaft 81 and weight carrying levers 82 will be rocked, swinging the inner ends of the levers 82 downward and the outer ends of the levers and the weights carried thereby upward. The links 86 and consequently the plungers 71 will therefore be drawn downward, compressing the coil springs 78 which surround the plungers 71, and closing the switch. In order that the switch may be held in the closed position, I have provided a toggle consisting of two arms 97 and 98, pivotally connected together by a pin or stud 99, and the former being connected by means of a pin or stud 100 to an arm 101 of the bell-crank lever 96 and the latter being pivotally supported on the two plates 79 by means of a transverse pin or shaft 102 extending between the plates. The inner end of arm 98 of the toggle extends beyond the connecting pin 99 and is provided with a notched or hooked portion 103.

Thus it will be seen that when the switch is closed by the solenoid 89, the movement of the bell-crank 96 will cause the arms 97 and 98 to be merely straightened and will cause the connecting pin 99 to be raised to a point just below a straight line between the pins or centers of movement 100 and 102. Any suitable stop device may be employed for limiting the movement of the toggle arms toward a straight line. To hold the toggle in this position, I have provided a holding and tripping device consisting of a latch 104 pivoted between the two plates 79 and having at its upper end a roller 105 which is adapted to be engaged by the notched portion 103 of the arm 98 of the toggle and having its lower end directly above a hammer 106 which projects above the cover 93 of the casing and is adapted to be struck and shifted upwardly by the core 107 of the tripping solenoid 90. The latch 104 is normally held in the position shown in Fig. 2 by means of a small coil spring 108, and when the switch is closed by the solenoid 89 and the arms of the toggle are brought nearly in a line, the notched or hooked portion 103 of the toggle arm 98 will be swung above the roller 105 at the end of the latch 104 and will be retained in that position. When the coil 109 of the tripping solenoid 90 is energized, the hammer 106 will be given a blow by the core 107, the latch will be rocked and the upper end will be swung inward out of engagement with the notched or hooked portion of the toggle arm 98, with the result that the switch will be immediately opened with an exceedingly quick movement by the force of gravity acting on the weights and by the action of the coil springs 78. The arm 98 of the toggle is provided with an extension 110 having a socket 111 in which is adapted to be inserted the end of a suitable bar or lever by means of which the switch may be closed by hand.

Suitable buffers are provided for cushioning the movement of the switch mechanism when the switch is opened, and this buffer mechanism is as follows: At the lower ends of the rods 71 are provided nuts 112 having conical or inwardly tapered surfaces, and arranged on diametrically opposite sides of each rod 71 are two hollow buffer blocks 113 having tapered inner ends adapted to be engaged by the tapered portion of the corresponding nut. These buffer blocks are supported on the lower sides of the triangular shaped frames 73 between pairs of downwardly extending lugs or ears 114 and upon cross pins 115 extending between the ears. The blocks have elongated slots 116 which extend in the direction of the lengths of the blocks, and through which the pins 115 loosely pass, so that the blocks may turn or rotate on the pins and also may move longitudinally. Secured on the interior of each

of the hollow blocks 113 by means of the cross pin 115 is a pin or plug 117 and intermediate the inner end of the block, which end is closed, and the end of the corresponding pin or plug 117 is a yieldable or elastic cushioning medium 118 preferably a block of rubber. The outer ends of the blocks are heavier than the inner ends and tend to hold the blocks in a horizontal position with the inner ends abutting against stop lugs 119 above the blocks. The inner ends of the blocks are therefore prevented by these stop lugs from rocking or turning upwardly beyond the horizontal position of the blocks but may swing downward. The result of this construction is that when the rods 71 are near the upward limit of their travel during the opening movement of the switch, the wedge-shaped nuts 112 on the lower ends of the plungers will engage the inner ends of the buffer blocks 113, causing the same to be spread apart or moved outwardly in a horizontal direction and causing the rubber blocks 118 to be compressed between the pins or plugs 117 and the closed ends of the buffer blocks. When the rods 71 are moved downward or when the switch is closed, the wedge-shaped nuts on the rods 71 will pass from between the buffer blocks, the latter swinging downward as shown in Fig. 8, to permit the rods and wedge-shaped nuts to readily move downward.

Secured to the side of the frame just above the operating mechanism of the switch and in position to be shifted thereby is a small auxiliary snap-switch 120, which, as will be explained more fully later, controls the indicating lamps, breaks the circuit of the coil of the closing solenoid 89 as soon as the main switch is closed and the operating mechanism is latched, and renders possible the closing of the circuit of the solenoid 89 after the main switch has been opened. The tact mechanism of the switch is inclosed within a cylindrical casing 121 and includes two pairs of stationary contacts and a movable bridging contact, to be referred to presently, the bridging contact being mounted upon a plunger 122 which is adapted to be shifted upward or downward with a quick movement by any suitable device but as here shown by means of a forked member 123 which is pivoted to a bracket 124 which supports the snap-switch, said forked member being adapted to be swung in one direction or the other by an arm 125 which is secured to or forms an extension of the outer end of the toggle arm 98. A spring 126 is secured at one end of the bracket 124 and at its opposite end to the forked member 123 in a manner such that when the forked member is shifted by the arm 125 until the line between the ends of the spring passes above or below the pivotal center of the forked member, the spring will cause the

forked member to be shifted quickly in one direction or the other, causing the plunger of the snap-switch to make or break the circuit of such switch with quick movements.

The controlling mechanism including the different controlling circuits and switches and the indicating mechanism will now be explained, reference being had particularly to the diagrammatic arrangement shown in Fig. 9. In this figure the main high tension conductors are designated 127, 128 and 129, these conductors forming the circuit which is provided with the switch, the structure of which has been previously described and which is shown conventionally at 130. In this figure are also shown one of the levers 82, the weight 83 mounted upon the lever, the closing solenoid 89, the tripping solenoid 90, the holding and tripping latch 104, and the snap switch 120, all of which parts have been previously described. The parts are not shown, however, in this figure in their true proportions or relations, this being true particularly of switch 120 which in Fig. 9 is shown in simplified form and transposed from its real position with respect to lever 82. At 131 and 132 are shown the positive and negative mains or bus bars of the low tension direct current operating circuit which supplies current to the indicating lamps and to the coils of the different operating switches. Means are provided for energizing the tripping coil or for closing the circuit through the latter either automatically on the occurrences of predetermined conditions in the main conductors 127, 128 and 129, or by the operation of a hand switch. The circuit is completed through the tripping solenoid 90 automatically by means of overload relays 133, 134, and 135, each relay comprising a solenoid coil 136 included in one of the main conductors, a pair of stationary contacts 137 and 138, a bridging contact 139, and a core 140 which carries the bridging contact. The contacts 137 of the relays are connected directly to conductor 131 of the low voltage operating circuit by means of a conductor 141, and the contacts 138 are connected to one terminal of the coil of the tripping solenoid 90 by a conductor 142, and the other terminal of the solenoid coil is connected by conductor 143 to conductor 132 of the operating circuit. In order that the switch may be opened or closed by hand, I have provided a double throw switch 144 which will be preferably mounted on a switch board, which may be located at any convenient place in the building or station. This switch, 144, includes a hand lever 145 and two pairs of contacts designated 146, 147, 148, and 149. The contact 146 is connected by conductor 150 to main 131 of the operating circuit, and contact 147 is connected by conductor 151 to conductor 142, which, as

before stated is connected to one terminal of the coil of the tripping solenoid 90. Therefore the main switch may be opened by the occurrence of an overload in any one or all of the main conductors causing the operation of at least one of the relays or by throwing the lever of switch 144 to the left so as to bridge contacts 146 and 147.

The snap switch 120 which is mounted on the frame near the operating mechanism and is operated by the latter when the main switch is open or closed, is provided with a bridging contact 152, and with two sets of stationary contacts which are designated 153, 154, 155 and 156. When the main switch is in closed position, the bridging contact of this snap switch 120 bridges the stationary contacts 153 and 154 and when the main switch is thrown to the open position, the bridging contact of the snap switch will be shifted and will engage the contacts 155 and 156.

In order that the operator may know positively whether the main switch 130 is open or closed, I provide two lamps 157 and 160, the former of which is adapted to glow only when the switch is closed and the latter is adapted to glow only when the switch is open. These lamps may have different indicating colors, and if desired, suitable designating characters may be provided on the switch board adjacent the lamps, such as "C" for "closed" and "O" for "opened." The two contacts 153 and 155 are both connected by conductor 161 to main 131 of the operating circuit and contact 154 is connected by conductor 162 to one terminal of the lamp 157 and the other terminal of the lamp is connected by conductor 163 to conductor 132 of the operating circuit. Thus it will be seen that when the main switch 130 is closed and the snap switch is in the position shown in Fig. 9, lamp 157 will glow. Contact 156 of snap switch 120 is connected by conductor 164 to one terminal of lamp 160, the other terminal of which is connected by conductor 163 to conductor 132 of the operating circuit. Therefore when the main switch is opened, and snap switch 120 is shifted from the position shown in Fig. 9, so that the contacts 155 and 156 will be bridged, lamp 157 will be immediately darkened while lamp 160 will glow. Conductor 164, which, as stated above, is connected to conductor 156 of the snap switch, is connected also by conductor 165 to contact 148 of the double-throw hand switch 144 and contact 149 of this hand switch is connected by conductor 166 to the coil 167 of an electromagnetically operated switch 168, having, as here shown, a stationary contact 169 and a pivoted switch lever 170. The other terminal of coil 167 of the switch 168 is connected by conductor 171 to conductor 132 of the operating circuit. The lever

170 of the switch 168 is biased to open position and is connected by conductor 172 to the conductor 131 of the operating circuit, and contact 169 of this switch is connected by conductor 173 to one terminal of the coil of the main closing solenoid 89, the other terminal of which is connected by conductor 174 to conductor 132 of the operating circuit. The purpose and operation of the devices just described will now be explained.

When the main switch 130 is open, the bridging member of the snap switch 120 will be bridging contacts 155 and 156. It may be here stated that the shifting of the bridging member of this snap switch not only causes lamp 160 to glow to indicate that the main switch is open, but renders possible the closing of the circuit through the closing solenoid, by the manipulation of the hand switch 144. When the main switch 130 is closed, the closing of the circuit through the coil of the solenoid 89 is prevented for the reason that even if the hand switch 144 were shifted so that its lever would bridge contacts 148 and 149, the circuit could not be completed through the coil of the switch 168 on account of the position of the snap switch. When, however, main switch 130 is open, and the contacts 155 and 156 are bridged by the bridging member of the snap switch, the circuit can be completed through the coil 167 of the switch 168 by simply throwing the lever of the hand switch 144 to the right so that contacts 148 and 149 are bridged, and when this is done, the switch 168 will be closed, completing the circuit through the coil of closing solenoid 89 and causing the main switch 130 to be thereby closed. As soon as the main switch is closed, the circuit of the closing solenoid will be immediately broken for the reason that by the closing of the main switch, the snap switch 120 is thrown, causing the circuit of coil 167 of the switch 168 to be broken. The advantages of this feature are that very little energy will be consumed in closing the switch 130; it will be impossible for any person to complete the circuit through coil 89 after the switch is closed and thereby cause a waste of energy, and it will be impossible for the main switch 130 to be held closed or to be retained in its closed position, in case the operator closes the main switch 130, when the overload still exists upon the line; for, no matter if he does continue to hold lever of the switch 144 so that the said lever bridges contacts 148 and 149, the circuits through the coil 167 and the coil of solenoid 89 cannot be maintained closed for the reason stated above. The switch 168 preferably will be located at the rear of the switch board and the contacts immersed in oil if necessary. Very little power will be required to operate the switch 168 or to energize the sole-

noid 90, but considerable power will be required to energize the solenoid 89 to an extent sufficient to cause said solenoid to close the main switch 130. By the arrangement of the switches above described, the main switch may be controlled by means of the hand lever 144, without any perceptible arcing taking place at the switch board, for the reason that, only the circuits through the coil of the tripping solenoid 90 and through the coil of automatic switch 168 are controlled directly by hand switch 144, while the circuit of the closing solenoid 89 through which considerable power must be supplied, is broken at the rear of the switch board or at a distance from the front of the switch board by automatic switch 168.

It will be seen that on account of the construction of the switch itself, the particular arrangement of the cooperating contact members and the manner of insulating the same, the quick movements with which the contacts are separated, and the particular construction and arrangement of the operating mechanism, there is provided a switch in which dangerous and destructive arcing at the contacts is reduced to a minimum. It is to be noted also that access can be readily had to all parts of the switch mechanism even though part of the mechanism is supported on the lower part of the tank. The movable switch mechanism can be removed as a unit from each tank after the beam 70 and the cover are removed, and in case it is necessary to inspect or repair the stationary switch mechanism, the supporting frame 29 and all the apparatus carried thereby, including the switch supporting insulators and the contact mechanism supported by the insulators, can be simultaneously lifted from the tank by grasping the terminal rods and drawing the same and all the parts connected thereto, upward out of the tank, the insulating barriers 33 and 34, being of course, first removed from the tank.

I do not desire to be confined to the exact details, but aim in my claims to cover all modifications which do not involve a departure from the spirit and scope of my invention.

What I claim as new is:

1. In combination, a main switch having a closing magnet and a tripping magnet, an

indicating and operating system therefor comprising suitable supply mains, an electrically operated switch having an operating coil, and when closed serving to connect the coil of the closing magnet to the supply mains, a double-throw switch operated by the closing and opening movements of the main switch, a double-throw hand switch, a pair of indicating lamps, and means whereby when the main switch is closed said automatic switch connects one of said lamps to the supply mains, and when said main switch is open said automatic switch connects the other lamp to the supply mains and at the same time permits the coil of the electrically operated switch to be connected to the supply circuit when the hand switch is thrown to one position so that said electrically operated switch will be closed and said closing magnet will be energized and will close said main switch, and means whereby when said hand switch is thrown to another position the tripping magnet will be energized and the main switch will be opened.

2. In combination, a main switch having a closing magnet, an indicating and operating system therefor comprising a suitable supply circuit, an electromagnetically operated switch for closing an operating circuit for said closing magnet, a switch automatically actuated to operative positions by the closing and opening movements of the main switch, a pair of signals for indicating the position of the main switch, said automatic switch being effective when the main switch is closed to render one of said signals active, and being effective when said main switch is open to render the other of said signals active and at the same time to cause the closing of a gap in the operating circuit of said electromagnetically operated switch, the activity of said latter signal being independent of the condition of said latter operating circuit.

Milwaukee, Wis., March 23, 1909.

In testimony whereof I affix my signature, in the presence of two witnesses.

HERBERT W. CHENEY.

Witnesses:

H. C. CASE,
CHAS. L. BYRON.