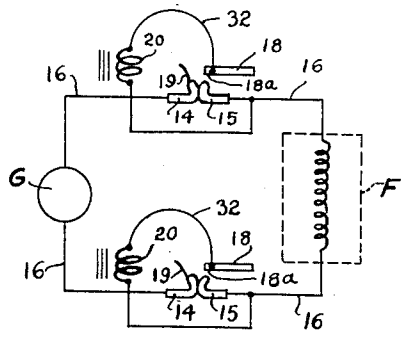
July 18, 1950 M. W. GRIFFES 2,515,596

ELECTRIC SWITCH

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FIG. 1



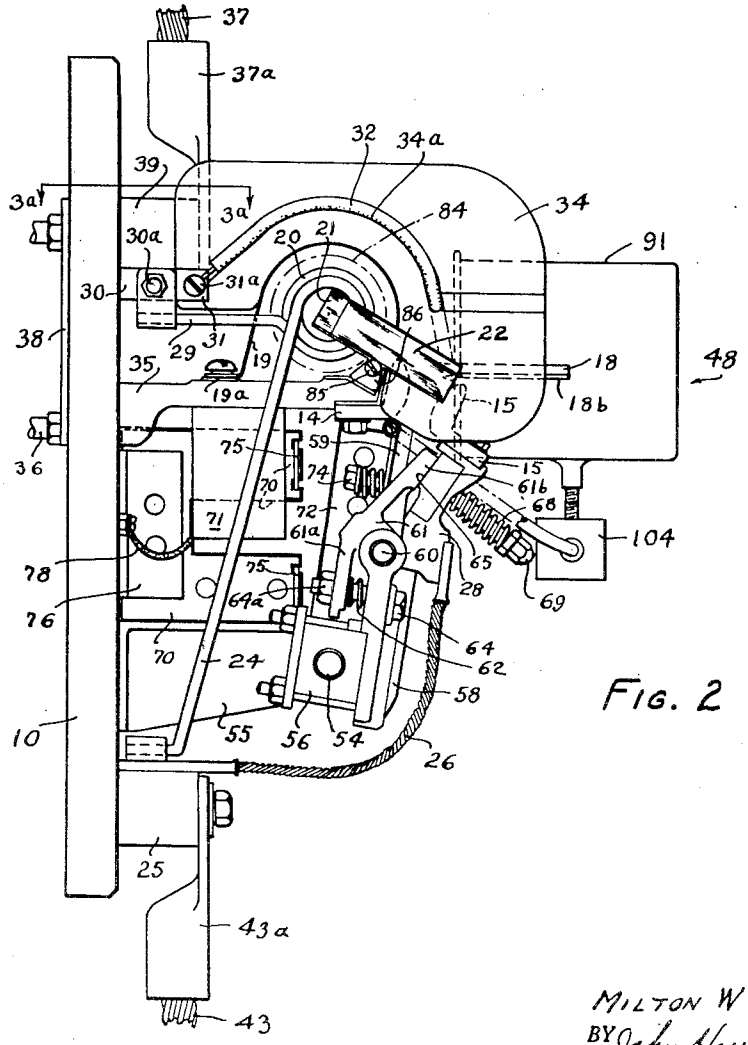


FIG. 2

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ELECTRIC SWITCH

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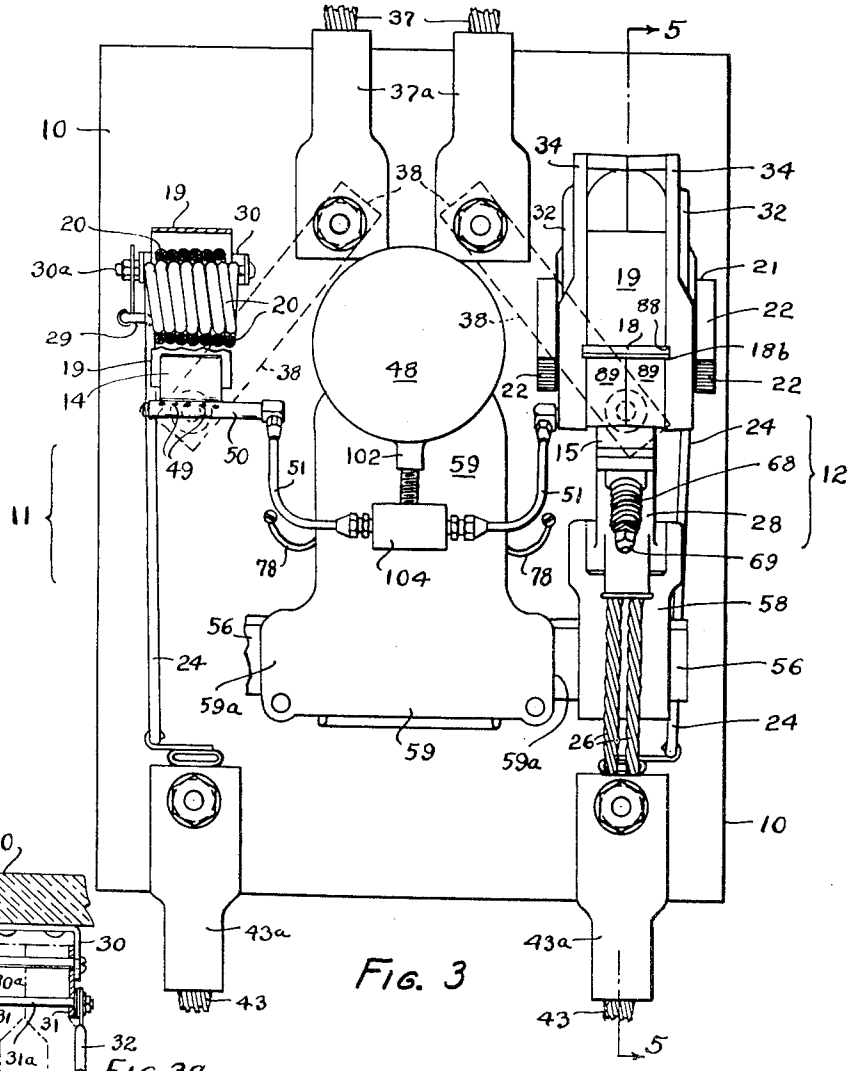


FIG. 3

FIG. 3a

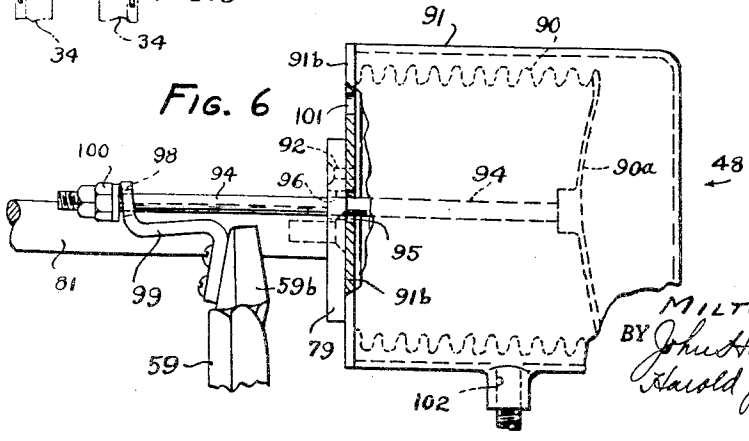


FIG. 6

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ELECTRIC SWITCH

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FIG. 4

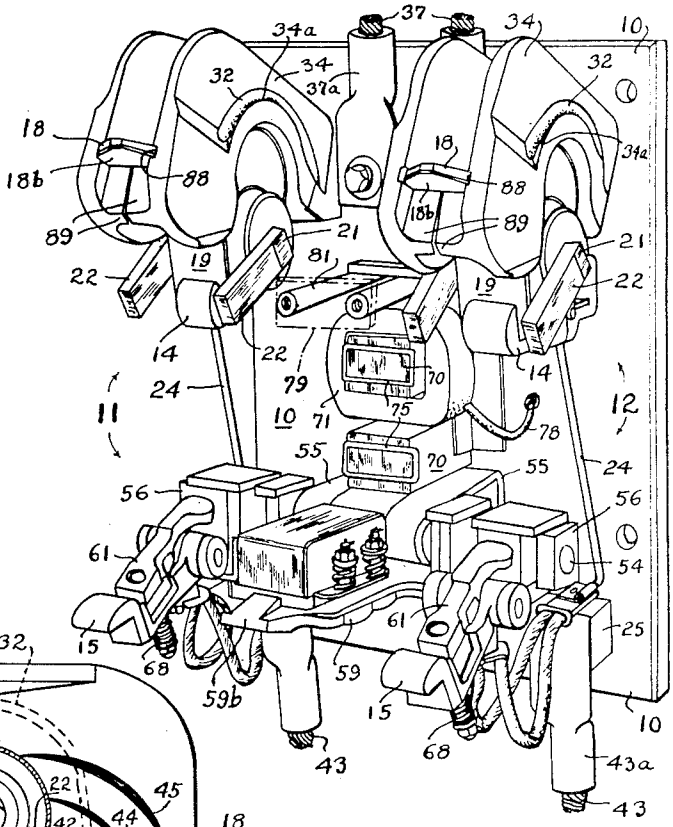
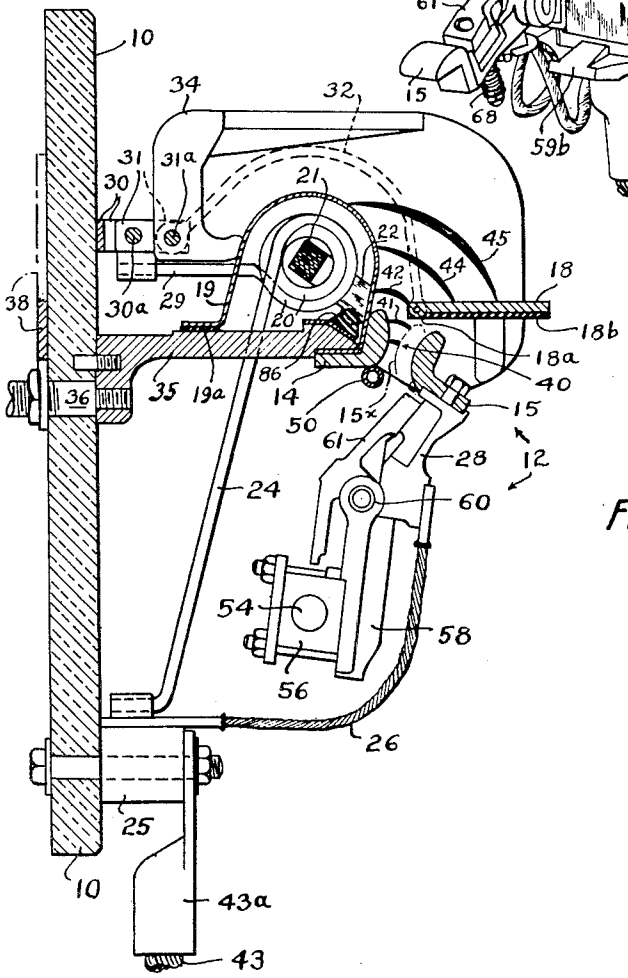


FIG. 5



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ELECTRIC SWITCH

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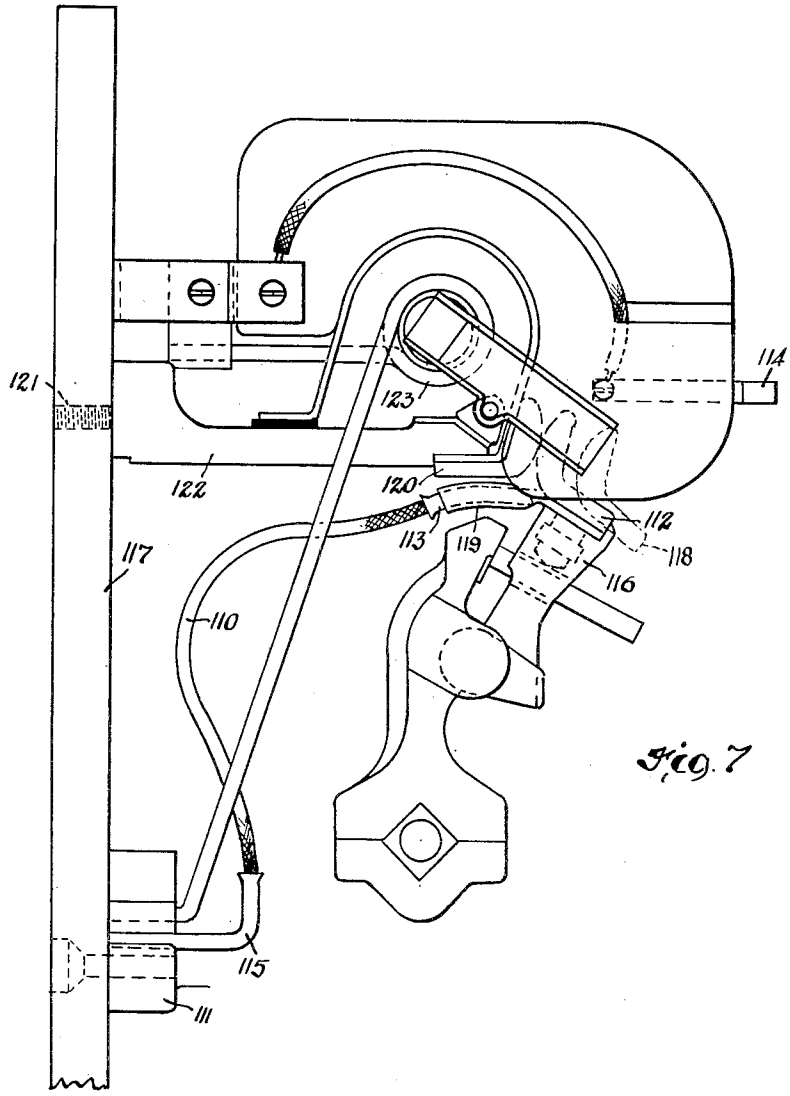


Fig. 7

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Patented July 18, 1950

2,515,596

UNITED STATES PATENT OFFICE

2,515,596

ELECTRIC SWITCH

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Application October 16, 1946, Serial No. 703,502

10 Claims. (Cl. 200—147)

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This invention relates to electrical current interrupters or switches, and more particularly to an electrical switch especially designed for interrupting alternating currents of power magnitudes and of relatively high frequency but usable also for interrupting alternating currents of the usual power frequencies and direct currents as well.

Some form of magnetic blowout structure is almost universally used to assist in extinguishing the arc or arcs formed when an air-break switch opens a circuit carrying a current having a magnitude within the range commonly used by industrial apparatus, and, in the case of switches of the electro-magnetic contactor type, the blowout structure generally includes a blowout coil which is connected permanently in series with the stationary contact of the contactor so that all of the current flowing through the contacts while the contacts are closed also flows through the blowout coil. No particular difficulty is involved in the design of a permanently connected blowout structure that neither offers appreciable impedance nor heats unduly when the switch carries currents of the magnitudes commonly used by industrial apparatus and of a frequency in the neighborhood of 60 cycles per second, but if the frequency of such currents is in the range of from say 200 to 10,000 cycles per second or higher, the impedance of the blowout coil and the heating thereof and of its associated iron structure is such that usual blowout practice cannot be followed. Consequently, conventional air-break, electro-magnetic contactor type switches which have permanently connected blowout coils and which are designed for interrupting alternating currents of the standard power frequencies, i. e. 25 or 60 cycles per second, are not suitable for interrupting alternating currents of the large magnitude and high frequency now commonly used, for example, to supply coreless type induction furnaces or heaters.

Electromagnetic contactors for industrial control service and having continuous 230 volt ratings of the order of 1200 amperes or less at standard power frequencies have become very highly developed and standardized so that it is desirable to adapt such contactors for service in comparable power ranges at frequencies of from 2000 to 10,000 cycles per second thereby to make them suitable for controlling induction heaters. Previous attempts to accomplish this result have involved the use of a means which short circuits the blowout coil during the closed period of the contactor and which is operable shortly before

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opening of the main switch contacts to remove the short circuit thereby to render the blowout coil effective to assist in arc extinguishment. In some instances the short-circuiting means is one pole of a triple-pole contactor and is connected in multiple with the blowout coil and the contacts of one of the other poles, the parallel combination being connected in one of the line conductors. The remaining pole, like the short circuiting pole, is not provided with a blowout coil and is interposed in the other line conductor. During circuit opening operation of such a contactor, the short circuiting pole opens first to insert the blowout coil into the circuit; the pole having the blowout coil then opens and the arc is extinguished, and then the remaining pole opens to completely isolate the two parts of the circuit.

Another prior contactor type switch designed for high frequency service involves the use of additional or arcing contacts connected in parallel with the main contacts of the switch and in series with the blowout coil so that the main contacts short circuit the blowout coil when they are closed. The main contacts of this latter type of prior contactor are arranged to open shortly before the arcing contacts open thereby to cause the blowout coil to become energized just before and to remain energized during the arcing period, the arc appearing across the arcing contacts only.

Both of the foregoing prior attempts to solve the problem of high frequency arc interruption by modified standard low frequency contactors have required considerable redesign of the standard low frequency contactors, and have necessitated a predetermined sequence of contact opening which is difficult to maintain. In both instances it has been necessary to derate the modified contactors considerably when used for high frequency service, and, in the case of the first described prior high frequency contactor, difficulty has been experienced because the last pole sometimes opens before the arc formed at the intermediate pole is completely extinguished thereby causing an arc to be formed on contacts which are not in a blowout field.

An object of this invention is to provide an improved electro-magnetic switch capable of interrupting relatively large currents of relatively high frequency.

Another object is to provide an electro-magnetic switch for interrupting high frequency currents and which does not have the foregoing disadvantages.

Another object is to provide a switch for interrupting high frequency currents and which is essentially similar to commercially available contactors in so far as the principal structural features are concerned.

While the improved contactor disclosed herein may be constructed by slight modification of many contactors now available commercially, the contactor disclosed in Trofimov Patent No. 2,071,595, issued February 23, 1937, is particularly well suited for this purpose and is the general type shown in the exemplary embodiments herein described.

In accordance with the present invention, the blowout coil of a contactor type switch is so connected that it is completely isolated from the circuit while the main contacts of the switch are closed, and is introduced for the first time into the circuit after an arc is formed and has been transferred by thermal forces from one of the contacts to an arc terminal receiving means in the form of an arcing plate. The arcing plate is electrically connected to the movable contact through the blowout coil and through a pair of parallel connected arc controlling conductors which are connected in series with the blowout coil and disposed on opposite sides of the arc path. The arc controlling conductors not only serve as a path for current flowing through the blowout coil, but also are so mounted with respect to the arc path that the current flowing in the conductors tends to confine the arc to a plane midway between the arc shields, as in the above mentioned Trofimov patent. The blowout structure is so designed that the impedance of the coil is a minimum thereby to facilitate arc transfer, but for interrupting currents having frequencies in the neighborhood of 10,000 cycles per second or whenever the arc does not transfer readily from the moving contact to the arcing plate due to the thermal effect of the arc itself, auxiliary means are provided to assist such transfer.

Switches are known in which additional blowout coils are added to a circuit in response to movement of an arc across an arcing surface, and in which the energization of a blowout coil is increased from a low to a high value consequent upon transfer of an arc from a movable contact to a stationary arcing plate. However, these prior switches are not suitable for high frequency service since they are provided with highly inductive magnetic means for effecting initial arc transfer and the impedance of the blowout coils is made as great as possible so as to assist in reducing the arc current. When the impedance of the blowout coil is relatively large, some means must be used to assist the thermal effect in order to move the arc to the stationary plate, and when this means is the usual blowout structure, the switch cannot be used for high frequency services. The present applicant has discovered that if the impedance of the blowout coil is kept as low as possible and the arcing plate is properly positioned relative to the path of movement of the movable switch contact, that arcs having a frequency as high as 6000 to 8000 cycles per second can be caused to move to the arcing plate without the use of an auxiliary means.

It is a further object of this invention to provide a blowout structure for high frequency arc interruption that is initially energized consequent upon transfer of the arc from a contact to an arcing surface.

Another object is to provide a switch for high frequency service in which the arc formed upon separation of the contacts is transferred from at least one of the contacts to a spaced arcing surface by the force of repulsion between the current in the arc and the current in an adjacent conductor.

Still another object is to provide an arc controlling structure for an electric switch including means utilizing the force of repulsion between oppositely flowing currents in adjacent conducting paths to expand an arc and to confine the arc laterally to a pre-determined path and further including magnetic blowout means effective only after initial expansion of the arc to assist in further expansion and ultimate extinction of the arc.

Still another object is to provide an arc controlling structure for an electric switch including means utilizing the force of repulsion between oppositely flowing currents in adjacent conducting paths to move an arc into a position in which it initiates energization of a blowout coil by which the arc itself is subsequently extinguished.

A more specific object is to so arrange the usual flexible conductor means leading to the movable contact of a clapper-type electromagnetic contactor that the current flowing through the flexible conductor means serves to repel and expand an arc immediately after its formation between the contactor contacts.

Other objects are to provide a switch having a blowout coil of minimum impedance that is energized only after an arc is formed; to provide a switch having means in addition to a magnetic blowout structure for expanding an arc, and to provide a switch having air-blast means for transferring an arc from a movable switch contact to a stationary arcing surface.

Other objects and advantages will become apparent from the following description wherein reference is made to the drawings, in which:

Fig. 1 is a circuit diagram;

Fig. 2 is a side elevation of a magnetic contactor in accordance with this invention;

Fig. 3 is a front elevation of the contactor of Fig. 2, portions of the structure, at the left, being broken away;

Fig. 3*a* is a detail sectional plan view taken as indicated at 3*a*—3*a* on Fig. 2;

Fig. 4 is a perspective view of the contactor of Fig. 2 with the air blast mechanism removed and the movable parts dropped to an abnormally open position;

Fig. 5 is a sectional view taken generally at 5—5 on Fig. 3, and

Fig. 6 is a detail view of an air blast generating mechanism of the switch.

Fig. 7 is a fragmentary side elevation of a contactor generally such as illustrated in Fig. 2, showing a modification of the invention.

Briefly stated, the form of the present invention shown in the drawings comprises an insulating base 10 mounting two identical pole structures 11 and 12 (Figs. 3 and 4) each of which has a pair of complemental contacts 14 and 15 adapted to engage each other to complete a suitable electrical circuit therebetween. As shown in Fig. 1 by way of example, such a suitable circuit may comprise, for each of the pairs of contacts 14 and 15, a supply conductor 16 extending from a source of alternating current G to an induction furnace F.

Since the poles 11 and 12 are identical and like

parts are referred to by the same reference numerals, the following description of one pole will suffice for both. Directly above the open contact 15 is positioned an arc terminal receiving means or arc-dissipating plate 18 having an inner end portion 18a (Figs. 1 and 5) of its lower or bottom face in close proximity to the path of travel of the top edge of the contact 15, while connected to and extending upwardly and rearwardly from the contact 14 is a generally inverted U-shaped conducting guard or arc-dissipating member 19. Between the front and rear walls of the member 19 is an arc-expanding means in the form of a blowout coil 20, a laminated, highly permeable core 21 of magnetic material surrounded by the coil, and a pair of laminated ear portions 22 of the core and of like magnetic material in magnetic flux conducting engagement with the core and extending toward and disposed on opposite sides respectively of the contacts 14 and 15. One terminal lead 24 of the blowout coil 20 is connected to a lower terminal block 25 to which the contact 15 is also electrically connected as by a flexible conductor 26 and a rocker arm 28. The other terminal lead 29 of the blowout coil is connected to a conducting U-shaped bracket 30 (see Fig. 3a) secured to the base 10 and pivotally mounting, as on a pin 30a, a pair of conducting plates 31 to which the inner ends of a pair of conductors 32 are respectively connected. The conductors 32 constitute arc-constraining means as will hereinafter be described. The plates 31 are rigidly fastened as by a bolt 31a to complemental arc shield members 34 of insulating material disposed on opposite sides of the contacts 14 and 15. The members 34 support the respective conductors 32 on curved ledge surfaces 34a formed on the outer surfaces of the respective members 34. The outer ends of the conductors 32 are connected to the plate 18, and, since the members 34 are disposed on opposite sides of the arc path, the conductors 32 are likewise so disposed. The contact 14 is mounted on the outer end portion of a conducting bracket 35 secured to the base 10 by a threaded stud 36 which is electrically connected, as by a bus bar 38, to an upper terminal block 39. The arc-dissipating member 19 which is also mounted upon the bracket 35 has its inner end insulated therefrom as by a fiber spacer 19a in order to prevent the completion of a short circuited turn about the blowout coil 20.

When the contacts 14 and 15 are in mutual contact, current reaching the switch through a conductor 37 and a lug 37a at the terminal 39, see Fig. 2, flows through the bus bar 38, the stud 36, the bracket 35, the contacts 14 and 15, the arm 28, and the conductor 26 to the terminal 25 to which an outgoing conductor 43 is connected by means of a lug 43a. The blowout coil 20 is thus completely isolated and no heating of the coil 20, core 21, and/or ears 22 results even though the switch is carrying currents of relatively high frequency. When an arc is formed as at 40 (Fig. 5) upon separation of the contacts 14 and 15, the thermal effect of the arc is such that the arc is both moved and bowed upwardly as indicated at 41 so that substantially when the contact 15 passes the inner edge portion 18a of the plate 18 (broken line position 15x) one end of the arc transfers from the contact 15 to the plate 18 as indicated at 42. It should be observed that the transfer of the arc may be obtained merely as a result of the thermal effects thereof and that the transfer is facilitated by the close proximity of the contact 15 and plate 18. Upon transfer of one end of the arc to the plate 18, the flow of current through the contactor is from the terminal 39 to the contact 14, as before, and from the contact 14 through the arc to the plate 18, through the spaced arc-constraining conductors 32 in parallel, the plates 31, the bracket 30, the lead 29, the blowout coil 20, and the lead 24 to the terminal 35. The blowout coil 20 is so wound that the magnetic field created thereby between the ears 22 in conjunction with the thermal effect of the arc itself causes the arc to expand upwardly and outwardly away from the point of its inception as indicated at 44 and 45. In some instances it may be desirable to raise the respective outer end portions of the blowout ears 22 slightly from the position shown in order to concentrate the flux more closely to the arc during its period of expansion.

During expansion of the arc, one end thereof moves forwardly along the plate 18 whereas the other end of the arc moves upwardly and rearwardly along the member 19. As described more in detail in the above mentioned Trofimov patent, the effect of the current flowing in the conductors 32 which, in the present invention, are energized as soon as the arc transfers from the contact 15 to the plate 18, is to constrain the arc to a position centrally of the spaced arc shield members 34 and thus to confine the arc in the strongest part of the blowout field between the ears 22 as well as to prevent the arc from contacting and burning the arc shields.

In event that the contactor is to be used for currents of frequencies in the neighborhood of 10,000 cycles per second or higher, non-electrical and non-magnetic means may be added to cause transfer of the arc from the contact 15 to the plate 18. Briefly, this means may comprise a bellows 48, Figs. 2, 3 and 6, operated by the contactor and arranged upon opening of the contactor to force streams of air from spaced orifices 49 in a nozzle member 50, Figs. 3 and 5, closed at one end and connected at the other to the bellows 48 through suitable tubes 51. The nozzle is mounted beneath the contact 14 and the jet orifices 49 are directed into the arc path, i. e. upwardly and across the forward face of the contact 14.

Transfer of the arc from a movable contact to an arcing plate may also be effected by utilizing the force of repulsion between two adjacent currents flowing in opposite directions as will be described hereinafter in connection with Fig. 7.

Having thus briefly described the salient features of the invention, attention is now directed to the general construction and arrangement of the contactor hereof.

A cylindrical operating shaft 54 rotatably supported by a pair of spaced brackets 55 mounted by the panel 10 has squared insulating tubes 56 disposed over opposite end portions thereof. Main contact arms 58 of the poles 11 and 12, respectively, are secured to the outer end portions of the respective tubes 56 and a magnet arm 59 has opposing leg portions 59a (Fig. 3) secured to the inner end portions of the respective tubes 56. Considering one of the identical poles 11 and 12, the arm 58 thereof journals a shaft 60 to which the rocker arm 28 is keyed and which rotatably supports an intermediately pivoted, double-ended, adjustable stop member 61. A compression spring 62, Fig. 2, interposed between the arm 58 and a lower arm portion 61a of the stop member 61 is guided by a bolt 64 which passes

freely through aligned openings in the arm 58 and the arm portion 61a, a nut 64a being threaded on the inner end portion of the bolt. The spring 62 biases the member 61 clockwise about the shaft 58 thereby forcing an upper arm portion 61b of the member 64 against a flat surface 65 of the contact supporting rocker arm 28. A pin 66 extends outwardly from the portion 61b, passes freely through an opening in the arm 28, and mounts a compression spring 68 disposed between the arm 28 and an adjustment nut 69 threaded on the outer end portion of the pin. By means of the construction just described the contacts 14 and 15 engage and disengage by rolling action and are held in engaged position by adjustable spring pressure as is well known in the art.

Movement of the contacts 15 to engaged position is effected magnetically by attractive force between a magnet core 70, mounting an operating winding or coil 71, and a laminated magnetic armature 72 resiliently mounted as by spring structures 74 on the magnet arm 59. In the embodiment shown, the core 70 is laminated, has shading coils 75, and is secured to the base 10 as by angle brackets 76. The coil 71 is provided with suitable terminal leads 78.

The magnet arm 59 has an upwardly extending portion 59b (Figs. 4 and 6) which, when the coil 71 is de-energized, abuts against a stop plate 79 secured to and spaced from the base 10 by a pair of elongated studs 81.

The blowout coil 20 may be of any type having sufficient turns to create an adequate blowout force, but, in order to have as low an inductance as possible, should not have an excessive number of turns. As shown, insulated round wire is used for the blowout coil and is form wound in a double layer before being slipped over the core 21, insulating discs or washers 84 being provided at opposite ends of the coil. The magnetic ears 22 are pivotally supported on a screw 85 passing through a triangular insulator 86 mounted on the outer end portion of the bracket 35 at the rear of the contact 14.

While the plate 18 may be a unitary piece of conducting metal, it preferably has a lower portion 18b of insulating material extending over the major portion of the length of the plate, but terminating to leave the conducting end portion 18a at the inner end. The purpose of the insulator 18b is to cause any arc drawn between the contact 15 and the plate 18 to be greatly lengthened after the contact 15 passes the end portion 18a during opening movement of the contact.

Opposing marginal side portions of the plate 18 are received in grooves 88 formed in the inner wall surface of the respective arc shield members 34. The arc shield members may be of molded insulation material and are held together by the pin 31a to which the inner ends of the arc guiding conductors 32 are secured. Projections 89 formed beneath the grooves 88 on the respective members 34 meet beneath the plate 18 to space the members 34 apart and to assist in the support of the plate.

If more positive means than the thermal effect of the arc itself is desired for effecting transfer of the arc from the contact 15 to the plate 18, the non-electrical and non-magnetic arc transfer assisting means comprising the bellows 48 and nozzles 50 may be used. The bellows 48 comprises a flexible plunger 90 (Fig. 6) mounted within a cylindrical container 91 which is fastened to the stop plate 79 as by a pair of screws 92. A plunger actuating rod 94 secured to the base wall 90a of the plunger 90 passes through aligned openings 95, 96 and 98 in a front wall 91b of the container, in the stop plate 79, and in an S-shaped bracket 99, respectively. The bracket 99 is secured to the extension 59b of the magnet arm 59. When the magnet arm 59 moves to the closed position (shown in Fig. 6) the plunger 90 is compressed as a result of the pulling force on the rod 94 exerted by the bracket 99 against a nut 100 threaded on the end of the rod, air inside the plunger 90 being discharged through a port 101 in the wall 91b. When the magnet arm returns to the open position, the plunger restores itself to its normal condition and forces air from the cylinder 91 through an outlet port 102 to a distributor 104. Because of the lost motion connection between the rod 94 and the bracket 99, the magnet arm 59 reaches its open position without interference from the rod.

Air entering the distributor 104 flows through the pair of outlet conduits 51 to the nozzles 50 of the two poles 11 and 12, respectively. The air is emitted from the nozzles 50 through the orifices 49 concurrently with the formation of an arc between the contacts 14 and 15. This puff of air assists the thermal effect of the arc and positively drives the arc upwardly so that the outer end thereof transfers from the contact 15 to the plate 18.

Referring to Fig. 7, the arc transfer may be effected by utilizing the force of repulsion between two adjacent currents flowing in opposite directions, as mentioned. For this purpose a flexible conductor 110, preferably uninsulated, comparable to the conductor 26, and interconnecting a terminal block 111 and the movable contact 112 is connected directly to the contact 112 through an elongated terminal tube or member 113. The member 113 is disposed beneath and in fairly close proximity to the arc during the initial period of arc formation. The current in the arc at any given instant is flowing oppositely from the current in the member 113 and the force of repulsion between these two currents forces the arc upwardly and facilitates its transfer to the plate 114, comparable to the plate 18 heretofore described.

The flexible conductor 110 is provided at its lower end with a terminal tube or member 115 electrically connected to the terminal block 111 and having its end portion bent at right angles to the portion adjacent the conductor 110. The upper end of the conductor 110 is received in the elongated terminal member 113 which is electrically connected to the movable contact 112 as by being clamped between the contact 112 and a rocker arm 116. The terminal member 113 is preferably in the form of a flattened hollow copper tube bent as indicated and extends rearwardly from the lower surface of the contact 112 toward an insulating base 117. The member 113 is of sufficient length so that it is disposed under the entire path of the initial arc drawn when the contact 112 moves from the solid line position to the open position shown by broken lines 118. Preferably heat resisting insulation 119, such as glass tape impregnated with a silicone resin, be provided for the terminal member 113.

When the movable contact 112 leaves the stationary contact 120, the current through the contactor flows from the stud 121 through the bracket 122, the contact 120, the arc, the con-

tact 112, the terminal member 113, the flexible conductor 110 and through the terminal member 115, to the terminal block 111. It is thus seen that the current in the arc is flowing in a direction opposite to the current in the member 113. The force of repulsion between these two oppositely flowing currents forces the arc upwardly and assists the inherent thermal effect of the heated arc to cause the outer end of the arc to transfer from the contact 112 to the plate 114, thus initiating energization of the blowout coil 123 which is the same as the blowout coil 20, and is connected in the contactor circuit in the same manner as the coil 20. The contactor of Fig. 7 is the same as that of Figs. 1 through 6 except that, instead of the air-blast producing means for initiating movement of the arc to the plate 18, the flexible conductor 110 has been rearranged so as to perform this function, thus making possible more effective movement of the arc and simplification of the structure.

This application is a continuation-in-part of my copending application Serial No. 602,194, filed June 29, 1945, and entitled "Electric Switches," now abandoned.

Other modes of applying the principle of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims or the equivalent of such be employed.

I therefore particularly point out and distinctly claim as my invention:

1. A switch for opening and closing an electric circuit comprising a pair of relatively separable contacts operative upon separation to form a gap between the contacts across which a current can normally flow as an arc, a conductor connected to one of said contacts and adapted for connection to one side of a circuit, the other of said contacts being adapted for connection to the other side of the circuit, an arc terminal receiving means adjacent to said contacts, a blowout coil connected between said arc terminal receiving means and said one of said contacts, and said conductor having a portion positioned relative to the gap between said contacts so as to conduct the circuit current past a sufficient portion of the length of the gap, in a direction opposite to any arc current between the contacts, at such proximity to the gap that the said current flowing through said conductor moves a terminal of the arc toward said arc terminal receiving means.

2. A switch for opening and closing an electric circuit comprising a stationary contact, a movable contact engageable with said stationary contact and separable therefrom to form a gap between the contacts across which a current can flow as an arc, a conductor connected to said movable contact and adapted for connection to one side of a circuit, the stationary contact being adapted for connection to the other side of the circuit, an arc terminal receiving means adjacent said movable contact, a blowout coil connected between said arc terminal receiving means and said movable contact, and said conductor having a portion positioned relative to the gap between said contacts so as to conduct the circuit current past a substantial portion of the gap, in a direction opposite to any arc current between the contacts, at such proximity to the gap that the said current flowing through said conductor moves a terminal of the arc on the movable contact toward said arc terminal receiving means.

3. A switch according to claim 2 further characterized in that means are provided for constraining to said position at least a portion of the conductor which is connected to the movable contact while leaving the movable contact unconstrained by the said means and conductor in its movement in the opening direction.

4. A switch according to claim 2 further characterized in that the conductor which is connected to the movable contact is flexible and means are provided for constraining at least a portion of said conductor to said position during the existence of said gap.

5. A switch according to claim 2 further characterized in that the conductor extends entirely across said gap when the contacts are in their fully separated positions.

6. A switch according to claim 2 further characterized in that said conductor has a rigid conducting portion connected to the movable contact so as to be moved thereby to, and supported thereby in, said position.

7. A switch for opening and closing an electric circuit comprising a pair of relatively separable contacts operative upon separation to form a gap between the contacts across which a current can normally flow as an arc, a terminal adapted to be connected to one side of said circuit, a conductor means connected between one of said contacts and said terminal, the other of said contacts being adapted for connection to the other side of the circuit, an arc terminal receiving means adjacent to said contacts, a blowout coil, additional conductors connecting the coil between said arc terminal receiving means and said one contact, said conductor means having a portion positioned relative to the gap between said contacts so as to conduct the circuit current past the gap in a direction opposite to any arc current between the contacts at such proximity to the gap that the said current flowing through said conductor moves a terminal of the arc toward said arc terminal receiving means so as to reposition one of the arc terminals thereon, whereby said conductors and blowout coil are energized through the repositioned arc, and said conductors being positioned so as to divide and conduct any current from the arc terminal receiving means past the repositioned arc in separate paths at opposite sides of the path of the repositioned arc in a direction opposite to the current of the repositioned arc in such proximity thereto that the current flowing through said conductors constrains the repositioned arc from lateral displacement.

8. A switch in accordance with claim 1 characterized in that said arc terminal receiving means is disposed above said contacts in the thermal path of movement of the arc and in that said conductor is positioned below the gap so as to urge the arc upward to augment the thermal effect of the arc.

9. An electromagnetic contactor for repeatedly opening and closing a circuit carrying an alternating current, said contactor comprising a pair of terminals, a circuit of low inductance extending through said contactor from one of said terminals to the other and including an upper portion and a lower portion which is disposed directly beneath and in close proximity to at least a substantial part of said upper portion, said upper and said lower portions defining opposing sides of the only loop in said circuit, a pair of separable contacts in said substantial part of said upper portion which when closed carry all

of the current passing through said contactor from one of said terminals to the other of said terminals and which upon separation while current is flowing therethrough draw an arc therebetween, said contacts being so disposed that said arc upon its initiation extends substantially in a horizontal plane at such proximity to said lower portion that the thermal effect of said arc and the force of repulsion between the current in said lower portion and the arc current conjointly cause a terminal of said arc to move upwardly along one of said contacts, an arc receiving means having an arc receiving surface closely adjacent the upper portion of said one of said contacts and in the path of said upward movement of said terminal of said arc, an electrical connection between said surface and the terminal to which said one contact is permanently connected, a blowout coil in said connection and of such low inductance that continued upward movement of said terminal of said arc causes said terminal of said arc to transfer from said one contact to said surface thereby to energize said blowout coil, and the flux produced by said blowout coil being

so directed that said arc is forced in the upward direction by said flux after said transfer.

10. A switch in accordance with claim 1 characterized in that the said portion of the conductor extends across the entire width of the gap in all positions of the contacts.

MILTON W. GRIFFES.

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FOREIGN PATENTS

Number	Country	Date
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