June 12, 1945. G. M. STAPLETON 2,378,162

ELECTRIC SWITCH

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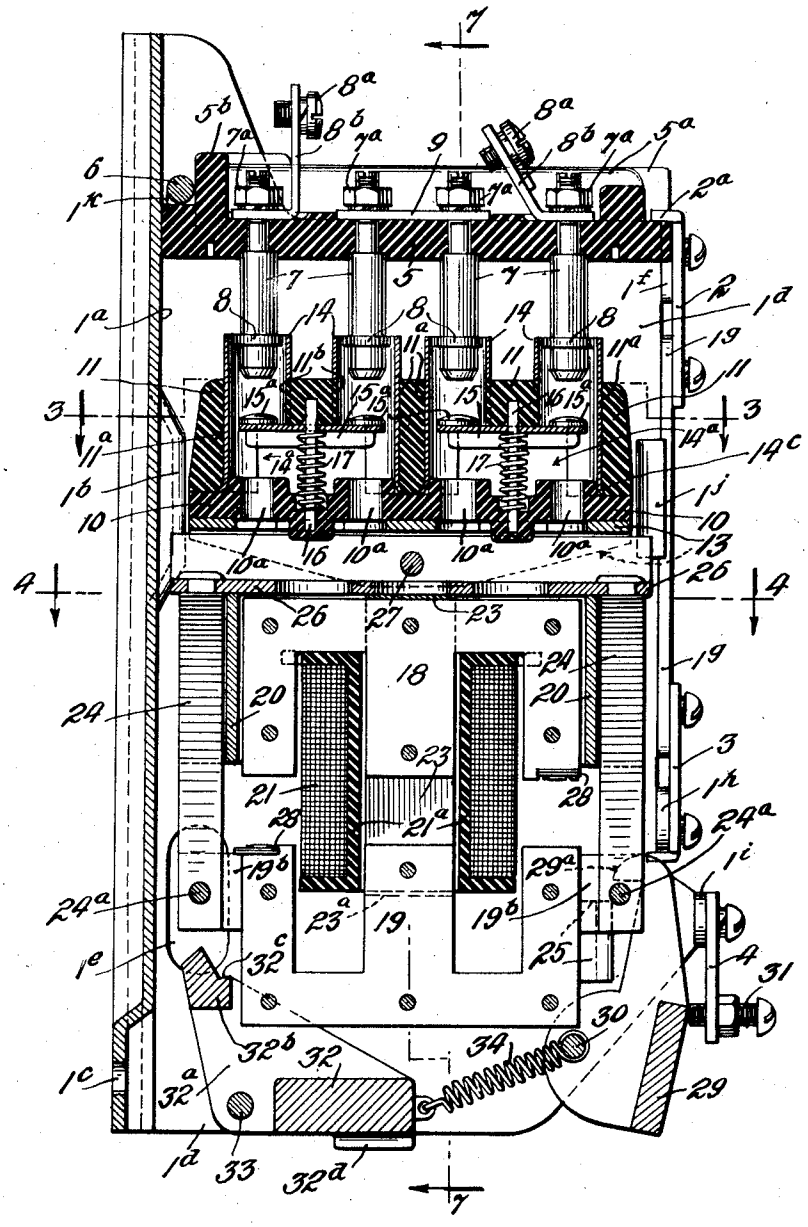


Fig. 1.

Inventor

George M. Stapleton

By Lawrence K. Sager

his Attorney

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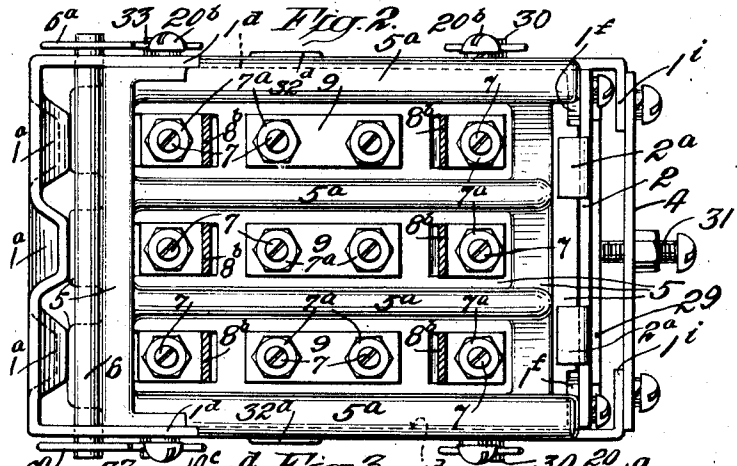


Fig. 2.

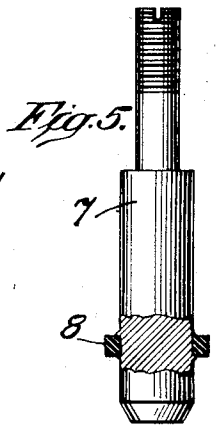


Fig. 5.

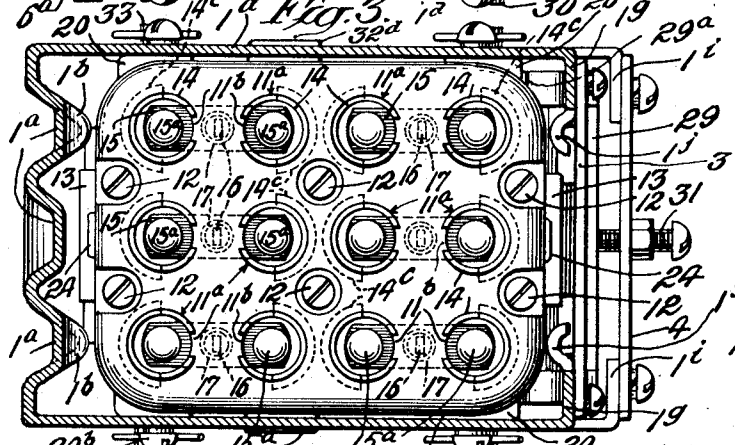


Fig. 3.

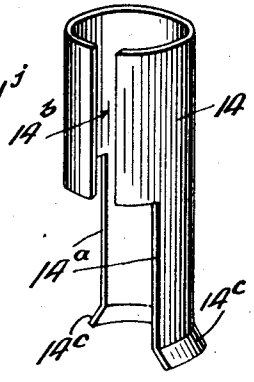


Fig. 6.

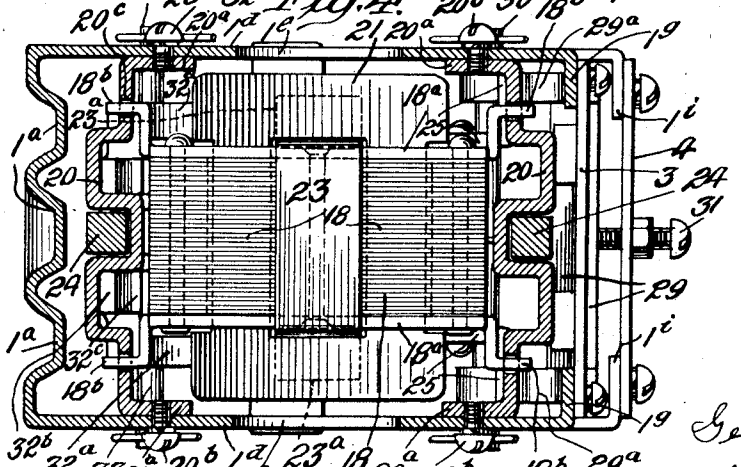


Fig. 4.

Inventor

George M. Stapleton

By Lawrence K. Sager

his Attorney

June 12, 1945. G. M. STAPLETON 2,378,162

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Fig. 7.

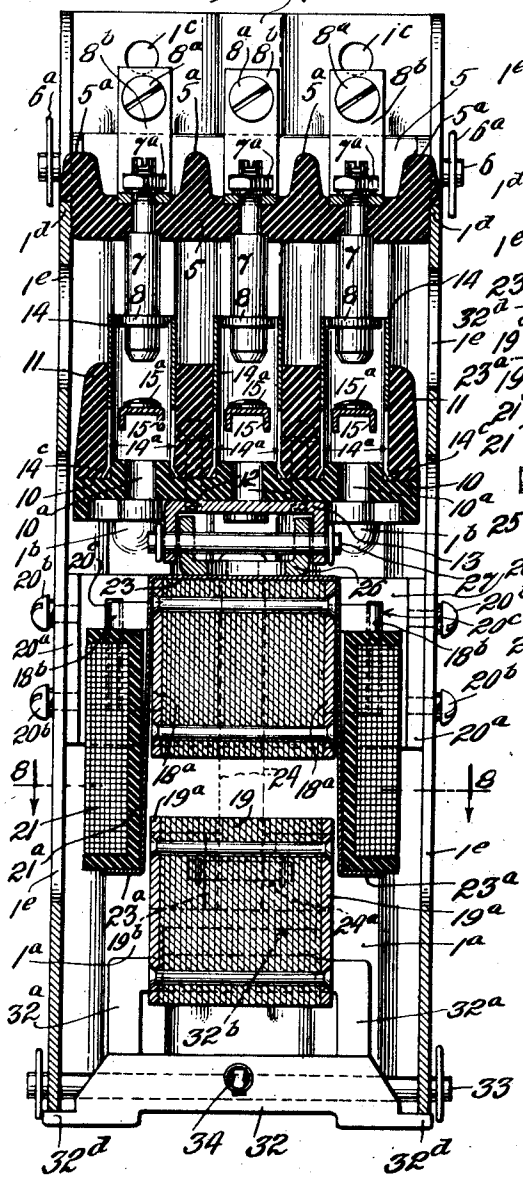
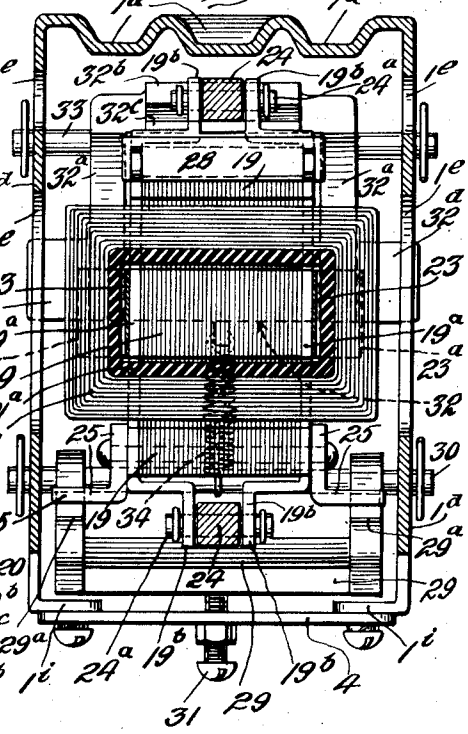


Fig. 8.



Inventor

George M. Stapleton

By Lawrence K. Sager

his Attorney

Patented June 12, 1945

2,378,162

# UNITED STATES PATENT OFFICE

2,378,162

## ELECTRIC SWITCH

George M. Stapleton, New York, N. Y., assignor to Ward Leonard Electric Company, a corporation of New York

Application November 25, 1941, Serial No. 420,327

5 Claims. (Cl. 200—104)

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 Frank G. Logan and are described and claimed in his pending United States application Serial No. 417,990, filed November 6, 1941.

Certain disclosures of this application not claimed herein are covered in a divisional application of this case, Serial No. 446,324, filed June 9, 1942.

The improvements described and claimed herein relate to features of construction of various parts and their relationship to each other for the general object of obtaining a compact form of switch which may be conveniently manufactured and assembled and be durable and dependable under long continued use. One particular object is to provide a supporting frame which may be simply formed and serve a number of different functions and also to avoid the necessity and expense of machining the parts to close clearances. It is adapted to conveniently support at its upper portion the fixed contact head so that it is readily removable together with the fixed contacts for inspection, renewal or cleaning of the parts. The frame likewise serves to restrain the movable contact head from abnormal displacement under severe shocks, one of the objects of this improvement being to provide a switch which will withstand severe shocks and jars. Another object is to support the non-actuated portion of the magnet in a simple manner by parts in such relation to the main frame as to permit it to be movably self-adjusting upon closing the switch; and a further object is to so relate the parts which loosely support the non-actuated portion of the magnet to the actuated portion of the magnet in a manner that such parts will also serve as guiding means for permitting freedom of movement and self-adjustment of the actuated portion of the magnet during the closing action. Another object is to provide a supporting frame which is so formed as to be of light weight and occupy small space while insuring sufficient strength and stiffness of the parts.

Another object is to relate the actuated portion of the magnet to the driving connection of the movable head so that such portion has relative movement with reference to the driving connection for the purpose of aiding in the self-alignment of the parts and avoiding unnecessary strains on the parts during and after the closing action of the switch.

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 *1a* 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 *1a* are further pressed forwardly forming projecting ribs *1b*, as shown in Figs. 1 and 4, for a purpose later explained. The back portion is provided with openings *1c* 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 *1d* 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 1*h* and serve to support another plate 4, the purpose of which will be later explained. The extensions 1*g* carry at their upper middle portions a pair of projections 1*j*, as shown in Figs. 1 and 3, which are curved inwardly and outwardly and serve a purpose later explained. They are opposite the projections 1*b* 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 1*d* of the frame, as shown in Fig. 7 and upon the front projection 1*f* 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 2*a* 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 1*k* in the side portions of the frame. The outer ends of the pins are formed with circumferential grooves which are engaged by spring clips 6*a*, 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 6*a* 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 6*a*, the pin can be withdrawn from the other side of the frame. The slots 1*k* 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 6*a* 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 2*a* after first loosening the screws holding the plate 2. 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 5*a*, as well shown in Fig. 7, which extend from front to back and also an upwardly extending rear cross-rib 5*b*, 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 7*a* 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 7*a* 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 8*b* which are bent to extend under the clamping nuts 7*a* and locking washers on the contact posts and are provided at their outer ends with screws 8*a* 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 7*a* 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 8*a* 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 8*a*. 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 11a which are opposite the contact posts 7 and these openings extend vertically downward and communicate with the openings 10a 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 11a 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 14a on one side, as particularly shown in Fig. 6 and a space 14b is left between the edges of the upper portion of the shield. The lower portion of the shield is flared outwardly at 14c 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 11b on the insulating block 11 which project within the openings 11a, as shown in Fig. 3. The width of each projection 11b corresponds with the opening 14b 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 11b 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 15a 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 14a 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 serve 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 surfaces 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 10a 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 extin-

guishing 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 imput 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 auxiliarly 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 23 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 **20***b* 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 **20***b* 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 non-actuated 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 **29***a* 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 with reference to the pivot 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 plate **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 32d 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 32c 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 overcoming the tension of spring 34 and due to the amplified relative movement of the notch 32c by reason 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 32c 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 vertically extending side supports, a fixed insulating contact head supported at the upper portion of said supports, a movable insulating contact head, an electromagnet having an actuated portion and a non-actuated portion, cross bracket secured to and extending between said supports at their front and rear portions respectively, means for loosely supporting the non-actuated portion of the magnet by said cross brackets to permit movement in all directions of the non-actuated portion of the magnet with reference to the brackets, and mechanical driving means connecting the actuated portion of the magnet to said movable contact head.

2. An electric switch comprising vertically extending side supports, a fixed insulating contact head supported at the upper portion of said supports, a movable insulating contact head, an electromagnet having an actuated portion and a non-actuated portion, cross brackets secured to and extending between said supports at their front and rear portions respectively, means for loosely supporting the non-actuated portion of the magnet by said cross brackets to permit movement in all directions of the non-actuated portion of the magnet with reference to the brackets, and mechanical driving means connecting the actuated portion of the magnet to said movable contact head, said brackets being formed to loosely guide said driving means.

3. An electric switch comprising vertically extending side supports, a fixed insulating contact head supported at the upper portion of said support, a movable insulating contact head, an electromagnet having an actuated portion and a non-actuated portion, cross brackets secured to and located between said supports at their front and rear portions respectively, means for loosely supporting the non-actuated portion of the magnet by said cross brackets to permit movement in all directions of the non-actuated portion of the magnet with reference to the brackets, and mechanical driving means comprising two upwardly extending drive rods connecting the actuated portion of the magnet to said movable contact head, said brackets being formed to loosely guide said drive rods respectively.

4. An electric switch comprising a frame having vertically extending side supports, a fixed insulating contact head supported at the upper portion of said supports, a movable insulating contact head, an electromagnet having an actuated portion and a non-actuated portion, cross brackets secured to and extending between said supports at their front and rear portions respectively, means for loosely supporting the non-actuated portion of the magnet by said cross brackets to permit movement in all directions of the non-actuated portion of the magnet with reference to the brackets, and mechanical driving means connecting the actuated portion of the magnet to said movable contact head, said frame having projecting portions for restraining said movable head from abnormal displacement.

5. An electric switch comprising a frame having vertically extending side supports, a fixed insulating contact head supported at the upper portion of said supports, a movable insulating contact head, an electromagnet having an actuated portion and a non-actuated portion, cross brackets secured to and extending between said supports at their front and rear portions respectively, means for loosely supporting the non-actuated portion of the magnet by said cross brackets to permit movement in all directions of the non-actuated portion of the magnet with reference to the brackets, and mechanical driving means connecting the actuated portion of the magnet to said movable contact head, said brackets being formed to loosely guide said driving means, said frame having projecting portions for restraining said movable head from abnormal displacement.

GEORGE M. STAPLETON.