H. L. SMITH.

OIL SWITCH.

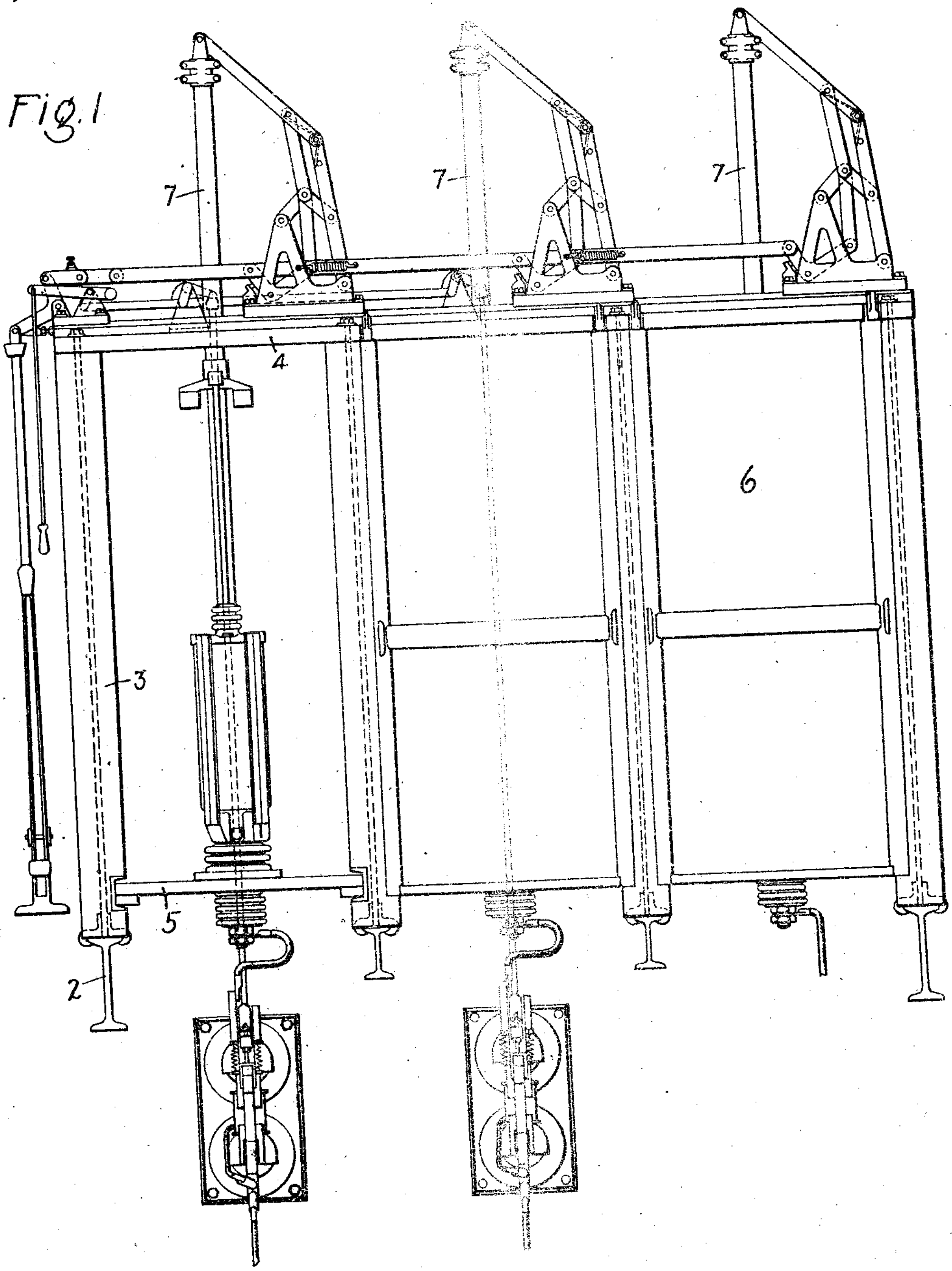
APPLICATION FILED DEC. 10, 1906.

1,031,479.

Patented July 2, 1912.

4 SHEETS—SHEET 1.

Fig. 1



Witnesses:

Lloyd C. Bush

J. Ellis Glen

Inventor:

Henry L. Smith,

By Albert G. Davis

Att'y

H. L. SMITH.
OIL SWITCH.
APPLICATION FILED DEC. 10, 1906.

1,031,479.

Patented July 2, 1912.
4 SHEETS—SHEET 2.

Fig. 2

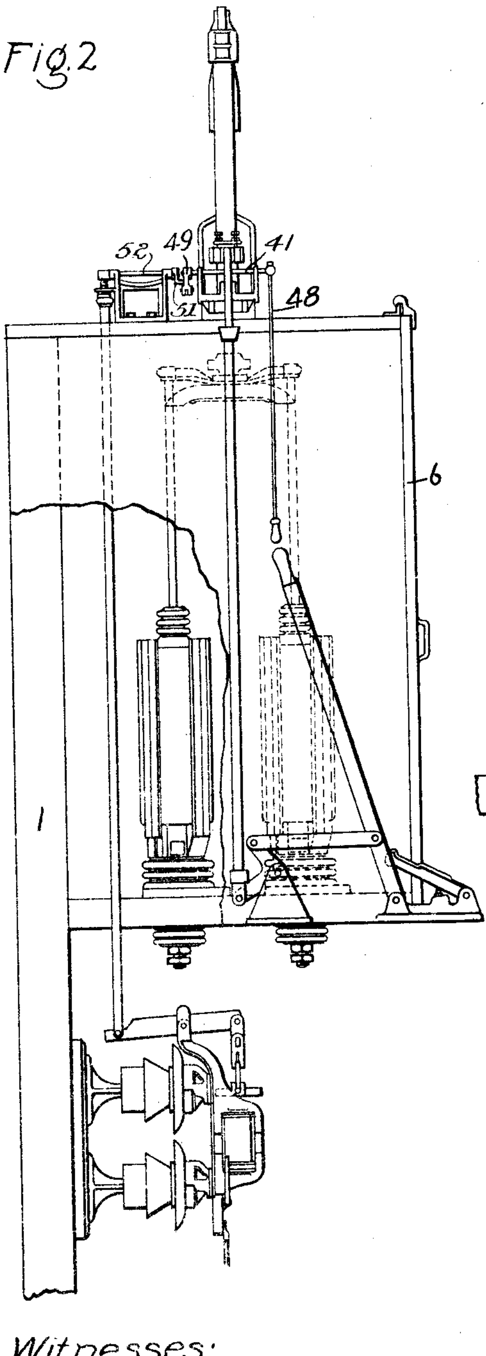
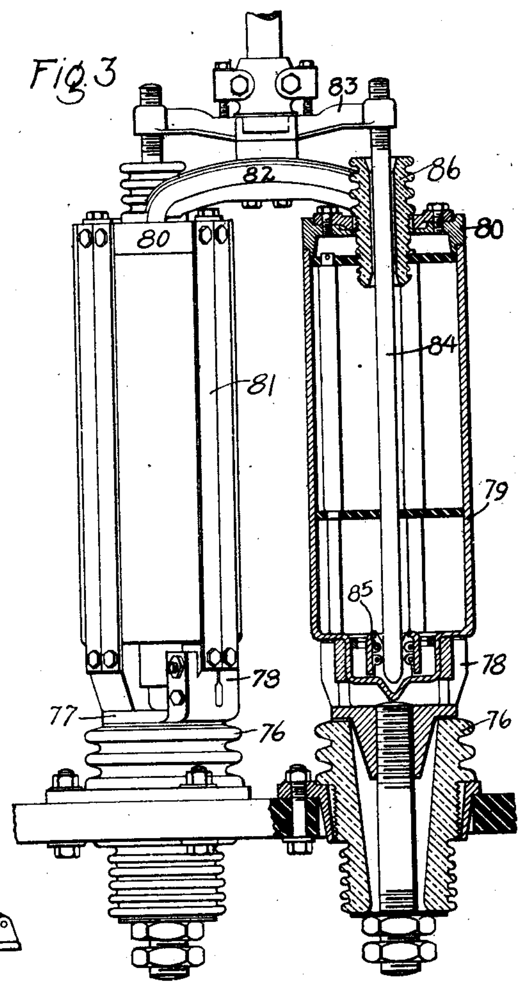


Fig. 3



Witnesses:
Lloyd C. Bush
J. Ellis Glen

Inventor:
Henry L. Smith,
By Albert G. Davis
Atty.

H. SMITH.

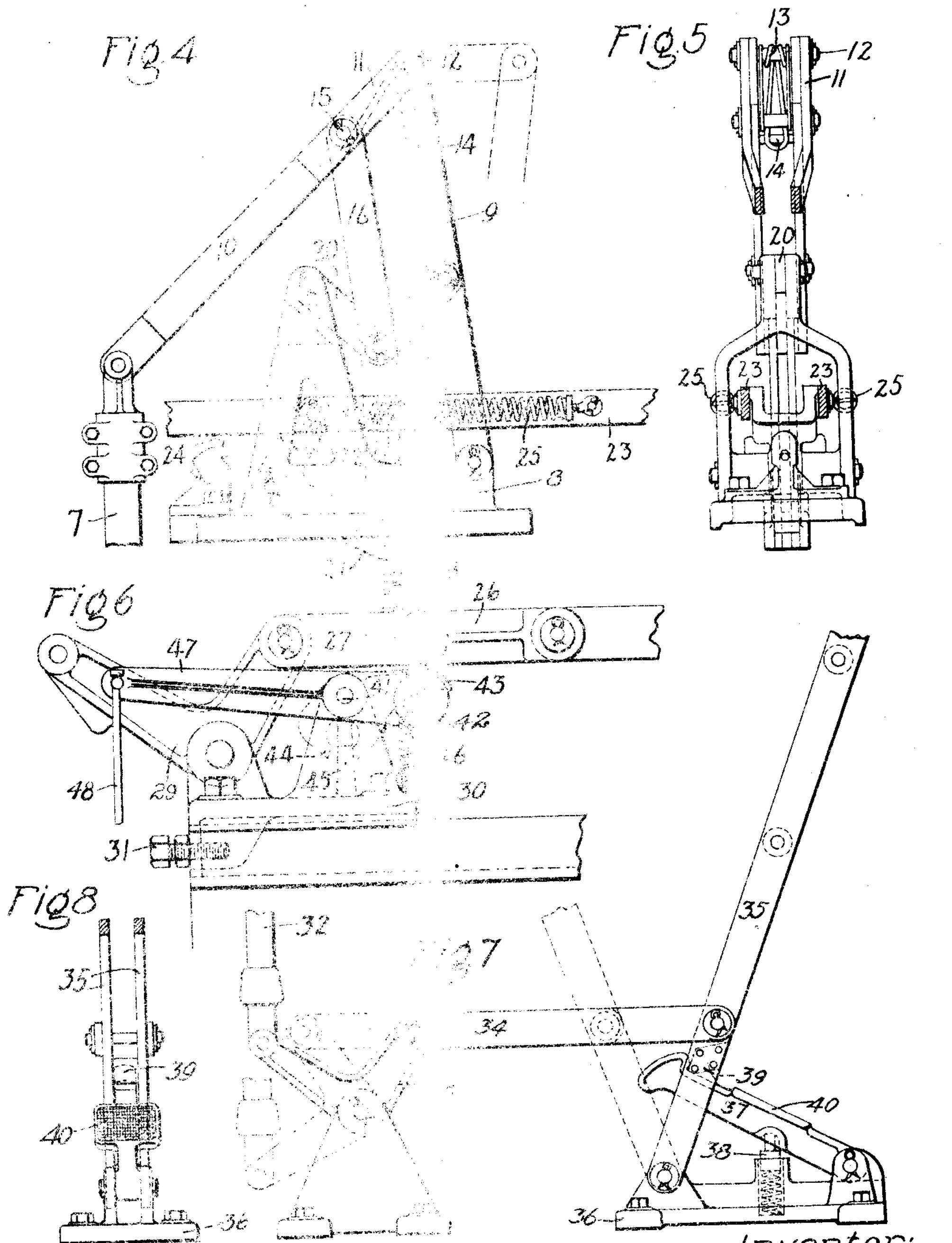
WITCH.

APPLICATI... FILED DEC. 10, 1906.

1,031,479.

Patented July 2, 1912

4 SHEETS—SHEET 3.



Witnesses:
Lloyd C Bush
J. Ellis El

Inventor:
Henry L. Smith,
By Allen A. Davis
Atty.

H. L. SMITH.
OIL SWITCH.
APPLICATION FILED DEC. 10, 1906.

1,031,479.

Patented July 2, 1912.
4 SHEETS—SHEET 4.

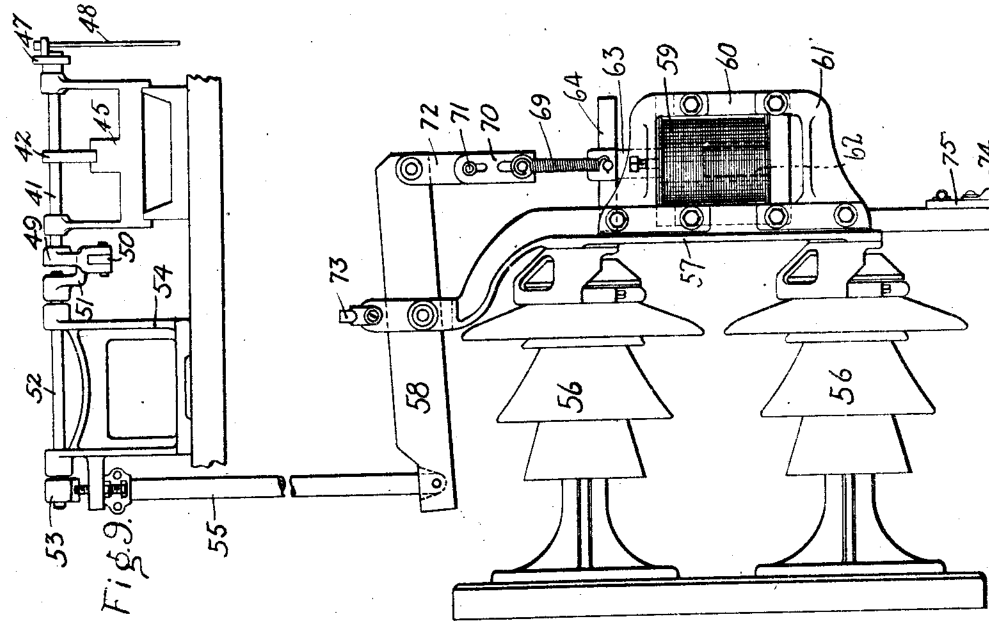


Fig. 9.

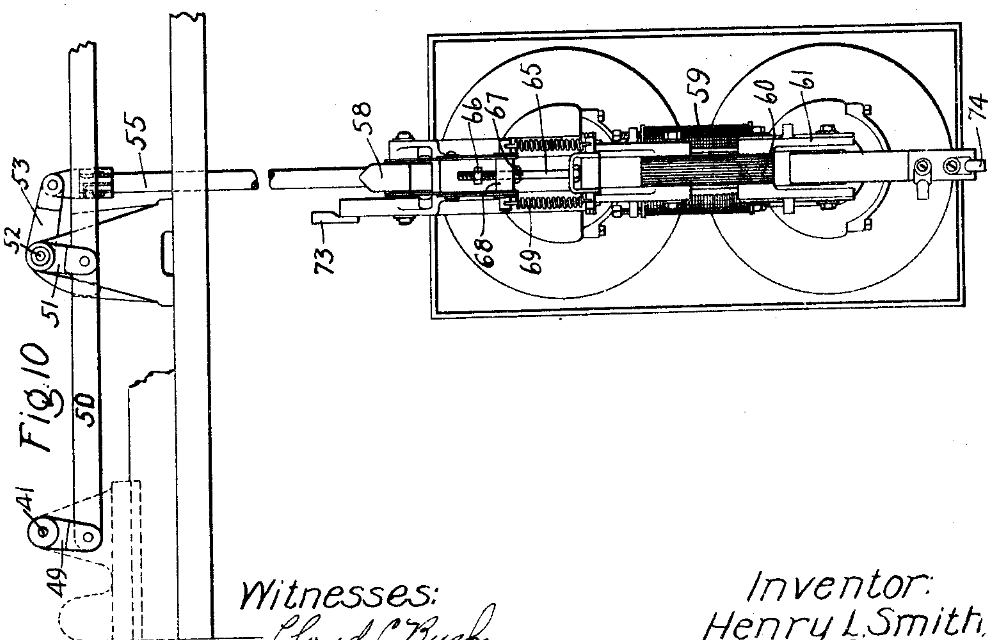


Fig. 10

Witnesses:
Lloyd C. Bush
J. Ellis Glen

Inventor:
Henry L. Smith,
By Albert G. Davis
Att'y.

UNITED STATES PATENT OFFICE.

HENRY LAWRENCE SMITH, OF PITTSFIELD, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

OIL-SWITCH.

1,031,479. Specification of Letters Patent. **Patented July 2, 1912.**

Application filed December 10, 1906. Serial No. 347,022.

To all whom it may concern:

Be it known that I, HENRY L. SMITH, a citizen of the United States, residing at Pittsfield, in the county of Berkshire and State of Massachusetts, have invented certain new and useful Improvements in Oil-Switches, of which the following is a specification.

My invention relates to oil-switches, and more particularly to oil-switches for controlling circuits of high voltage. Conditions often arise in connection with high-tension transmission systems which render it desirable to install oil-switches at various points on the system, so that if desired any branch of the system may be cut out without interfering with the remainder. For such service it is desirable that the switches open automatically, in case an abnormal current is flowing in the circuit, so that the circuit may always be protected, and that the switches be so arranged that they can be easily operated when desired, but to install the well-known power operated switches, at such points would add considerably to the cost of such systems, and would require the installation of some means to furnish power to operate the switches. Switches controlling the branches of a transmission system are opened and closed comparatively seldom, usually when there is some derangement of the system, or when work is being done on the branch or section controlled by the switch. It is therefore desirable to provide an oil-switch opening automatically upon the occurrence of an abnormal current in the circuit, and which may be easily and conveniently operated by hand, so that the men who are repairing or working upon a section controlled by the switch may operate it without difficulty when desired. When the switch is used to control circuits of high tension it is desirable to operate the trip-coil for opening the switch upon the occurrence of an abnormal current directly from the high tension circuit, thereby saving the cost of the transformer required when the ordinary trip-coil is operated from the high tension circuits, since the cost of transformers increases very rapidly as the voltage is increased.

The object of my invention is to provide an oil-switch capable of controlling circuits of high voltage, but which, by slight changes, may be adapted for circuits of great amperage; which is easily operated by hand if desired, though well adapted for power actuation if power be available; which will open automatically in case abnormal currents are flowing through the circuit, or may be tripped open by hand when desired; which cannot be held closed in case of conditions upon the circuit which cause abnormal currents to flow, and which will be simple and strong in construction and require a minimum of floor-space.

My invention, therefore, consists of an oil-switch having operating mechanism so arranged that the switch requires a minimum of floor-space and may be easily closed or opened by hand, though any suitable power-actuating means may be used if desired; which opens automatically and cannot be held closed in case an abnormal current is flowing; which has an improved form of oil-pot especially adapted to control heavy currents, and which has a tripping mechanism operated from a trip coil included in the main circuit, thereby dispensing with the use of transformers when the switch is used to control high tension circuits.

My invention also consists of a trip-coil which may be directly included in a main circuit carrying high tension alternating current, without unduly increasing the impedance of the circuit, and in other details and improvements hereinafter described in the specification, and pointed out in the claims.

My invention will best be understood by reference to the accompanying drawings, in which—

Figure 1 is a view of a switch for a three-phase circuit shown in elevation, the door of one of the cells being removed to show the oil-pots; Fig. 2 an end view of the switch, part of the walls being broken away; Fig. 3, a view of a pair of oil pots, one of which is shown in section; Fig. 4 a view of the parallel-motion actuating mechanism for moving the contacts; Fig. 5 an end view of the mechanism shown in Fig. 4; Fig. 6 a view of the trip mechanism; Fig. 7 a side elevation of the hand-operating mechanism; Fig. 8 an end view of the operating handle; Fig. 9 an elevation of the series trip coil and its connections; and Fig. 10 an end view of the series trip-coil.

My invention is shown as embodied in a

switch for controlling a three-phase circuit. The switch is mounted upon a supporting wall 1, which also forms the back walls of the cells in which the oil pots are placed. Beams 2 extend at right angles to the supporting wall and support fire-proof walls 3, usually made of fire-brick or similar material, and forming the walls of the cells for the oil pots, while caps 4, of insulating and fire-proof material form the tops of the cells. The caps 4 are held in position and the fire-proof walls 3 are strengthened by bolts passing through the walls and engaging the beams 2. Each cell has a bottom 5 of insulation, and a removable door 6 preferably made of metal or other fire-resisting material; hence, the oil pots for each phase of the circuit are completely inclosed in a fire-proof insulating cell or chamber rendering it impossible for an arc to strike from one phase to another.

Contact-rods 7, preferably of wood or other similar insulating material, extend through the caps 4 for operating the movable contacts of the switch, and are moved by an actuating mechanism for each phase, the mechanism being mounted upon the cap of the cell in which the contacts controlling that phase are placed. The actuating mechanism has a base 8 to which one end of a rocking-arm 9, composed of two parallel links, see Fig. 4, is pivoted, the other end of said arm being pivoted to an actuating arm 10, one end of which is connected to a contact rod 7, and the other end of which is provided with forks 11 engaging the rocking-arms 9. A pivot 12 connecting the rocking-arm and the actuating-arm is surrounded by a spiral spring 13, one end of which engages a pin 14 carried by the rocking-arm, and the other end of which engages a pivot 15 passing through the forks 11 of the actuating arm. This spring is so arranged that when the switch is closed the spring is under strain and tends to move the actuating arm 10 in a direction to open the switch. Links 16 are connected at one end to the pivot 15 and at the other end to links 17 by means of a pin 18. A link 19 is connected to the pin 18 and to the rocking-arm 9, while a link 20 is connected to the pin 18 and to a fixed point on the base 8. The parts are proportioned to form a parallel-motion mechanism which will cause the contact rod 7 to move up and down in a right line, and the actuating-arms are placed lengthwise of the switch structure, to reduce the width of the switch to a minimum, thereby saving floor space. A bell-crank lever having arms 21 and 22 is pivoted to the base 8, the arm 21 being pivoted to one end of the link 17, the arm 22 being connected to operating rods 23, and also engaging an adjustable stop 24 when the switch is open. Extension springs 25 are connected at one end to the base 8 and at the other end to the operating rods 23. A toggle having links 26 and 27, the link 26 carrying an adjustable stop 28, controlling the extent to which the toggle may be over-set, connects the operating rods 23 with a bell-crank 29 pivoted to a base 30 mounted at one end of the switch; the base carries an adjustable stop 31, with which one arm of the bell-crank 29 engages when the switch is open, this arm being connected by means of the rod 32, the bell-crank 33 and rod 34 with a hand-lever 35 pivoted to a base plate 36 secured to the floor of the station, or in some other position which will make the operation of the hand-lever 35 convenient. A latch 37 pivoted to the base-plate 36 is engaged by a spring-pressed plunger 38, which normally holds the latch in engagement with a lug 39 on the hand lever 35, thereby holding the hand lever in the position shown in Fig. 7, which is the position assumed when the switch is closed. A foot-plate 40 is provided on the latch 37 by means of which the latch may be depressed out of engagement with the lug 39, thereby releasing the hand lever 35 and permitting the switch to open. Any other form of hand-operating mechanism may be used, and any suitable source of power may be used instead of hand-operation. In many cases where heavy currents are to be handled and power for operating the switches is available, a switch constructed according to my invention and provided with some power-actuating means would be desirable on account of saving of floor-space and other advantageous features.

A rock-shaft 41 suitably mounted in the base 30 on the end of the switch, carries rigidly secured thereto, a trip-arm 42 and having a trip surface 43 engaging the toggle 26—27, and stop-shoulders 44 coöperating with a stop-lug 45 to limit the extent of movement of the trip-arm. A spring 46 tends to hold the trip-arm in the position which permits the toggle 26—27 to remain over-set, as shown in Fig. 6, in which position the toggle forms a rigid connection between the bell-crank 29 and the operating rods 23. A trip-lever 47 secured to one end of the rock-shaft 41 carries a trip-rod 48 extending to a position where it may easily be reached by the operator, so that, if desired, the trip arm 42 may be moved by hand to break the toggle 26—27 and permit the switch to open. As shown in Fig. 10, a crank 49, secured to the other end of the rock-shaft 41, is connected by means of connecting-rods 50 to cranks 51, each of which is mounted upon one end of a rock-shaft 52, to the other end of which a crank 53 is secured. The shafts 52 are mounted in frames 54 secured to the caps 4 of the switch. The cranks 53 are connected by means of connecting-rods 55 to two automatic trip-coils each in a different phase of the circuit. When the switch is closed the parts are in the position shown in Figs. 4 and 6, the springs 13 and 25 tending to open the switch; but resisted by the over-set toggle 26—27 connected to the bell-crank 29, which in turn is held in position through the connections to the hand-lever 35. When abnormal current flows through the circuit, the connecting rod 55, Fig. 9, is moved upward, thereby moving the connecting rod 50 by means of the cranks 53 and 51 and bringing the tripping surface 43 against the toggle 26, 27, buckling it and causing it to collapse and thereby permitting the operating rods 23 to move toward the left under the influence of the springs 25 and 13, and open the switch.

When a high tension circuit is to be controlled, the series coil for the tripping mechanism is connected directly in the high tension circuit, thereby avoiding the expense incurred by the use of a current transformer. The trip-coil is mounted upon insulators 56, carried by the supporting-wall 1 and carrying a base-plate 57, to the upper end of which is pivoted a lever 58, preferably of wood or similar material with the upper edge beveled as shown in Fig. 10 so as to prevent the accumulation of dust and dirt. The trip-coil 59 is mounted in an iron yoke 60, preferably laminated, the yoke being carried by brackets 61 secured to the base-plate 57 and preferably made of brass or other non-magnetic material. A fixed core 62 secured to the yoke 60 projects into the opening of the coil a short distance at one end, and a movable core 63 in alinement with the other end of the opening of the solenoid is carried by an armature 64. The armature carries a rod 65 having adjustable stops 66 and 67 mounted thereon, one on each side of a cross-bar 68, through which the rod 65 passes, the opening through the cross-bar being considerably larger than the diameter of the rod 65. The cross-bar 68 is provided with extensions to which springs 69 are connected; these springs also being connected to corresponding extensions on the armature 64. The extensions on the cross bar 68 pass through openings in side-plates 70 secured by means of adjusting screws 71 to links 72, which in turn are connected to one end of the lever 58, the other end of said lever being connected to the rod 55. The end of the rod 55 is rounded and fits in a correspondingly shaped depression in the lever 58, being held in position by a pin which passes through the rod. The strain of operation is received by the end of the rod, the pin being normally under no strain at all. The adjusting screws 71 pass through slots in the side-plates 70, and by means of these screws the position of the plates with reference to the links 72 may be altered, thereby altering the position of the cross-bar 68 with reference to the links 72, and hence altering the position of the core 63 and the armature 64 with reference to the trip-coil 59. By altering the position of the adjustable stop 67 upon the rod 65 the distance between the cross-bar 68 and the armature 64, and hence the tension of the springs 69, may be altered. When the armature 64 moves toward the coil 59, the springs are extended until the stop 66 comes into engagement with the cross-bar 68, and the distance which the armature may move before this engagement takes place may be adjusted by altering the position of the adjustable stop 66 upon the rod 65. A cable connection 73 for one of the leads of the main circuit is secured to the upper end of the base-plate 57, and the middle of the base-plate is secured to one end of the winding of the trip-coil 59, the other end of the winding being carried to a cable connection 74 mounted upon a fiber-plate 75. As a result of this arrangement all the metal parts of the frame carrying the trip-coil are at the same tension as the cable connections 73, but are insulated from the remainder of the trip mechanism by the wooden or other insulating lever 58, and insulating rod 55, and the only difference of potential between the various metal parts of the tripping mechanism is that due to the drop in voltage from one terminal of the coil to the other. The insulation of the coil is, therefore, not subjected to severe strains when used on circuits of high voltage.

When the parts of the tripping device are in the normal position, as shown in Fig. 9, there is a large air-gap in the magnetic circuit formed by the laminated yoke, the fixed core, the armature and the movable core, and very little iron within the windings of the solenoid, and therefore, the tripping coil offers very little impedance to the flow of alternating-current. As a result of this construction, however, the pull of the solenoid upon the movable core is very slight when the core is in normal position, and would not be sufficient to trip the switch, except in case of very heavy currents. Provision is therefore made for permitting the core to approach and enter the solenoid coil before the power for tripping the switch is required to be furnished. This is accomplished by the construction shown in Figs. 9 and 10, in which, when the solenoid is energized by abnormal current, the springs are extended until the core enters the solenoid to such a position that the pull exerted by the solenoid is sufficient to trip the switch. When the core reaches this position the stop 66 engages the cross-bar 68, forming a rigid connection with the tripping means, and as at this time the force exerted by the solenoid is sufficient to move the core against the resistance of the tripping means, the switch is tripped and the main circuit is opened.

When the switch is used to control circuits in which currents of great volume are flowing it is desirable to use a different form of oil pot from that used where the current is of high tension and small volume, and the improved oil-pot which I have invented for such service may be advantageously used on any type of oil switch controlling current of great volume. It has been found that when a circuit is opened under a body of oil, contained in a substantially closed vessel, the arc formed when the contacts separate is quickly extinguished, but when the current is of great volume, the pressure developed in the substantially closed oil vessel is very great, and it is necessary and desirable that the oil vessel should be of great tensile strength so that it will not be destroyed by the pressure generated therein in case the switch is required to open a short circuit. I therefore, use an oil pot made of some material having requisite tensile strength, such as steel. In the type of switch to which the improved form of oil vessel is particularly adapted, very little of the current flows through the contacts within the oil vessel when the switch is closed, practically all the current flowing through the walls of the oil vessel to a heavy laminated contact in engagement therewith, but as the steel oil pot is not well adapted for carrying currents of great volume, particularly alternating currents, I arrange heavy connectors of good conducting material in parallel with the oil vessel, so that losses incident to flow of current through the steel oil pot are avoided.

Figs. 2 and 3 show means for controlling one leg of a 3-phase circuit, the current flowing through one oil-vessel, through bridging contacts, and thence through the other oil vessel. In the bottom of the switch cell insulators 76 are mounted, each of which carries a clamp 77 made of copper or a similar good conducting material, and through which connection to a lead of the circuit is made. Each clamp is provided with shoulders or lugs 78 as shown in Fig. 3. An oil pot 79 of great tensile strength and preferably made of seamless drawn steel or similar material, and having the bottom so formed as to be engaged by the clamp 77, contains the oil, and is substantially closed by a cap 80 firmly secured in the end of the pot 79 with part of its upper surface forming a fixed contact. Heavy bars 81, of copper or similar good conducting material, of such cross-section that a very heavy current may flow through them without causing undue heating, connect the lugs 78 with the cap 80, and current flowing from the clamp 77 to the cap 80 will flow through the bars 81 as well as through the walls of the pot. The caps 80 on the oil pots are engaged by laminated main bridging contacts 82 on the contact rod 7, while a shunt bridging contact 83 carried on the same rod is provided with contact rods 84, extending into the oil pots 79 and engaging with fixed shunt contacts 85 secured to the bottom of the oil pots. The contact rods 84 pass through the insulators 86, firmly secured in the caps 80. When the switch is closed and the parts are in the position shown in Fig. 3, the current flows from the line to one clamp 77, thence through bars 81 to one cap 80, thence through the bridging contacts 82 to the other cap 80 through bars 81 to the other clamp 77 and thence back to the line. When the circuit is opened the bridging contacts 82 break engagement with the caps 80 before the shunt contacts 84 separate from the shunt contacts 85, the arcing, therefore, taking place under the oil in the oil pots 79. In case of very heavy load or severe short circuit the pressure developed by the arc formed when the contacts 84 leave the contacts 85 is very great, but in the construction shown it is successfully resisted by the drawn steel pot 79 with the caps 80 threaded into the ends thereof, the bars 81 assisting, to a certain extent, the screw threads in retaining the caps 80 in the ends of the oil pots 79.

It is apparent that the improved form of oil pot may be used on any switch required to control currents of great volume, whether operated by power or hand. Where a switch constructed in accordance with my invention is used to control currents of very great volume and is provided with the improved form of oil pot above described, it may be desirable to operate the rod 32 by means of some power mechanism, such as an electric motor or a fluid pressure motor, in order to close the switch quickly and bring the requisite pressure upon the bridging contacts 82. Such modification I consider to be within the scope and spirit of my invention.

The operation of the switch is as follows: When the switch is open the parts are in the position shown in Fig. 1. If it be desired to close the switch the hand lever 35 is moved in a clockwise direction, thereby moving the operating rods 23 to the right and through the parallel-motion mechanisms moving the contact rods 7 downward to bring the contacts into engagement, thereby closing the circuit. The movement of the operating rods 23 to the right extends the springs 25, and a downward movement of the actuating arms 10 puts the spiral springs 13 under strain which tends, when the switch is closed, to move it to the open position. This tendency is resisted by the over-set toggle 26—27, the bell-crank lever 29, and through the connections to the operating handle 35 by the latch 37. If an abnormal current should flow upon the circuit while the switch is closed, the trip coil 59 will be energized sufficiently to attract the armature 64 and core 63. The parts are so proportioned that under normal conditions the springs 69 hold the armature 64 and the core 63 in the position shown in Fig. 9. With the core outside the coil and with a maximum gap in the magnetic circuit of the series coil, the impedance is very slight. When the current in the series coil, however, reaches the value for which the device is set, the armature 64 and core 63 are attracted with sufficient force to overcome the springs 69. The only resistance to be overcome at this stage of the movement is that due to the springs 69, since the armature is not in rigid connection with the tripping mechanism until the adjustable stop 66 engages the cross-bar 68. As the core 63 enters the solenoid and the armature 64 approaches the yoke 60, the pull of the solenoid rapidly increases and the armature and core move rapidly. Eventually the adjustable stop 66 engages the cross-bar 68, thereby forming a rigid connection between the armature and core of the trip-coil and the tripping mechanism of the switch. The parts are so proportioned that when the armature and core reach this position the pull of the coil, due to the abnormal current flowing, is sufficient to furnish power enough to operate the trip mechanism. The armature and core therefore, continue to move until the magnetic circuit of the solenoid is practically completed, and this movement is transmitted through the tripping connections to the trip-arm 42, causing the tripping surface 43 to come into contact with the toggle 26—27 and breaking the toggle. When the toggle 26—27 is broken, the force exerted by the springs 25 and 13 is sufficient to separate the contacts of the switch, and the parts of the switch assume the position shown in Figs. 1 and 2, in which position the circuit is open. As soon as the circuit is opened the trip-coil is deënergized and the parts of the tripping mechanism again assume their normal position. If the operator should desire to open the switch, it may be done either by the use of the trip-rod 48, by means of which the toggle 26—27 may be broken, or it may be accomplished by pressing the latch 37 by means of the foot-plate 40, which will permit the hand-lever 35 to move in a counter-clockwise direction, thereby opening the switch.

It is evident that my invention may be embodied in many other forms than that shown and described, and I therefore do not wish to be restricted to the precise structure shown, but aim to cover by the claims all changes and modifications which are within the spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is,

1. In an electric switch, the combination with a trip for said switch, of a solenoid, a movable core normally outside the windings of the solenoid, and drawn into said solenoid by abnormal current through the solenoid, means for yieldingly counter-balancing the weight of the core and maintaining it in normal position, and a connection between the core and the trip, whereby the trip is actuated when the core is attracted.

2. In an electric switch for alternating current circuits, the combination with a trip for said switch, of a solenoid, a movable core normally outside the windings of the solenoid, and drawn into said solenoid by abnormal current in the circuit, resilient means for counterbalancing the weight of the core and maintaining it in normal position, and a lost motion connection between the core and the trip whereby the core engages the trip to move it when the core is partly within the coil.

3. In an electric switch for alternating current circuits, the combination with a trip for said switch, of a solenoid, a movable core normally outside the windings of the solenoid, springs counter-balancing the weight of the core and maintaining it in normal position, a lost motion connection between the core and the trip whereby the core engages the trip to move it when the core is partly within the coil, and means for varying the amount of lost motion in said connection.

4. In an electric switch for alternating current circuits the combination with a trip, of an electromagnet, a movable armature for said electromagnet arranged so that the self-induction of the magnet is small when said armature is in normal unattracted position, yieldable means for holding said armature in normal position, and connections between said armature and said trip for actuating said trip when said armature is attracted.

5. In an electric switch for alternating current circuits, the combination with a trip, of an electromagnet, a movable armature for said electromagnet arranged so that the self-induction of the magnet is small when said armature is in normal position, yieldable means for counter-balancing the weight of the armature and holding it in normal position, and a lost motion connection between said armature and said trip for permitting said armature to move through part of its path without moving the trip.

6. The combination with an electric switch having a trip, of a member connected with said trip to actuate it and thereby open said switch, an electromagnet, a movable armature for said electromagnet arranged so that the self-induction of said magnet is small when said armature is in normal posi-

tion, resilient means secured to said member for counterbalancing the weight of said armature and maintaining it in normal position, and means for adjusting said resilient means with reference to said member to vary the normal position of the armature with relation to the electromagnet.

7. The combination with an electric switch having a trip, of a member connected with said trip, to actuate it and thereby open said switch, an electromagnet, a movable armature for said electromagnet arranged so that the self-induction of the magnet is small when said armature is in normal position, a spring connected to said member and to said armature to counterbalance the weight of said armature and to hold the armature in normal position, and means for adjusting the position of the end of said spring on said member to vary the normal position of said armature.

8. The combination with an electric switch having a trip, of a member connected with said trip to actuate it and thereby open said switch, an electromagnet, a movable armature for said electromagnet mounted for vertical movement adjustably secured to said member and a block with which said armature has a lost motion connection, a spring connected to said block and to said armature to resiliently support said armature in normal position, and means for adjusting the relative position of said member and said block to vary the normal position of said armature in relation to said electromagnet.

9. In an electric switch for high tension circuits, the combination with a trip for the switch, of a trip coil directly connected with the high tension circuit, an iron supporting frame electrically connected to one end of the winding of said coil and partially encircling said coil to render said coil an iron-clad electromagnet, and an insulating support for said frame.

10. In an oil switch, an oil vessel of great tensile strength, a shunt contact carried by said vessel, and a main contact in parallel with and carried by said vessel.

11. An oil vessel comprising a seamless steel pot, coöperating shunt contacts therein, a copper clamp engaging said pot near the bottom thereof, a copper cover for said pot forming a fixed main contact, and copper bars connecting said clamp and said cover.

12. In an oil switch, the combination with movable main and shunt contacts, of an oil vessel of great tensile strength, and fixed main and shunt contacts carried by said vessel and coöperating with said movable contacts, said fixed main contacts being connected in parallel with the oil vessel.

13. In an oil switch, the combination with movable main and shunt contacts, of an oil vessel of great tensile strength, carrying a fixed shunt contact coöperating with said movable shunt contact, and a fixed main contact carried by said vessel and in parallel therewith, by means of connections of greater electrical conductivity than the vessel.

14. In an oil switch, the combination with vertically moving main and shunt contacts connected to one lead of a circuit to be controlled, of a seamless steel vertical oil pot, a copper clamp engaging the lower end of said pot and connected to the other lead of the circuit, a fixed shunt contact in the lower end of said pot, a fixed main contact attached to the upper end of the pot, and copper bars connecting said clamp and said fixed main contact.

In witness whereof, I have hereunto set my hand this sixth day of December, 1906.

HENRY LAWRENCE SMITH.

Witnesses:
JOSEPH INSULL,
P. A. SMITH.