Sept. 17, 1946. F. G. LOGAN 2,407,710

ELECTRIC SWITCH

Original Filed Nov. 6, 1941 3 Sheets-Sheet 1

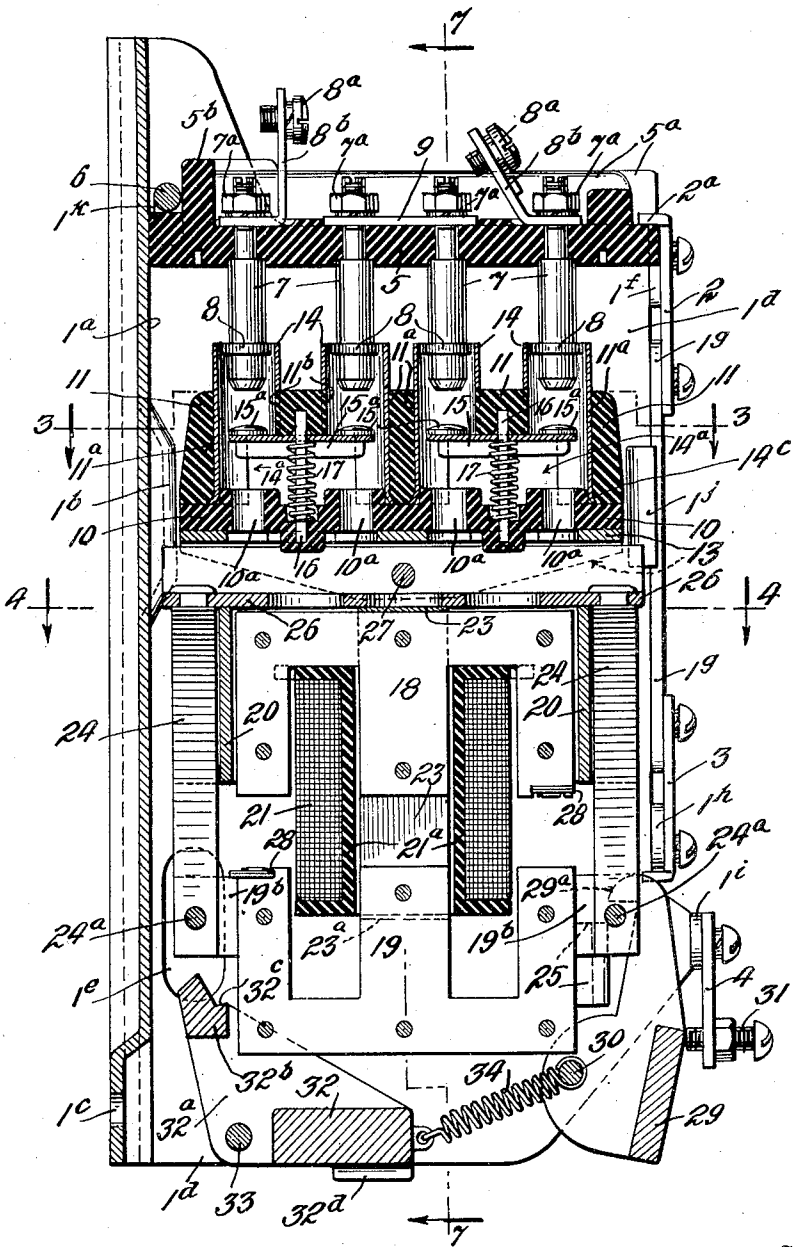


Fig. 1.

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Fig. 2.

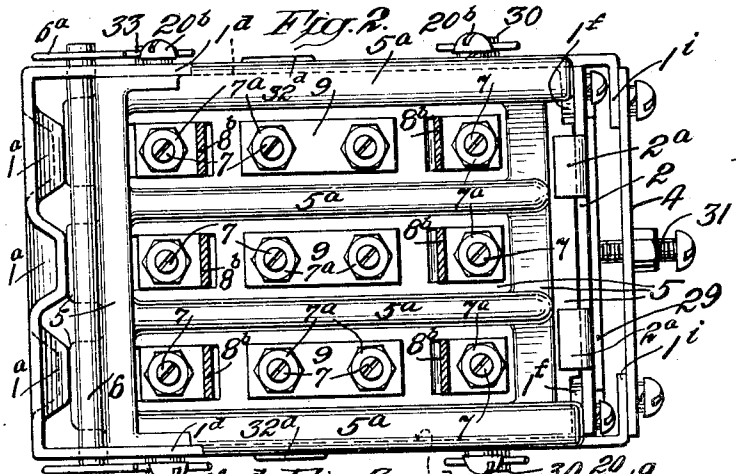


Fig. 5.

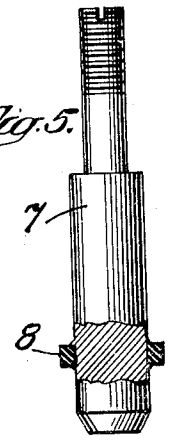


Fig. 3

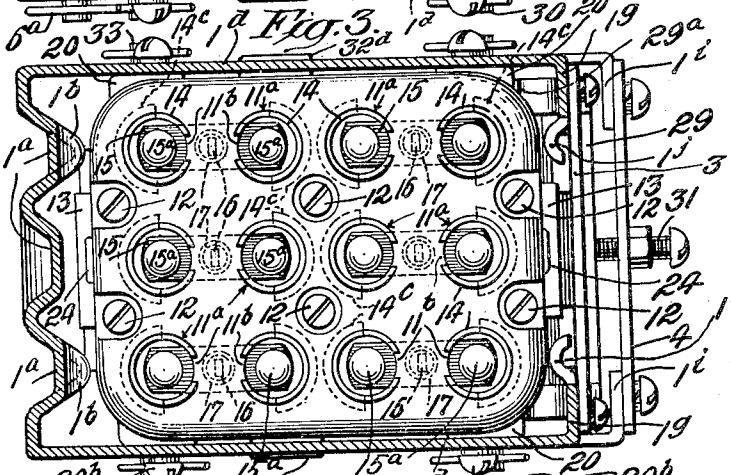


Fig. 6.

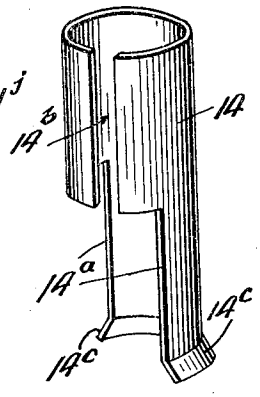
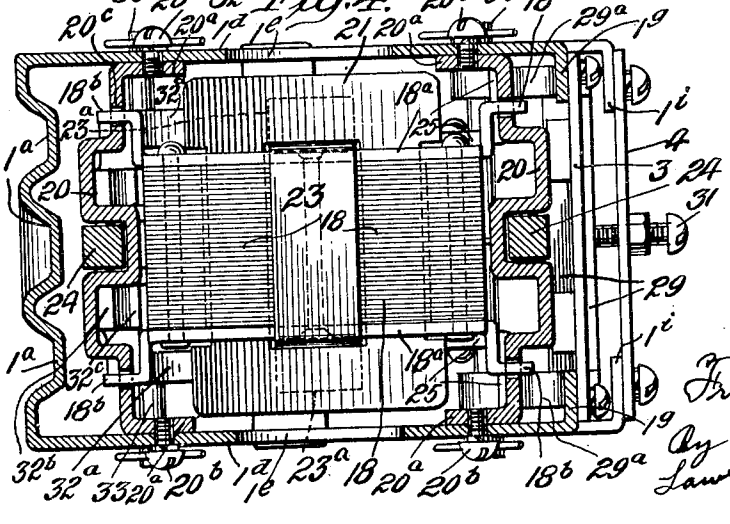


Fig. 4.



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Fig. 7.

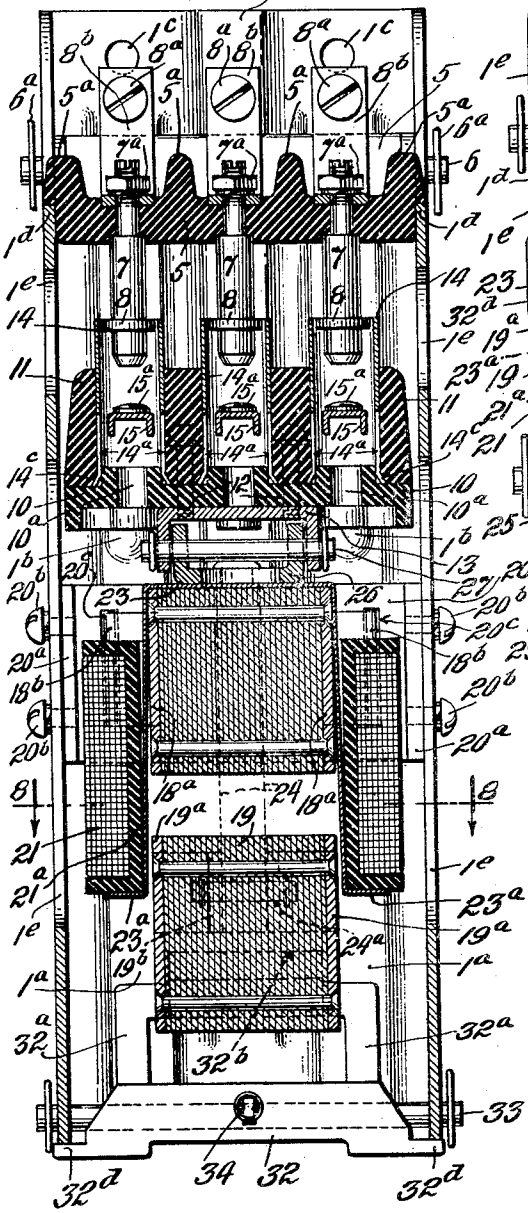
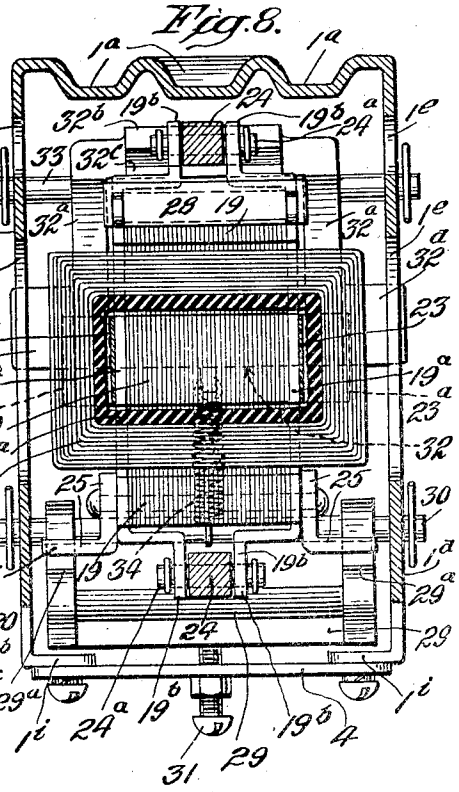


Fig. 8.



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Patented Sept. 17, 1946 2,407,710

UNITED STATES PATENT OFFICE

2,407,710

ELECTRIC SWITCH

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Original application November 6, 1941, Serial No. 417,990, now Patent No. 2,378,022, dated June 12, 1945. Divided and this application March 27, 1943, Serial No. 480,767

4 Claims. (Cl. 200—144)

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This invention relates to electric switches adapted for general use and for control purposes and is of the magnetically operated contacting type although certain features of this improvement are applicable to other types of switches. Certain of the improvements disclosed herein and not claimed are the inventions of George M. Stapleton and are described and claimed in his pending United States application Serial No. 420,327, filed November 25, 1941, now Patent No. 2,378,162, issued June 12, 1945.

This application is a division of my pending original application Serial No. 417,990, filed November 6, 1941, now Patent No. 2,378,022, issued June 12, 1945.

The general object of the improvements described and claimed herein are to produce an improved switch which is of compact form and of comparatively large current and rupturing capacity, and which will be durable and dependable under long continued use. A particular object is to provide an improved form of arc chambers and relationship to the contacts for effectively quenching the arc and occupying small space. This is accomplished in general by providing arc chambers which individually encircle the contacts in comparatively close proximity thereto and by mounting them so as to be movable with the movable contacts of the switch. The improved construction permits the arc chambers to be made of light weight and of a sturdy form of structure that will effectively cool and quench the arc and permit the effective carrying away of the hot gases upwardly in their natural tendency to rise. The permissible proximity of the arc chambers to the contacts has the advantage of rapidly cooling the arc and heated gases and by reason of the fact that the chambers are movable with the movable contacts, there rises the advantage of exposing fresh arc barrier surfaces to the arc continuously during the opening movement of the contacts. Also, during the opening movement provision is made not only for the escape of hot gases upwardly but for providing free access of air to the bottom of the chambers so as to permit a free and enforced movement of the hot gases upwardly and permit them to escape through the top of the arc chambers to the outside atmosphere. The free upward passage of the hot gases is facilitated further by cutting away the lower parts of the arc chambers to permit free inward passage of air upwardly through the chambers and these cut-away portions of the chambers also permit entrance of the supports for the movable contacts while maintaining ample provision of arc quenching and cooling surfaces within the arc chambers; and the relationship of the parts is such that the arc is electromagnetically forced against the walls of the chambers which are opposite the cut-away portions which insures the effective cooling and quenching of the arcs by the arc barrier surfaces on the opposite side of the chambers from the cut-away portions. The arc chambers or shields are preferably made of metal as such material can effectively withstand the heating effects of the arcs without objectionable deterioration and the high thermal conductivity of metal assists in the cooling of the arc and the heated gases. Either magnetic material, such as iron or sheet steel, may be used for the arc chambers but non-magnetic material, such as brass likewise may be used. Also, the chambers may be made of other suitable material than metal which is adapted to effectively withstand the effects of the arcs and hot gases without objectionable deterioration of the exposed surfaces.

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Other objects and advantages of this invention will be understood from the following description and accompanying drawings which illustrate one embodiment of the invention.

Fig. 1 is a vertical central section in a plane at right-angles to the back of the switch; Fig. 2 is a top plan view with the connecting terminals shown in section; Fig. 3 is a horizontal section on the line 3—3 of Fig. 1; Fig. 4 is a horizontal section on the line 4—4 of Fig. 1; Fig. 5 is an enlarged side view, partly in section, of one of the fixed contacts; Fig. 6 is an enlarged perspective view of one of the arc chambers or shields; Fig. 7 is a vertical section on the line 7—7 of Fig. 1; and Fig. 8 is a horizontal section on the line 8—8 of Fig. 7.

The apparatus is supported by a frame or base of sheet metal having a general U-shaped form. The base of the U extends vertically and the two side portions extend forwardly from the base portion. The rear portion of the frame is corrugated for strength, the projecting ribs 1*a* which extend vertically along the back, being forced forwardly from the metal sheet before it is cut and bent to the desired form. At about the middle of the back portion, two of the ribs 1*a* are further pressed forwardly forming projecting ribs 1*b*, as shown in Figs. 1 and 4, for a purpose later explained. The back portion is provided with openings 1*c* at the top and bottom, as shown in Figs. 1 and 7, for the purpose of securing the frame to a supporting panel. The forwardly extending side portions 1*d* are provided

with a number of openings 1e as shown in Figs. 7 and 8 for the purpose of ventilation and accessibility during assembly, and in repair or adjustment of the parts. A number of projecting portions extend from the side portions and are bent inwardly at right-angles at the front of the frame for forming supports for various parts. A pair of these projections 1f, shown in Figs. 1 and 2, forms a support for a front plate 2 which may be utilized for supporting auxiliary control apparatus or parts and also serves another function to be described later. The plate 2 is also secured to a pair of inwardly turned projections 1g of the frame which extend vertically along a considerable portion of the frame. A pair of similar projections 1h are positioned below the projections 1g, as shown in Fig. 1, and serves, together with the projections 1g, to support another front plate 3 which may be utilized for supporting auxiliary control apparatus or parts. A pair of similar projections 1i from the frame are positioned below the projections 1h and serve to support another plate 4, the purpose of which will be later explained. The extensions 1g carry at their upper middle portions a pair of projections 1j, as shown in Figs. 1 and 3, which are curved inwardly and outwardly and serve a purpose later explained. They are opposite the projections 1b of the rear portion of the frame. The main frame and its various extensions and projections not only serve for supporting various parts but also accomplish other objects, as later described.

In describing the construction of the switch and the relationship and operation of its parts, the upper portion will first be described and the description continued by reference to the other parts in progressive steps downwardly. The fixed contacts and inter-connections thereto are supported by a block 5 of insulating material molded to the desired form. It extends horizontally across the upper portion of the switch and is supported at its sides by resting upon the side portions 1d of the frame, as shown in Fig. 7 and upon the front projection 1f as shown in Figs. 1 and 2. The front tie plate 2 is provided at its upper part with a pair of inwardly extending projections 2a which extend over the front edge of the insulating block 5 and thereby serves to hold the front portion of the block in fixed position. The rear portion of the block 5 is held in place by a cross-pin 6 which extends over the rear part of the block, as shown in Fig. 1. This pin extends through slots 1k in the side portions of the frame. The outer ends of the pins are formed with circumferential grooves which are engaged by spring clips 6a, as shown in Fig. 2, for preventing endwise movement of the pin. When it is desired to remove the block 5, it is merely necessary to remove one of the clips 6a and then move the pin 6 endwise a short distance so as to clear the inside of a side portion of the frame and then by raising the free end of the pin and after removing the other clip 6a, the pin can be withdrawn from the other side of the frame. The slots 1k permit this tilting and their final removal from either side of the frame as may be desired. Of course, the pin may be removed by pulling it out longitudinally after removing one of the pins 6a but where a number of these switches are stacked side by side closely in a row, the above described tilting method of removal of the pin can be accomplished even though another switch is mounted closely on each side. After removal of the pin the rear end of the block 5 is free to be raised from the frame and thus permit the front edge of the block to be withdrawn from under the clamping extensions 2a. Thus the insulating block 5 may be readily removed and replaced, together with the parts carried by it, for inspection, cleaning or adjustment of the parts.

The block or head 5 is provided on its upper surface with ribs 5a, as well shown in Fig. 7, which extend from front to back and also an upwardly extending rear cross-rib 5b, as shown in Fig. 1. These ribs are for the purpose of strengthening the block and for also separating the upper portions of the fixed contacts which portions lie in the valleys between the ribs. The fixed contacts are in the form of downwardly extending metal rods 7, the lower ends of which form the contacting faces of the fixed contacts which faces are preferably formed of silver, or alloys of silver, or other suitable material, for obtaining good contact surfaces. The upper ends of the contact rods or cylinders 7 are of reduced diameter and project upwardly through openings in the head 5, being secured to the head by washers and nuts 7a on the upper threaded ends of the contact rods. The upper ends of the contact rods are slotted so that they may be held by a screwdriver from turning while the clamping nuts 7a are turned tightly for locking the parts in fixed position. The lower portion of each fixed contact rod is encircled somewhat above its lower end by a ring 8 of insulating material, as shown in Fig. 1 and more particularly in Fig. 5. This insulating ring may be secured to the rod in any suitable manner but, as shown in Fig. 5, is held in place by spinning or upsetting a portion of the metal rod 7, as shown in Fig. 5, against the upper and lower inner edges of the insulating ring. This ring acts as a spacer on each fixed contact for preventing engagement with adjoining parts and likewise as a barrier, although permitting free escape of the gases upwardly around its outer rim. In the particular switch shown, there are twelve fixed contacts 7 in three rows of four each. The front and rear contacts of each row are adapted to be connected to the controlled circuit, or circuits, by terminal connections in the form of flat strips 8b which are bent to extend under the clamping nuts 7a and locking washers on the contact posts and are provided at their outer ends with screws 8a and locking washers for receiving the conducting leads. The inner two contact posts of each row are connected by a metal link 9 which lies on the top of the contact head and extends under the clamping nuts 7a and washers of the two contact posts. The two front contact posts of each row are adapted to be bridged by a movable contactor, as indicated in Fig. 1, and the two rear contact posts of each row are adapted to be bridged by a contactor. Thus the circuit may be traced from the outer terminal 8a of one row through the front contact post and bridging contactor to the second contact post and then through the link 9 to the next contact post and thence through the rear bridging contactor to the rear contact post and rear terminal 8a. When the circuit of each row is opened there are thus secured four breaks in the circuit in series with each other which tends to reduce the arcing at each contact. The provision of the terminals affords means for connecting the switch in any way desired to the outside circuit and by locating the links 9 at the top of the insulating head, they are conveniently accessible and removable if desired for replacement

by the connection of overload controlling devices between the inner terminals of the different rows, or by the connection of ammeters or other devices for particular purposes.

The movable contact assembly is formed of two separable blocks of molded insulating material which are securely clamped together for holding the various associated parts in place. The lower insulating block 10 extends horizontally between the side portions of the frame. The upper block 11 similarly extends horizontally between the side portions of the frame and is removably secured to the lower block by screws 12, well shown in Figs. 3 and 7, which pass vertically down through the upper block and lower block and have a threaded engagement at their lower ends with a channel shaped sheet metal strip 13 to be later described. The lower insulating block 10 is provided with a number of vertical openings 10*a* each of which is below and opposite the previously described fixed contacts. These openings are for the purpose of providing a free flow of air upwardly to and beyond the contacts to aid in extinguishing the arcs and in carrying away the hot gases. The upper block 11 of the movable assembly is provided with twelve cylindrical openings 11*a* which are opposite the contact posts 7 and these openings extend vertically downward and communicate with the openings 10*a* in the lower block 10, as well shown in Figs. 1 and 7. A cylindrical arc shield or barrier 14 is positioned within each of the openings 11*a* and each of these shields extend upwardly above the block 11 a short distance and the upper end of each shield surrounds the insulating ring 8 but is spaced therefrom to permit the free escape of gases upwardly between the shield and the insulating ring. The lower portion of each shield is cut away at 14*a* on one side, as particularly shown in Fig. 6 and a space 14*b* is left between the edges of the upper portion of the shield. The lower portion of the shield is flared outwardly at 14*c* and, as well shown in Fig. 1, the adjoining portions of the insulating blocks 10 and 11 are shaped to receive these flared portions of the shields so that when the two insulating blocks are clamped together by the screws 12, the shields 14 will be held in fixed position. Provision is also made for insuring that the shields are maintained in their proper positions with reference to the movable contacts. This is accomplished by forming vertical projections 11*b* on the insulating block 11 which project within the openings 11*a*, as shown in Fig. 3. The width of each projection 11*b* corresponds with the opening 14*b* of each shield and when the shield is passed into its opening in the insulating block, the vertical edges of the upper portion of the shield will engage the projection 11*b* and thereby insure that each shield is maintained in its proper position. The barriers or shields 14 may be formed of sheet metal and it should be noted that each of these shields is individually insulated from other portions of the apparatus. Metal shields are desirable owing to their ability to resist objectionable disintegration from effects of arcs; and either magnetic or non-magnetic metal may be used, such as iron or brass but the shields may be made of material other than metal which will retain its form and be capable of withstanding the effects of the arcs.

Each of the movable contacts bridges a pair of fixed contacts, as shown in Fig. 1, and is in the form of a sheet metal channel piece 15, as well shown in Fig. 7 and is preferably made of copper; and this channel piece carries at each end a

contact 15*a* which is securely fastened to the piece 15 as by riveting or otherwise. These contacts are preferably formed with a face of silver or silver alloy for insuring good contact with the fixed contacts when engaging them. Each of these bridging movable contact assemblies extends through the cut-away portions 14*a* of a pair of shields so that the contact faces are centrally positioned within the shields and opposite a pair of fixed contacts, as shown in Fig. 1. Each bridging contact is kept in proper alignment by a contact guide 16 in the form of a metal strip of rectangular form, as shown in Figs. 1 and 3. The lower end of each of these guiding strips is knurled or roughened and is forced into an opening in the insulating block 10 so as to be firmly retained in position by the block 10. The strips are secured in position in the block 10 before the block 11 is fastened thereto; and the openings formed in the insulating block 11 for reception of the upper ends of these strips are of sufficient size to freely receive the upper ends of the strips in assembling the parts. Each bridging piece 15 of the movable contacts is provided with a central slot of the same form as the cross section of the strip and is adapted to freely move along the guiding strip. A spring 17 encircles each guiding strip 16 and one end of the spring is positioned below each of the bridging pieces 15 while the other end seats in an opening formed in the insulating block 10.

The movable contact assembly, as previously described is composed of two separable blocks of molded insulation fastened together and they support and carry the arc barriers or shields as well as the spring pressed bridging contacts. The fastening screws 12 serves as a common means, not only for holding the insulating blocks 10 and 11 together, but by engaging the metal piece 13 of U form, serve to hold all parts of the movable contact head together.

The parts are shown in the open position of the switch and when the part 13 is moved upwardly upon the energization of the magnet, the movable contact assembly including the arc chambers or shields 14, is moved upwardly and thereby cause the bridging movable contacts to engage their respective pairs of fixed contacts 7. After initial engagement and upon further upward movement of the parts, the movable bridging contacts are forced downwardly by their engagement with the fixed contacts along the guiding strips 16 against the pressure of the springs 17. As the bridging contacts have a certain freedom of movement on the guiding strips, they are self-adjusting so that the pressure of the movable contacts against the fixed contacts is equalized, thereby insuring proper engagement and sufficient contact pressure of each movable contact with its fixed contact. Also, by reason of the movable contact assembly being pivotally connected, as hereinafter explained with the actuated portion of the magnet, the movable contact head is capable of movement as a whole so as to be self-adjusting in relation to the fixed contacts in order to further insure equalization of contact pressure in all parts.

When the magnet is deenergized for opening the switch, the pressure of the contacts and the springs 17 together with the weight of the parts, force the movable contact head downwardly with a quick opening movement. In this opening action the arc barriers are, of course, moved downwardly with the movable contact head and this action results in constantly bringing fresh sur-

faces of the shields opposite the arcs and thereby aid in cooling and extinguishing them. Furthermore, by bringing new surfaces opposite the arcs, the arc chambers are less subject to deterioration from effects of the arcs, as compared with fixed arc barriers where the arcing effects are concentrated on the same portions of the barriers. Also, the free spaces between the arc chambers and the fixed contacts and around the insulating rings 8 provide open passages for the free flow of the hot gases upwardly in their natural tendency of movement and out through the top of the chambers, this free passage of the hot gases upwardly and outwardly being assisted by the free inflow of air through the openings 10*a* below each of the contacts. The arc chambers also serve to cool the hot gases as they pass freely upwardly and out from the chambers. The cut-away portions of the chambers for the purpose of permitting the introduction of the movable contacts and of the bridging elements carrying them, do not lessen the effectiveness of the structure in extinguishing the arcs because, with reference to each pair of contacts, the current passes through a loop formed by one fixed contact, the bridging contacts and the other fixed contact which results in forcing the arcs outwardly from the loop always against the portions of the chambers which are not cut away. The cut-away portions of the chambers serve also to facilitate the inward passage of air to the chambers to aid in the upward and outward passage of the hot gases through the chambers.

The function of the inwardly pressed projections 1*b* from the rear of the main frame and of the projections 1*j* at the front portion of the frame on opposite ends of the movable contact head is for restraining the movement of the head under shocks and jars. The movable head is normally guided in its movement by parts hereinafter described but the projecting portions referred to serve as restraining means under unusual or severe conditions for preventing the movable head being jolted to an abnormal position, as one of the purposes of this improved switch is for adaptation to withstand severe shocks and jars as, for example, when used on naval vessels.

The magnet core actuating the switch to closed position is composed of two similar laminated parts and on account of the fact that the part corresponding to the usual fixed part is movable for the purpose of securing self-alignment and self-adjustment, it will be referred to herein as the non-actuated part of the magnet and the other part as the actuated part of the magnet. Each part is built up of laminations of general E form and the laminae of each part are of the same size and shape which simplifies the stocking problem and the cost of assembly. The faces of the ends of the three legs of the E are ground, after assembly of the core parts, to lie in the same plane; and when the parts are in their attracted position, there is no air gap between the engaging faces of the core portions. This not only simplifies the cost of manufacture by permitting the grinding of the engaging faces by one operation in the same plane but the omission of any air gap results in the advantages of lower volt-ampere input to the magnet coil, uniformity of coil inductance and a slight time delay before actuation of the switch to open position, due to higher residual magnetization and higher induced secondary currents in the iron core, the last named advantage being particularly desirable in overcoming the opening of the switch when the circuit of the magnet coil is momentarily

opened at auxiliary control contacts by severe shocks on the apparatus.

Referring to Fig. 1, the three-legged form of the laminae 18 of the non-actuated portion of the magnet is shown as having the legs extending vertically downward and the three-legged laminae 19 of the actuated portion of the magnet is shown with its legs extending upwardly and, as already explained, the engaging faces of the legs are ground, after assembly, in the same plane so as to insure uniform good surface contact. The end plates 18*a* of the non-actuated portion of the magnet core are shown in Fig. 4 as provided at each end with angular extensions 18*b* which project rearwardly and forwardly. These extensions respectively engage sheet metal brackets 20 which are bent to a desired shape, as shown, and provided with side portions 20*a* by which they are securely fastened to the side portions of the main frame by the screws 20*b*. The projections 18*b* from the end plates loosely engage vertical slots 20*c* in the cross brackets 20 so as to permit considerable freedom of movement of the non-actuated portion of the magnet in all directions for the purpose of self-adjustment, as later explained, but is, of course, restrained by the slots from assuming extreme or abnormal positions. In assembling the core of the non-actuated portion of the magnet, the end plates 18*a* having the projections 18*b* are permanently fastened to the laminae, as by riveting, and the pole faces afterwards ground. This eliminates possible distortion of the parts which might occur if the end plates or their supporting extensions were attached after grinding. The magnet coil 21 is carried by a spool 21*a* of insulating material and is held in place, as shown in Fig. 7 by a U-shaped strip 25 of metal, the base of the U passing over the top of the laminae 18 and the legs extending downwardly inside the magnet coil. The supporting strip 23 is provided with outwardly extending projections 23*a* at the lower ends of the legs which pass under and support the magnet coil.

The actuated portion of the magnet comprising the laminae 19 is provided with end plates 19*a* which extend along opposite sides of the laminae and are bent at right-angles, as shown in Fig. 8, to pass inwardly over the ends of the laminae and again bent outwardly at right-angles to form extensions 19*b*. These end extensions are spaced from each other for receiving the driving rods 24 which latter are connected for actuation of the movable contact head. At the front portions of the end plates 19*a* is secured a pair of angular pieces 25 which are bent at right-angles so as to extend toward the side portions of the main frame as shown in Fig. 8. In assembling the core structure of the actuated part of the magnet, the end plates 19*a* and the angular pieces 25 are permanently fastened together and to the laminae as by riveting the parts, after which the pole faces of this portion of the magnet are ground in a single operation in the same plane. This avoids possible distortion of this portion of the magnet which otherwise might occur if the end plates or pieces 25 were attached to the laminae after the grinding operation.

There are two drive rods 24, one in the back and one in the front portion of the apparatus, for connecting the actuated portion of the magnet with the movable contact head. These rods are of square cross section, as shown in Fig. 4, and are pivotally connected by pins 24*a* between the extensions 19*b* of the end plates, as shown in

Fig. 8. The drive rods extend upwardly from these pivotal connections and are loosely guided in their movement by the two brackets 20, as shown in Fig. 4, these brackets being bent at their middle portions to form vertical guiding channels for the rods. The upper ends of the rods are riveted, or otherwise firmly secured to the ends of a metal strip or yoke 26 of channel form, the bent side portions extending upwardly, as shown in Fig. 7. These side portions fit freely within the downwardly extending side portions of the strip or yoke 13 which has been previously described as being fixed to the movable contact head by the screws 12. The two yoke pieces are pivotally connected together at their middle portions by a pin 27, as shown in Figs. 1 and 7.

Thus the actuated portion of the magnet is not only pivotally connected to the drive rods but there is also a pivotal connection between the yoke of the drive rods and the yoke of the movable contact head. This gives a flexibility of movement between the parts and provides for the self-adjustment and alignment of the parts for insuring the proper seating of the pole faces of the magnet and aids in the proper seating and balancing of pressure of the contacts. The axes of these pivotal connections are at right-angles to the side plates of the main frame and to the bridging movable contacts for permitting self-adjustment of the parts in planes perpendicular to the back portion of the main frame; and the slight looseness of the connections permits sufficient freedom of movement for adjustment in the direction of planes parallel to the back portion of the main frame.

Also, instead of providing a heavy main supporting frame in the attempt to secure rigidity of the non-actuated part of the magnet in a fixed position, the non-actuated part of the magnet is mounted, as already described, so as to be movable with reference to the supporting frame and movable with reference to other parts of the switch for securing proper alignment and engagement of the parts by self-adjustment. This avoids the time and expense otherwise required to machine the parts to close clearances and likewise avoids the time and care required in making refined adjustments after the assembly of the parts. Furthermore in the prior rigid and attempted perfectly aligned structures, the alignment is not permanent, especially when subjected to severe shocks, owing to the distortion of the parts which inevitably follows pronounced shocks and jars. In the present form of construction the free floating and self-adjustment of the parts with reference to each other insures permanent and proper relationship of the parts which is not affected by distortion of the main support or other parts of the apparatus. Moreover, with this improved structure the proper seating and self-alignment of the parts give continued quiet operation when energized and in fact becomes more quiet with continued use owing to continued improvement in the surface engagement of the parts the longer the switch is used.

In assembling this improved structure, the parts are connected together as described except that the screws 20b which hold the cross-brackets 20 to the main frame are left to loosely engage the parts until after the magnet is energized when the screws 20b are tightened up gradually in succession a little at a time until they are all uniformly tight. In this manner the best relative position of the parts is secured for insuring a uniform and balanced engagement of the parts in proper alignment and insures a minimum noise level in later use after the magnet is energized.

The usual lag loop or coil is provided within the faces of one or more poles of the magnet and in the present structure this is preferably in the form of a rectangular copper loop 28, as shown in plan view in Fig. 8 and held in place by upsetting portions of the edges of the laminae over the loop. As shown in Fig. 1, one of these lag loops is provided on the outer pole face of the nonactuated portion of the magnet, while the other of the lag loops is provided on the face of the inner pole of the actuated portion of the magnet. This relative arrangement insures that at least one of the two engaging faces of each pole of the magnet will be a solid, smooth face and thereby avoid distortion or unevenness of the pole faces under continued use. These lag loops are applied to and secured in place on the two portions of the magnet before the final grinding operation of the pole faces.

Special additional provision is made for preventing undesired opening or closing of the switch when subjected to severe vertical shocks or to vertical components of shocks. This is accomplished by the provision of inertia controlled latches, the operation of which is dependent upon change of motion of the entire structure. One of the latches is for preventing the switch from closing under severe shocks and the other is for preventing the switch from opening under severe shocks. One of these inertia latches is shown in the lower right-hand portion of Fig. 1. It comprises a weighted body portion 29 which extends across the lower front portion of the main frame, as shown in Fig. 8, and is provided with a latch 29a at each end which extends upwardly and is provided with an inwardly projecting hooked end. These two ends of the latches are normally positioned, as shown in Fig. 1, somewhat above and in front of the angular pieces 25 secured to the actuated portion of the magnet core. The two latches are pivoted on a pin 30 which is supported at its ends in the side portions of the main frame. The weighted portion 29 of the latch being positioned outwardly from the pin 30, tends to maintain the latches in the position shown in Fig. 1 out of engagement with the angular pieces 25. An adjustable screw 31 mounted on the tie-plate 4 limits the outward movement of the latches. The radius from the axis of the pin 30 to the center of gravity of the mass 29 is shorter than the distance from the axis of the pin 30 to the hooked ends of the latches. It follows that any movement of the mass 29 about its pivot is amplified in the movement of the hooked end of the latch in proportion to their relative distances from the pivot pin. Under normal conditions the latches are out of engagement with the angular pieces 25 and thus energizing of the magnet coil will permit the switch to be closed in the manner already described. But if the switch is in the open position and the apparatus is subjected to a severe vertical shock, or to the vertical component of such a shock, the actuated portions of the switch might move with relation to the fixed contacts and result in an undesired closing of the switch. However, before this can occur, the mass 29 will move upwardly and by the amplification of movement referred to, the hooked ends of the latches will be rapidly moved inwardly and engage the angular pieces 25 before the switch can close and

thereby restrain and prevent the closing of the switch. After the passing of the shock the inertia latch will fall to its normal position so that the switch will be free to close upon energization of its magnet.

A similar inertia latch or stop prevents the undesired opening of the switch under severe vertical shocks by a reverse manner of operation. A mass **32** is positioned at the lower central portion of the switch, as shown in Fig. 1, and extends crosswise between the side portions of the main frame. The mass is provided near its ends with supporting plates **32***a* which are pivotally mounted upon a pin **33** which extends between and is supported by the side portions of the main frame. Between the extensions **32***a* is a cross-bar **32***b*, the upper portion of which is notched at **32***c*. A spring **34** is connected at one end to the weight **32** and at its other end to the pin **30** for normally holding this shock preventing means in the position shown in Fig. 1. The mass **32** is provided with extensions **32***d* as shown in Fig. 7 which normally engage the lower edges of the side portions of the main frame for limiting the upward movement of the restraining means to the position shown in Fig. 1. When the switch is closed, the lower inside corner of the actuated portion of the core is positioned opposite and above the notch **32***c* of the inertia latch. When the apparatus is subjected to a severe vertical shock, or to a vertical component thereof, when the switch is closed, the opening of the switch is prevented because any tendency to open the switch will cause the mass **32** to move downwardly and due to the amplified relative movement of the notch **32***c* by reasons of its distance from its axis from the pin **33** being greater than the distance from its axis to the center of gravity of the mass **32**, the notched portion **32***c* will move under the lower inside corner of the actuated core portion of the switch before the switch has had time to open. This action will prevent the opening of the switch until the full effects of the shock or shocks have passed, after which the spring **34** will move the restraining means to the normal position shown in Fig. 1 where it will permit the normal opening of the switch when desired.

Although a particular embodiment of this improvement has been shown and described, various modifications may be made therein for adaptation to particular requirements without departing from the scope of the invention.

I claim:

1. An electric switch comprising a fixed insulating support, a contact carried thereby and extending downwardly therefrom, a vertically movable insulating support below said fixed contact, a contact carried by said movable insulating support and adapted to engage said first named contact upon the upward movement of said movable insulating support, a vertically extending arc shield surrounding and spaced from said contacts throughout the length of the shield and fixed at its lower end to said movable insulating support and having openings at both of its ends, said movable support having an opening opposite the lower end of said arc shield for the free passage of gases therethrough and upward through the space between the arc shield and the contacts for extinguishing the arc upon the opening of the switch, and the downward movement of said insulating support and of said arc shield exposing fresh surfaces of the interior of said arc shield to the effects of the arc during the separation of the contacts in the opening movement.

2. An electric switch comprising a fixed insulating support, a contact carried thereby and extending downwardly therefrom, a vertically movable insulating support below said fixed contact, a contact carried by said movable insulating support and adapted to engage said first named contact upon the upward movement of said movable insulating support, a vertically extending arc shield of metal surrounding and spaced from said contacts throughout the length of the shield and fixed at its lower end to and insulated by said movable insulating support and having openings at both of its ends, said movable support having an opening opposite the lower end of said arc shield for the free passage of gases therethrough and upward through the space between the arc shield and the contacts for extinguishing the arc upon the opening of the switch, and the downward movement of said insulating support and of said arc shield exposing fresh surfaces of the interior of said arc shield to the effects of the arc during the separation of the contacts in the opening movement.

3. An electric switch comprising a fixed insulating support, a pair of contacts carried thereby and extending downwardly therefrom, a movable insulating support, a pair of contacts connected by a bridge and carried by the movable insulating support for engaging the first named pair of contacts respectively upon the upward movement of the movable insulating support, a pair of arc shields carried by said movable insulating support, each of said shields having a top opening, said shields surrounding each pair of the engaging contacts respectively and spaced therefrom throughout the length of each shield for providing an intervening air space between the shields and the contacts for permitting the free passage of gases from the arc therethrough, each of said shields having a side opening opposite the side opening of the other shield for receiving the bridge connection of said second pair of contacts and for permitting the free passage of air to the shields and around the contacts and through said top openings for extinguishing the arc upon the opening of the switch, and means for actuating said movable insulating support for closing and opening the switch and for exposing fresh surfaces of the interior of said arc shields to the effects of the arc during the separation of the engaging contacts by the downward movement of said movable insulating support in opening the switch.

4. An electric switch comprising a fixed insulating support, a pair of contacts carried thereby and extending downwardly therefrom, a movable insulating support, a pair of contacts connected by a bridge and carried by the movable insulating support for engaging the first named pair of contacts respectively upon the upward movement of the movable insulating support, a pair of arc shields of metal carried by said movable insulating support and insulated thereby, each of said shields having a top opening, said shields surrounding each pair of the engaging contacts respectively and spaced therefrom throughout the length of each shield for providing an intervening air space between the shields and the contacts for permitting the free passage of gases from the arc therethrough, each of said shields having a side opening opposite the side opening of the other shield for receiving the bridge connection of said second pair of contacts and for

permitting the free passage of air to the shields and around the contacts and through said top openings for extinguishing the arc upon the opening of the switch, and means for actuating said movable insulating support for closing and opening the switch and for exposing fresh surfaces

of the interior of said arc shields to the effects of the arc during the separation of the engaging contacts by the downward movement of said movable insulating support in opening the switch.

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