July 24, 1934. A. E. GREENE 1,967,752

HEAVY CURRENT SWITCHING APPARATUS

Filed Dec. 23, 1931 2 Sheets-Sheet 1

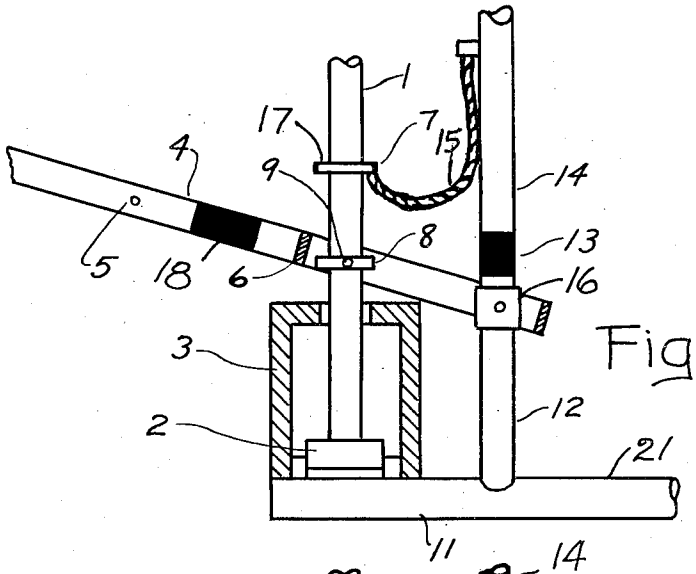


Fig. 1.

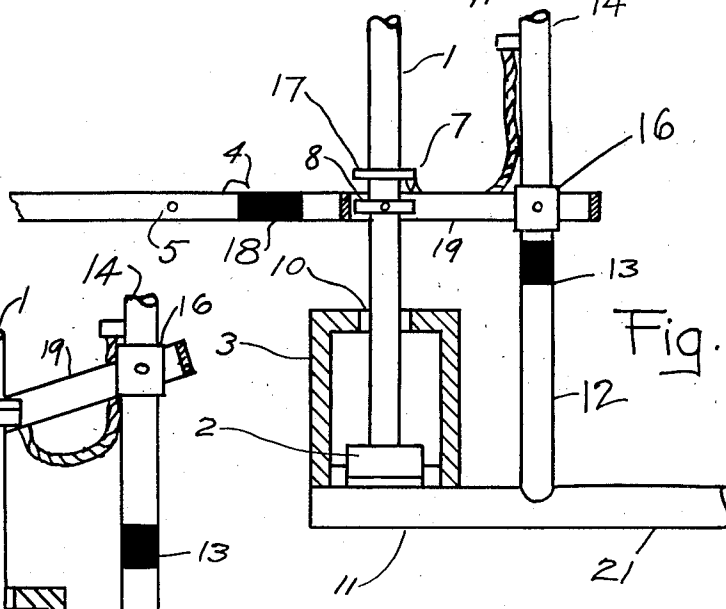


Fig. 2.

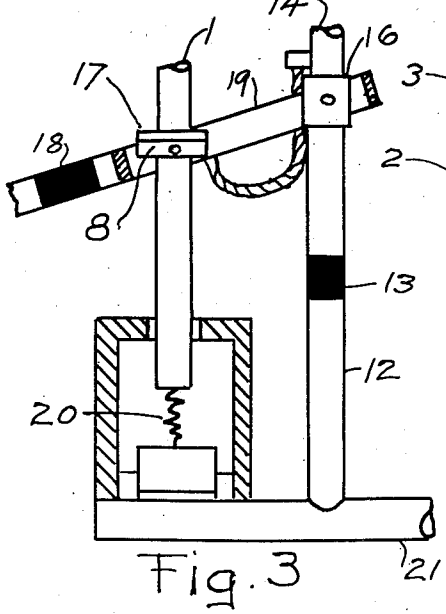


Fig. 3

INVENTOR

BY Fennig, Davis, Marvin & Edmonds

ATTORNEYS

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HEAVY CURRENT SWITCHING APPARATUS

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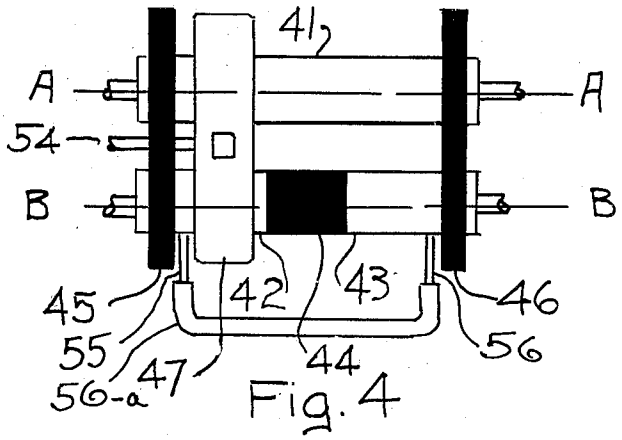


Fig. 4

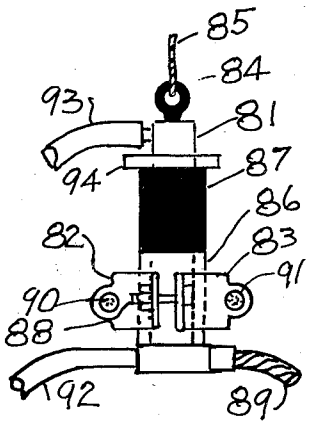
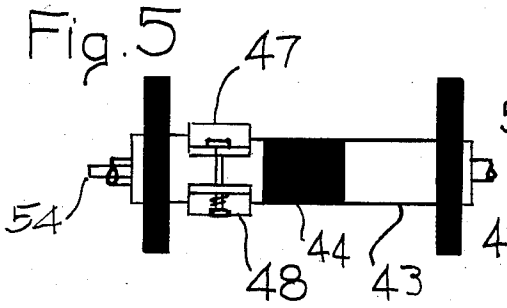


Fig. 10.

Fig. 5



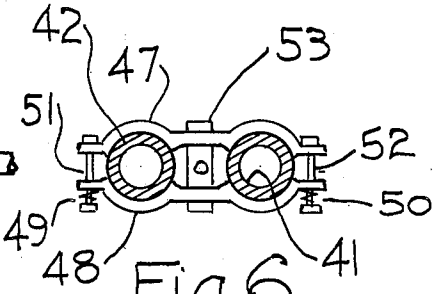


Fig. 6

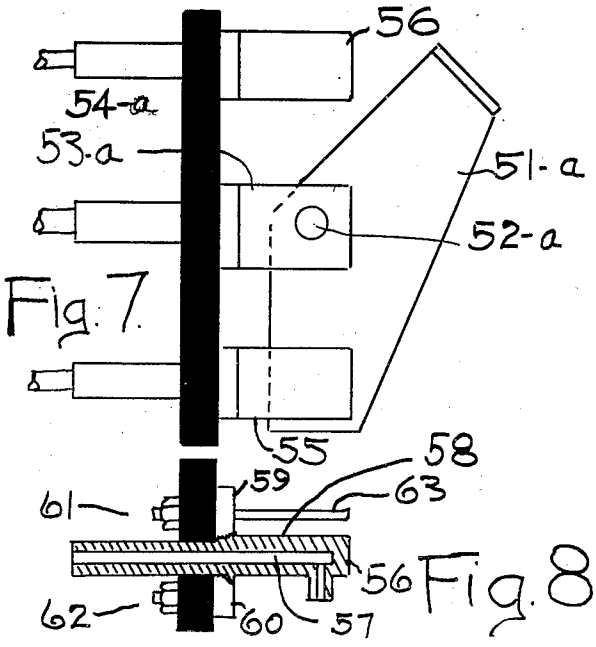


Fig. 7.

Fig. 8.

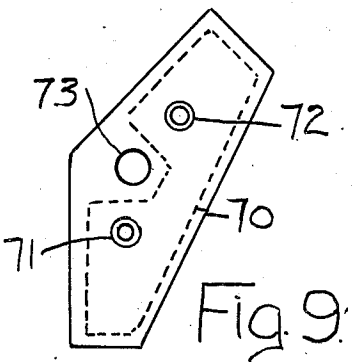


Fig. 9.

INVENTOR

BY Dennis, Davis, Marvin & Edmonds

ATTORNEYS

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UNITED STATES PATENT OFFICE

1,967,752

HEAVY CURRENT SWITCHING APPARATUS

Albert E. Greene, Seattle, Wash.

Application December 23, 1931, Serial No. 582,732

6 Claims. (Cl. 200—16)

My present invention relates to improvements in switch and circuit breaker apparatus for carrying and breaking large currents, and more particularly to such apparatus in which certain of the parts are especially constructed for fluid cooling.

Heretofore, in the construction of switching apparatus for very large currents, such as 5,000 or 10,000 amperes and more, laminated conductors have been resorted to, and even then the cost of such switches has been prohibitive. As a result, particularly in electric furnace and similar operations, transformation apparatus has been used and switching of smaller currents at higher voltages has been resorted to. Thus, in the case of an electric furnace taking its power from a 40,000 volt power line, it has even been found economical to use a double transformation in order to locate the switches on a circuit of lower voltage than the 40,000 volt circuit, and yet not have to carry excessively large currents through the switch apparatus. If an economical heavy current switch had been available in that instance, the use of a double transformation might have been avoided.

My invention has for its object the improvement which utilizes hollow conductors for current carriers in the switch apparatus, and in which the currents are naturally forced into the outer part of a hollow conductor by reason of the skin effect. In its simplest form, my invention comprises, in one modification a tubular or hollow conductor which is fluid cooled by passage of cooling fluid through it, and a sliding contact for making circuit or for keeping the circuit open.

Another object of my invention is the combination with hollow, fluid cooled switching means, of a circuit breaking apparatus comprising an electrode for opening and closing circuit within a refractory arc chamber.

My invention will be better understood by reference to the annexed drawings in which

Fig. 1 is a sectional elevation of a circuit breaker embodying my invention;

Fig. 2 is another view of the circuit breaker shown in Fig. 1; and

Fig. 3 is still another view of this same breaker, these last two, Figs. 2 and 3 showing the circuit breaker in different operating positions;

Fig. 4 is a plan view of a double throw tubular fluid cooled switch embodying my invention;

Fig. 5 is a side elevation view of the switch of Fig. 4;

Fig. 6 is a sectional elevation view of the switch of Fig. 5 taken just this side of the contact and through the line A—A;

Fig. 7 is a view of a knife type fluid cooled switch mounted in vertical position so that this is an elevation view;

Fig. 8 is a plan view partly in section through one of the fluid cooled contacts of the switch of Fig. 7, both these being illustrations of a modification of my invention;

Fig. 9 is an illustration of a water-cooled or fluid cooled movable contact member such as might be used in the switch of Fig. 7; and

Fig. 10 is a diagrammatic elevation view of a simple form of my invention comprising a movable copper tube member which can be held between contacts to complete the circuit or which can be lowered through the contacts into a position in which the tube is insulated from the contacts and clamped there.

Referring now particularly to Figs. 4, 5 and 6, I will now describe this modification of my invention in detail. This switch is for a single circuit, corresponding to a single pole double throw knife switch. It consists of a tubular fixed copper tube member 41 mounted with its axis at A—A, and two other copper tubes having a common parallel axis B—B. These other copper tubes are marked 42 and 43 and between them is an insulating member 44 of the same outside diameter and with the same axis B—B. The tubes are all held fixed in insulating members 45 and 46 which may be of ebony asbestos wood, for example. The tubes 42 and 43 may be seen in the elevation view, Fig. 5, and the tubes 42 and 41 are shown in the sectional elevation view of Fig. 6.

Sliding contacts 47 and 48 of conductor metal, such as copper are provided for movement along the tubes in the direction of their parallel axes. The upper contact 47 rests on the tubes and the lower contact 48 is held against the bottom of the tubes by means of springs shown at 49 and 50 on bolts 51 and 52 between the outer ends of the contact members. Movement of the two contacts is accomplished through a vertical member 53 which may be of wood, and a rod 54 extending through the insulation 45, by means of which the contacts may be moved from one side to the other of the insulation 44. Thus, the switch serves to connect which ever of the two tubes 42 and 43 may be desired with the tube 41. This combination may serve for one phase of a three phase circuit and two more sets of tubes may be provided for the other two phases. These may be operated by a single lever or separately. Electrical connection may be had through the extensions outside the

insulating supports 45 and 46 and the oil or water or other cooling fluid may be circulated through the tubes as indicated. Thus, the fluid may enter one end of the tube 41 and pass out the other end of it and thence into the end of tube 42 and out the outlet 55, and thence through insulating tubing 56*a* to a corresponding inlet 56 in tube 43 and out the end of tube 43.

Referring now to Figs. 7 and 8, I have shown here a modified type of double throw knife switch with fluid cooled contacts. The switch has a movable element 51*a*, mounted on a pin 52*a*, the pin being held in a contact member 53*a* mounted in turn on suitable insulation as a base, such as ebony asbestos wood, at 54*a*. The movable element 51*a* may be moved to contact with either of two fluid cooled contact members 55 or 56, also held by the insulation base member 54*a*. Fig. 8 shows a section through the contact member 56. This member may be a copper casting with hollow space within indicated at 57 and contact surface at 58. It is shown with lugs 59 and 60 for attaching to the insulating base 54 by means of bolts 61 and 62. Above the contact surface 58 is a member 63 which may be of spring copper and which serves to hold the member 51 against the contact surface 58 in a manner similar to that of an ordinary knife switch, except that one of the contacts is water cooled. This member 63 is shown as mounted in the lug 59. Any alternative means for pressing the movable contact member against the fluid cooled contact may be used without getting away from any improvement.

In Fig. 9 I have shown a water or fluid cooled contact similar to that at 1 in Fig. 7, except for the fluid cooling space. The dotted line 70 shows the outline of the cooling cavity. An inlet opening for cooling fluid is shown at 71 and an outlet at 72. A hole for the pin is indicated at 73.

Referring now to Figs. 1, 2 and 3 which illustrate a circuit breaker embodying my invention. I will now describe this apparatus in detail. It consists of an adjustable arcing electrode 1 and an arcing terminal 2 within an arc chamber of refractory material 3. The arcing electrode 1 connects by means of a cable 15 to a conductor tube 14 which in turn connects to one side of an electric circuit. The arcing terminal 2 connects by means of a conductor tube 11 and 21 to another part of the circuit. In Fig. 1 the arcing electrode 1 is shown in contact with the arc terminal 2 so that the circuit between 14 and 21 is closed through the electrode 1. The adjustable electrode 1 may be raised and lowered by a lever mechanism comprising a lever 4 mounted on a fulcrum 5, the lever carrying a sliding member 8 which serves to lift the electrode when it rises against the collar 17 held tightly on the electrode 1. The lever is preferably provided with insulation indicated at 18 to insulate the electrode parts which are alive from the ground. The lever has an extension 8 which carries a contact 16 which slides on the tube 12 and also across insulation 13 and on the tube 14. The contact 16 is in electrical contact with the collar 17 and therefore with the line which is in connection with the tube 14. The collar 9 is held in suitable trunnions in a slot in the lever bar 4, which slot is not shown.

The operation of this mechanism provides for lowering the electrode 1 into contact with the terminal 2 so as to close the electrical circuit between 14 and 21. The position of the parts on open circuit is shown in Fig. 3, with both electrode 1 and contact 16 raised so that no circuit exists between 14 and 21. I have shown an arc 20 in this Fig. 3 but the electrode 1 can be raised sufficiently so that this arc will not continue. In closing the switch and breaker, the lever 18 and 19 first drops the electrode 1 until it touches the arc terminal 2 and thus closes the circuit and then the contact 16 can be lowered to the position shown in Fig. 1.

In other words this circuit breaker may be used for closing and opening an electric circuit under load in the following manner. Suppose that the circuit breaker is in the open position shown in Fig. 3 and that no current is flowing, but that on closing this circuit current will flow. The contact 16 is above the insulation member 13 and this insulating member 13 insulates the line 14 from the line 21. The lever 4 or 18 is lowered until the electrode 1 is in the position shown in Fig. 2 thus making contact with the terminal 2 within the arc chamber. Any arcing at the time of contact within this chamber is not objectionable because the arc chamber is made for this purpose. The contact 16 is still above the insulation joint 13 although current flows through the electrode circuit. Since the electrode circuit is of higher resistance than desired, the provision is made for closing the auxiliary circuit from the line 14 through the cable and part 19 of the lever which may be of suitable conducting material to the conductor 12 and line 21. This auxiliary contact is made when the lever 19 drops so that contact 16 engages the conductor tube 12. The apparatus is then in the position shown in Fig. 1.

When it is desired to open the circuit, the lever 4 is raised from the position shown in Fig. 1 so that it first raises the contact 16 above the insulation 13 and opens the auxiliary circuit, current continuing to flow, however, through the electrode circuit. The lever is still further raised until the member 8 lifts the electrode held in the member 17 so as to open the circuit between the electrode 1 and the arcing terminal 2. An arc forms at this point within the arc chamber and this arc, indicated at 20 breaks at a certain elevation of the electrode 1 above the terminal 2. This arc opens the circuit gradually and thus cushions the surge. The terminal 2 may be of carbon or graphite or of metal such as copper or iron, and the electrode 1 is preferably of graphite because of low resistance.

It is understood that the mechanism by which the auxiliary circuit cannot be closed without the electrode circuit being closed may be other than that which is shown, provided that the auxiliary circuit is thus controlled. My improvement embodied in this circuit breaking apparatus is especially advantageous for heavy current apparatus such as arc furnace equipment where the current is to be broken at relatively low voltage and correspondingly high amperage.

Thus, where a power transformer takes a power from a high voltage line of say 40,000 volts or more and delivers current at a voltage of less than 150 or 200 volts to an arc furnace, my apparatus of this invention is particularly advantageous since it is much less expensive to build and to keep in repair and is very substantial in its ability to break heavy current. It may be constructed in a combination of single phase units for a polyphase circuit, and where higher voltages are to be opened, it may be made with more than one arcing contact, so that at least two or more arcs are made when the switch is opened.

My invention embodying a fluid cooled switch is likewise important since it provides for much higher current densities in switch parts than has

been heretofore possible, and furthermore takes advantage of the skin effect to use the inside of the conductor for cooling purposes. Thus it is possible in a conductor of only about 3 to 4 inches outside diameter to carry currents of 10,000 to 20,000 amperes and more.

In Fig. 10, I have illustrated diagrammatically a simple form of switch embodying my invention. It consists of a movable copper tube member 81 which can be raised or lowered through the contacts 82 and 83 by means of an insulated hook member 84 and cable 85. Around the tube 81 is placed a larger piece of copper tube 86 fitting tightly against the inner tube and fitting closely within the contacts 82 and 83 when the latter are closed. The contacts may be held tight against the outer pipe 86 by means of a bolt 88 or equivalent means for tightening and loosening this contact. Above the outer pipe 86 is a piece of insulation 87 fitting over the tube 81 and having the same outside diameter as the pipe 86 so that the assembled tube 81 with pipe 86 and insulation sleeve 87 can be lowered through the contacts when they are open into a position where the closing of the contacts will be against the insulation. The two sides of the circuit are the conductor 89 which leads to the movable tube and is in electrical contact with it, and the cables 90 and 91 leading to the two parts of the contact members 82 and 83, and electrically attached within the cables holes in these contacts. The cooling circuit comprises the hose member 92 through which water may enter and pass up inside the tube 81 and then out through the hose 93. The insulation member 87 is fitted tightly on the tube 81 so that when the tube 81 is lowered through the open contacts its weight may rest on the flange 94 which in turn rests on the top of the contacts. The conductors leading to the contacts are flexible, allowing for opening and closing of these against the pipe or insulation, and the conductor leading to the tube is also flexible, allowing for raising and lowering of the tube 81. Other means of operating this type switch may be used without getting away from my invention, as for example a lever mechanism for movement of the tube and a separate clamping mechanism for operating the contacts. Likewise, this switch may be operated horizontally instead of vertically.

I claim:

1. A heavy current switch comprising in combination a tubular conductor adapted to pass a cooling fluid therethrough fixedly mounted in insulating supports, a sliding contact thereon, means for holding the contact against the tubular conductor, and means for sliding the contact to a position which opens the circuit, the tubular conductor and contact being electrically connected to opposite sides of the circuit.

2. A heavy current switch comprising two parallel hollow conductors mounted in insulating supports, a sliding contact adapted for movement in the direction of their axes whereby in one position connection is made through said sliding contact between the two parallel conductors and whereby in another position this connection is broken, and means for cooling said conductors by passing cooling fluid therethrough.

3. A heavy current switch of the double-throw type, comprising a hollow conductor mounted in insulating supports, and two hollow conductors having a common axis but separated from each other by insulation, a sliding contact for connecting the first mentioned hollow conductor with either one or the other of the last mentioned conductors, and means for cooling said conductors by passage of cooling fluid through them.

4. In a fluid-cooled hollow conductor switch, two parallel tubular conductors each connected to a different potential, a sliding contact held in tight contact with said conductors and means for moving said contact in a direction parallel to the axes of said conductors to a position in which the circuit between said conductors is open.

5. A heavy current switch comprising in combination two hollow conductors each of which is attached to a part of a circuit of different electrical potential, means for cooling each hollow conductor by passage of fluid therethrough, a movable contact element adaptable to establish circuit contact with each of the hollow members, and means for holding said conductor in close contact therewith.

6. A heavy current switch comprising in combination a hollow conductor having contact with an electrical circuit, means for cooling the hollow conductor by passage of a fluid therethrough, a second conductor in connection with a part of the circuit of different electrical potential, a movable conductor member in contact with the second conductor adaptable to be moved into and out of circuit establishing contact with the hollow conductor member.

ALBERT E. GREENE.